Biological Opinion and Informal Consultation of the U.S. Fish and Wildlife Service for the Proposed Continuing Operations at Kōkeʻe Air Force Station and Microwave Antenna Site, Island of Kauaʻi

Photo Credit: Kristen Rex, CSU CEMML

February 14, 2017
(01EPIF00-2016-F-0497)

TABLE OF CONTENTS

CONSULTATION HISTORY…..……2

Description of the Proposed Action…….8
Project Description……..8
Conservation Measures to Avoid and Minimize Effects to Listed Species……9

Action Area……...17

Analytical Framework for the Jeopardy/Adverse Modification Analyses…….19

Status of the Species……19
Status of the Newell's Shearwater…….19
Status of the Hawaiian Petrel…….32
Status of the Band-Rumped Storm Petrel……..38

Environmental Baseline of the Newell's Shearwater, Hawaiian Petrel, and the Band-Rumped Storm-Petrel……41
Previous Consultations in the Action Area……45

Effects of the Action……46
Exposure Analysis Approach…….46
Effects to Newell's Shearwater, Hawaiian Petrel, and Band-Rumped Storm-Petrel...……47

Cumulative Effects……...51

Conclusion……51

INCIDENTAL TAKE STATEMENT……...51

AMOUNT OR EXTENT OF TAKE……..52

Effect of the Take……52

Reasonable and Prudent Measures……52

Terms and Conditions……53

CONSERVATION RECOMMENDATIONS……...53

REINITIATION-CLOSING STATEMENT……54

LITERATURE CITED…….....55

APPENDICES……..66

Appendix A. Informal Consultation for the Hawaiian Hoary Bat and Hawaiian Goose...……..A-1

Appendix B. Building Exterior and Perimeter Lighting Inventory at Kōkeʻe AFS, 2015.....……..B-1

Appendix C. Walking Path Bollard Light Model Design Proposed by the USAF for Usage at Kōkeʻe AFS.……...……...……C-1

Appendix D. Seabird Monitoring and Predator Control Work Plan……..D-1

LIST OF FIGURES

Figure 1. Light Sources at Kōkeʻe Air Force Station, Kauaʻi, 2015.....13
Figure 2. Proposed Bollard Lighting Walking Path at Kōkeʻe AFS.....14
Figure 3. Proposed Bollard Light Model 14
Figure 4. Map of Action Area Showing Kōkeʻe AFS and Newell's Shearwater Breeding Distribution in the Action Area.....18
Figure 5. A Comparison of the Historic and Current Breeding Range for the Newell's Shearwater.....21
Figure 6. Regression line showing mean movement rates of adult Newell's shearwaters during their incubation and early chick-rearing stage for all 13 radar sites surveyed, 1993-2013.....25
Figure 7. Map of Kauaʻi Showing Newell's Shearwater Breeding Colony Locations.....25
Figure 8. Map of Modern and Historic Breeding Range of the Hawaiian Petrel 33
Figure 9. All Recorded Fallout on Kōkeʻe AFS, Attributed to Each Night, Since First Bird Reported (September 1 to 14, 2015).....44

LIST OF TABLES

Table 1. Summary of Conservation Measures and Schedule and Frequency of Implementation…. 10
Table 2. Reproductive Success Rates for Newell's Shearwater Breeding Pairs (*n*) 26
Table 3. Status of All Known Extant Hawaiian Petrel Breeding Colonies. 35
Table 4. Known Take of Federally Listed Seabirds at Kōkeʻe AFS, Prior to Issuance of 2011 BO…. 42
Table 5. Known Take of Seabirds at Kōkeʻe AFS, After Issuance of 2011 BO.....43
Table 6. Estimated Predation Offset 50

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawai'i 96850

In Reply Refer To:
01EPIF00-2016-F-0497

FEB 2 8 2017

Lt. Col. Jeremiah J. Hammill
Commander
Department of the Air Force
Pacific Air Forces
611th Civil Engineer Squadron
10471 20th Street, Suite 302
JBER, Alaska 99506-2201

Subject: Biological Opinion and Informal Consultation for the United States Air Force Pacific Air Forces Regional Support Center Proposed Continuing Operations at Kōke'e Air Force Station and Microwave Antenna Site, Island of Kaua'i

Dear Lt. Col. Hammill:

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) based on our review of the United States Air Force Pacific Air Forces Regional Support Center (USAF) proposed continuing operations at Kōke'e Air Force Station (AFS) and Microwave Antenna Site (MAS), on the island of Kaua'i, and its effects on the federally threatened Newell's Shearwater (*Puffinus auricularis newelli*), endangered Hawaiian Petrel (*Pterodroma sandwichensis*), and the endangered Hawai'i population (distinct population segment (DPS)) of the band-rumped storm-petrel (*Oceanodroma castro*) in accordance with section 7 of the Endangered Species Act of 1973 as amended (Act) (16 U.S.C. 1531 *et seq.*). Your request for formal consultation was received on August 11, 2016.

A separate informal consultation is found in Appendix A for project impacts that may affect but are not likely to adversely affect the federally endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) and endangered Hawaiian goose (*Branta sandvicensis*).

This biological opinion is based on information provided in: (1) the August 11, 2016, Biological Assessment (BA) for your proposed project; (2) email and verbal communication between the USAF staff and our office; (3) survey and reports; and (4) other information available to us. A complete administrative record of this consultation is on file in our office. Our log number for this consultation is 01EPIF00-2016-F-0497.

CONSULTATION HISTORY

The Service has been working with the USAF to assist in the conservation and management of listed species. Correspondence applicable to the completion of conservation measures and other consultation requirements after issuance of the 2011 BO is not discussed below. The following represents a detailed chronology of actions and correspondence applicable to beginning work on this BO.

August 7, 2015 – The Service received information regarding one dead Newell's shearwater and one dead Hawaiian petrel at Kōkeʻe AFS. Both birds had brood patches and were transmitted to the Waimea Fire Station and later received by the Kauaʻi Humane Society – Save Our Shearwaters Program (SOS).

August 11, 2015 – The Service received information regarding another Hawaiian petrel found dead at Kōkeʻe AFS.

August 27, 2015 – The Service emailed the USAF requesting follow up information regarding the August 7 and 11 fallout reports.

August 31, 2015 – The USAF emailed the Service regarding interest for a site visit during the migratory bird and fallout refresher training for the staff at Kōkeʻe AFS. It was arranged for October 2, 2015, to allow for the widest information dissemination of training refresher for staff.

September 2, 2015 – The SOS updated the Service on total birds received by the Kōkeʻe AFS: two Hawaiian petrels (one dead, one alive) and 10 Newell's shearwaters (one dead, nine alive). The Service informed, via email, the USAF of the updated information.

September 2, 2015 – The USAF emailed their downed bird log report to the Service. Records included all endangered species from February 26, 2013 to September 1, 2015. A total of 12 fallouts (identified all as Newell's shearwaters by Kōkeʻe AFS point of contact) was documented during thick fog events on the night of September 1. The USAF requested initiation of dialogue regarding the use of lasers or other light emitting devices to identify "lines" on property. The Service requested more detailed information regarding conditions of the station during the fallout. The USAF provided more information regarding the fog and green lighting conditions, as well as the timing of fallouts throughout the night.

September 8, 2015 – The USAF emailed an update to their downed bird log report to include one live Newell's shearwater downed on September 5. The USAF also updated the Service on additional information regarding facility lighting conditions and the request for staff to replace any missing window blinds.

September 9, 2015 – The Service received an unofficial phone update and emailed the USAF that 26 birds were downed at Kōkeʻe on September 8: all were breeding adults (10 dead and 16 alive in various conditions). We requested the USAF to get personnel on site to evaluate and shut off all non-essential lights prior to the Service October 2 site visit.

September 9, 2015 – The Service received an email from the SOS stating that 22 Newell's shearwaters (16 alive; 6 dead) were brought down from Kōkeʻe AFS on the morning of September 9. The Service called the USAF and discussed efforts to minimize continued fallout, as well as have Service and seabird biologists to assist in assessment and retrieval of birds for the night of September 9. The USAF provided an updated downed bird report and maps for these September 8 and 9 birds.

September 10, 2015 – The Service received reports of 43 Newell's shearwaters and one Hawaiian petrel found at Kōkeʻe AFS at midnight on September 9. The Service emailed and phone called the USAF to take immediate action to preclude additional take of birds by nightfall on September 10. The USAF emailed a request of review for several intermittent fixes to attempt to reduce the fallout. The USAF stated the perimeter lights would be turned off from 9:00 pm to 11:00 pm and request for an electrician to re-orient lights to a downward facing position. Lighting within the perimeter would be turned off at the determination of Kōkeʻe personnel for safety requirements. Seabird biologists and a Service biologist provided assistance for the evening at the USAF site.

September 11, 2015 – The USAF turned off lights from 6:00 pm to 11:00 pm on September 10, and found 20 Newell's shearwaters and one Hawaiian petrel from the night of September 10. The USAF found an additional 6 Newell's shearwaters that came down after lights were turned on at 11:00 pm. The Service notified the USAF that all lights need to be turned off for the entire night through the dark moon phase, for two weeks, and until the USAF could address the required light modifications which they have submitted for a work order. The USAF emailed the Service that the command and leadership has been briefed on the current topic and previous nights' observations via three separate teleconferences (relayed importance of making installation less attractive via interim fixes as well as longer term more expensive fixes; perimeter lights would be off all night, except when required for safety or security; Department of Defense electricians have been scheduled for redirecting upward pointing perimeter lights to the downward position; and Service and seabird biologists would be on site to assess facility minimization measures and assist with the retrieval of any downed birds.

September 12, 2015 – The SOS notified the Service that they received eight Newell's shearwaters that morning and received a phone call that two Newell's shearwaters had been dropped off at the Waimea Fire Station (one found on the road by tourists and the second by Kōkeʻe AFS staff) (10 total retrieved Newell's shearwaters for September 12).

September 14, 2015 – The SOS emailed the Service of their receipt of two Newell's shearwaters on Sunday, September 13 (one from an individual who found it on the road outside the Kōkeʻe AFS), and one Newell's shearwater on September 14.

September 24, 2015 – The USAF notified the Service of the cooperative agreement award for avian monitoring in 2015.

October 8, 2015 – The USAF emailed the Service regarding a refined plan of action for employment of additional labor to monitor effects of the installation operations on protected seabird species. The timing and parameters of a proposed green light trial (post re-alignment;

only perimeter lights) were described within the email. The USAF requested comment on proposed monitoring for efficacy of retrofitted lights.

October 9, 2015 – The Service responded via email and agreed that such trial should take place in order to evaluate the re-adjustment of errant perimeter lights which may have spilled excessive light into the night sky. Additionally, the Service recommended the USAF avoid the week of October 12, 2015, due to new moon conditions.

October 15, 2015 – The USAF emailed the Service and State of Hawai‘i Department of Land and Natural Resources – Department of Forestry and Wildlife (DOFAW) biologists regarding a proposed lighting attraction trial for the purposes of determining how seabirds respond to the re-angled green security perimeter lights. The proposed plan would be to accomplish a thorough seabird sweep right at dusk to ensure there were no hiding seabirds on site prior to the testing of the lights. Approximately 30 minutes after full darkness only the green perimeter security lights will be turned on. The USAF biologist would be standing by to observe and respond to any attraction or potential fallout that might occur. Should the biologist note either unusual attraction to the lights by the birds or any fallout, the lights will be turned off and any downed birds recovered. The DOFAW seabird biologist suggested the trial project be postponed a couple more weeks to a more appropriate moon phase to minimize fallout of birds.

October 16, 2015 – The USAF emailed regarding the postponement of the light attraction trial at Kōke‘e AFS due to a more appropriate moon phase. A USAF biologist would be on site the night of October 16, to monitor any seabird activity while the station was still dark.

October 22, 2015 – The USAF emailed the Service and DOFAW biologists regarding details of the proposed lighting trial targeted for the next full moon on Tuesday, October 27, 2015. The parameters of the lighting trial would include: only the recently re-angled green perimeter security lights will be tested; all other facility lighting be turned off; the perimeter security lights be turned on approximately 30 minutes after full darkness; the USAF hired biologist present for the light trial; the lights remain on until any unusual attraction to the security perimeter lights is noted, or if any fallout occur.

October 23, 2015 – The DOFAW emailed the USAF and the Service stating they would have a seabird biologist on site for the October 27 lighting trial.

October 27, 2015 – The USAF notified the Service that evaluation of re-adjustments to lighting infrastructure begins with monitoring for seabird species.

November 18, 2015 – The USAF emailed the Service that their USAF biologist found a fledgling Newell’s shearwater at Kōke‘e AFS during her nightly monitoring the night of November 16. The bird was taken down for care at the SOS. The USAF confirmed the end of perimeter light trial due to downed bird trigger. The USAF requested from their USAF leadership to have blackout lighting conditions through December 15 based on this November 18 bird documentation. The USAF discussed the perimeter lighting trial had been ongoing since October 27, 2015, with no observed birds during the interim period, giving some hope that the re-alignment would be successful, however, based on the discovery of a fledgling fallout, they

would assume the bird was attracted by their newly modified green lights and would move forward with a revised approach. The USAF reiterated their previous phone conversation with Service staff on re-initiation of their section 7 consultation.

November 18, 2015 – The Service emailed the USAF about a potential opportunity for the USAF to fund a seabird conservation project for a barn owl control team to work the Northwestern part of Kaua‘i. The funding source for this project was expiring and there would be potential to continue the program.

November 19, 2015 – The USAF emailed and discussed their questions regarding the barn owl control work and Service recommendations for the proposed seabird conservation project.

January 26, 2016 – The USAF notified the Service that they have solicited for a contract or cooperative agreement for barn owl control work and wanted to notify the Service that the $100,000 solicitation was placed on Grants.gov from 12 Dec - 19 Jan. There was no interest, but would be discussing interest or non-interest from current implementers with seabird management experience and would update the Service on a status update once it was discussed. This solicitation pre-empts the delivery of the formal re-initiation package, but the USAF was already putting efforts to focus on the 2016 late summer-fall period at Kōke‘e AFS. This solicitation was for seabird research/management/monitoring support at Kōke‘e AFS. Additionally, the USAF would be funding work for on-site monitoring during fallout periods, specifically fall 2016. The project tasks were listed in the version of the draft BA and would be forthcoming.

March 11, 2016 – The Service emailed the USAF requesting a status of re-initiation. The Service also requested status of lighting conditions, specifically if there would be blackout conditions, for the upcoming breeding season. We emphasized that adult seabirds are likely prospecting for sites and would not want to attract adult birds.

March 11, 2016 – The USAF emailed the Service stating the BA was awaiting approval of the walking path light concept from their Security Forces, which would be used during a “mutually agreeable fallout period,” and would call to discuss that element further. The USAF agreed the fallout period not only includes fledgling seabirds, but also adults, and would include a wider time period given the previous year’s data of fallout birds. Additionally, the USAF Fiscal Year (FY) 2016 site monitoring and execution of conservation measures was granted authority to sole source to the University of Hawai‘i (UH), and a proposal for the statement of work would be worked out towards this conservation measure. Finally, the USAF would call to discuss the time periods of usage of the walking path lights so the Service and the USAF would be both in agreement.

March 25, 2016 – The USAF emailed to let the Service know that they funded a cooperative agreement to continue progress towards achievement of current conservations measures. The USAF wanted to document and ensure the Service that the USAF had been making attempts in FY16 to fund tasks that would result in the monitoring of potential impacts to threatened and endangered species and would further contribute to invasive species removal.

April 4, 2016 – The USAF emailed the Service requesting our thoughts on a recommended blackout period for high mountain installations on the island of Kauaʻi of April 1 to December 30 based on the natural history and behavior of Newell's shearwaters and Hawaiian petrels. The Service emailed the USAF and agreed on the knowledge of the seabird expert for his recommended dates to be as conservative as possible and to minimize take of adult breeding birds.

April 5, 2016 – The USAF requested a written documentation from the Service on our recommended blackout period dates.

April 21, 2016 – The Service received the 2016 *Monitoring of Endangered Seabirds on Kōkeʻe Airforce Station and off-site Predator Control* work plan and staff list.

May 3, 2016 – The Service mailed a hard copy and digital copy (via email) (Service File: 01EPIF00-2016-TA-0292) letter recommending a complete shut off of all lights (blackout conditions) from April 1 to December 30, the adult prospecting and breeding period as well as the fledgling fallout period, to minimize the incidental take of Newell's shearwaters and Hawaiian petrels.

May 4, 2016 – The USAF notified the Service that the cooperative agreement had been approved for continued monitoring efforts and some off site invasive owl work.

May 9, 2016 – The Service received an email from the UH stating the SOS had been notified of a downed Newell's shearwater from Kōkeʻe AFS the morning of May 9. The Service emailed the USAF regarding a report of a downed Newell's shearwater on the night of May 8 and for an update of the status of approval for blackout conditions.

May 9, 2016 – The USAF notified the Service (via email and phone call) that on Monday, May 9, 2016, on-site installation notified the 611th EV office of a single Newell's shearwater individual. The bird was taken to the SOS location. Additionally, the Service letter requesting blackout of lights had been forwarded via email to the USAF decision authority and was awaiting their response and action.

May 10, 2016 – The USAF notified the Service (via email and phone call) that a second Newell's shearwater had been found on the night of May 9 and that according to Kōkeʻe AFS Chief at approximately at 8:07 pm, the night of May 9, the perimeter security lights were off, while the building exterior lights were on. A security officer found the downed Newell's shearwater on the grass near the guard shack. The bird was picked up and placed into a cardboard box and taken to the Waimea fire station on the morning on May 10.

May 10, 2016 – The Service requested the USAF to expedite the approval for blackout conditions to prevent further fallout.

May 10, 2016 – The USAF emailed the Service stating the perimeter lights were not on at Kōkeʻe AFS the night of May 9.

May 10, 2016 – The Service received an email from SOS regarding the Newell's shearwater received from Kōkeʻe AFS from the night of May 9.

May 10, 2016 – The USAF emailed the Service that the Commander had issued the edict for lights out at Kōkeʻe AFS in order to address impacts to seabirds.

May 19, 2016 – The Service emailed the USAF requesting the status of the USAF BA.

June 2, 2016 – The Service emailed the USAF requesting the status of the USAF BA.

June 3, 2016 – The USAF responded to the Service (via email) on the status of their BA. The USAF anticipated a complete draft by the end of the week and welcomed the Service to provide feedback on the preliminary list of measures provided in email.

August 11, 2016 – The USAF submitted a digital copy of the BA and cover letter requesting re-initiation of section 7 consultation. The Service responded with confirmation of receipt of both documents.

August 18, 2016 – The Service emailed the USAF regarding the band-rumped storm-petrel, a species proposed for listing as endangered, and requested the USAF to confirm if they would like to include in their section 7 consultation request.

August 25, 2016 – The USAF emailed the Service requesting the initiation of a formal conference to address the band-rumped storm-petrel. The Service responded to the USAF with receipt of their request.

August 24, 2016 – The USAF requested to have a meeting to discuss the BA.

September 1, 2016 – The Service met with The USAF to discuss the conservation measures and the BA. The Service was satisfied with the information provided in the BA and discussed moving forward on the consultation.

September 7, 2016 – The Service sent a letter to the USAF confirming our initiation of formal consultation.

September 19, 2016 – The USAF requested the Service comment on the proposed light model for the walking path at Kōkeʻe AFS.

October 6, 2016 – The Service provided other examples of bollard style lighting for the USAF to consider.

October 7, 2016 – The USAF emailed the Service stating they had reviewed the options we sent in regarding the type of bollard lights and would be discussing two of them with the contractor.

October 26, 2016 – The USAF emailed to schedule a possible Service site visit to Kōkeʻe AFS.

November 7, 2016 – The USAF and the Service conducted a site visit at Kōkeʻe AFS and discussed the proposed bollard lighting path locations and existing exterior lights. It was agreed that all exterior lights on the building would be kept off during the adult prospecting and breeding period as well as the fledgling fallout season (April 1 to December 30) and only used in cases of emergency. The Service and USAF also discussed the walking path bollard light locations and discussed that lights should only be used to illuminate the walking path and an insert could be installed to block all other lights that are not directed onto the path.

November 10, 2016 – The USAF emailed requesting our review and comment of the USAF proposed bollard pathway lighting route.

November 17, 2016 – The Service responded (via email) to the USAF regarding the proposed bollard pathway lighting route.

Description of the Proposed Action

Project Description

The USAF Pacific Air Forces Regional Support Center (PRSC) proposes to continue operations at Kōkeʻe AFS and Kōkeʻe MAS on the island of Kauaʻi.

Since the establishment of the Kōkeʻe AFS in 1961, its mission has been to detect and track all aircraft operating in the area of the Hawaiian Islands. The 150th Aircraft Control and Warning Flight, of the 154th Wing of the HIANG Guard, operates Kōkeʻe AFS and Kōkeʻe MAS as a critical component of the Hawaiʻi Region Operations Control Center. Kōkeʻe AFS and Kōkeʻe MAS support the HIANG State and Federal missions. The HIANG State mission is to provide organized, trained units to protect Hawaiʻi's citizens and property, preserve peace, and ensure public safety in response to natural or human-caused disasters. The HIANG Federal mission is to provide operationally-ready combat units, combat support units, and qualified personnel for active duty in the Air Force in times of war, national emergency or operational contingency.

Forty-one HIANG and reserve personnel assigned to Kōkeʻe AFS are responsible for the operation of the installation. Normal operations dictate approximately 16 people are on site during duty hours, and 6 at all other times. Occasionally, contractors and material or supply delivery vendors also visit the site, as well as staff from squadrons within the PRSC. The installation also commonly receives maintenance support from the Naval Facilities Engineering Command (NAVFAC) offices based at the Pacific Missile Range Facility, Kauaʻi. There are no on-site personnel at the Kōkeʻe MAS.

Kōkeʻe AFS uses an AN/FPS-117v4 Long Range Radar that operates at a frequency of 1250 to 1400 megahertz and is capable of tracking aircraft 200 to 250 miles away. Because of the critical role of this facility, the radar is in almost continuous operation. Kōkeʻe AFS also uses ultra-high frequency radios for ground-to-air communication. The station distributes collected data to other sites by low-powered microwave links. The AFS is approximately one-fifth of a mile away from the Kalalau Lookout. The Kalalau Lookout is near a cliff, which overlooks the Nā Pali Coast.

The nearby Kōkeʻe MAS contains an 80-foot tall antenna with four guy wires fixed to the ground, which supports communications and mission activities; the site is fully automated. There is one exterior building light, but it is kept off at night in order to reduce the probability of seabird attraction. There are also several red obstruction lights on the tower in order to abide by safety and aviation regulations (FAA 2000, as cited in USAF 2016). The HIANG decommissioned USAF equipment at the site in March 2016. The USAF real estate agents are in the process of releasing management of the Kōkeʻe MAS site to an alternate land manager, however, the real estate transaction has not occurred to date. Kōkeʻe MAS occupies a triangular piece of land 1.25 acres in size, approximately 7.5 miles south on the road from Kōkeʻe AFS. Its grounds (open space, semi-improved) are covered with crushed rock.

Primary purposes of the proposed action are summarized as follows:

- Detect and track all aircraft operating in the area of the Hawaiian Islands
- Provide ground-to-air communication using ultra-high frequency radios
- Distribute collected data to other sites via low-powered microwave links
- Protect Hawaiʻi's citizens and property, preserve peace, and ensure public safety in response to natural or human-caused disasters

Continuing operations at Kōkeʻe AFS and Kōkeʻe MAS include the following activities:

- Security surveillance
- Radar operations
- Digital communication operations
- Continued maintenance of site infrastructure and improved grounds

<u>Conservation Measures to Avoid and Minimize Effects to Listed Species</u>
The USAF proposes measures to reduce and eliminate the effects from proposed actions by including the following:

- Decreasing light pollution
- Effectiveness monitoring of minimization measures
- Control of predators within Kōkeʻe AFS and within seabird colonies
- Implementation of outreach and education
- Funding support to SOS for Kōkeʻe AFS fallout birds

Table 1. Summary of conservation measures and schedule and frequency of implementation.

Conservation Measure	Schedule and Frequency of Implementation
Blackout period	April 1 to December 30; annually
Installation seabird monitoring	April 1 to December 30; annually
Off-site predator control	Colony dependent; annually
Conservation measure reporting	October 31; annually
Construct perimeter walking light path	To be completed in FY17
SOS husbandry support	Annually (contingent on birds discovered per year)
Engineering evaluation	

Decrease Light Pollution

In accordance with the 2011 BO, various lighting infrastructure alterations were conducted in order to eliminate seabird fallout. The installations appearance at night changed significantly after the implementation of the green light conservation measure. A conversion from white and yellow bulbs to green was reported as completed by February of 2013 during biannual reporting (USAF 611 CES 2013, as cited in USAF 2016). As a result of the 2015 fallout event, light monitoring was conducted and infrastructure was inventoried on September 14, 2015, which resulted in a thorough status of inventory and performance for all perimeter and building lights (PRSC 2015a, 2015b, 2015c, as cited in USAF 2016). Identification of operational motion sensors, status of window coverings, and identification of inoperable equipment was also noted within this set of USAF reports. During monitoring efforts of the fall of 2015, various sources identified potential lights which could be further reduced in angle, resulting in a greater reduction of light emittance from the installation (PRSC 2016, as cited in USAF 2016; Raine *et al.* 2015). NAVFAC efforts on September 14, 2015, resulted in re-positioning of problematic perimeter lights. DOFAW confirmed a re-positioning effort was completed, but cited that potential room for further light reduction may still exist. Information collected by DOFAW after the light adjustment from September 14 – 30, 2015, identified no fallout (Kaiakapu Personal Communications 2015, as cited in USAF 2016).

In order to further analyze the installation light system, the USAF worked cooperatively with CSU CEMML in order to update a roster of all lighting conditions and develop a corresponding map (Figure 1), such that the status of each light could be tracked over time. Site visits during 2015, allowed for the update of the master installation lighting inventory. The installation map displays not only current light conditions and bulb color but also depicts the overall infrastructure layout and density of light placement. Further information pertaining to the type and status of each light is found on page two of each report found within Appendix B.

Fallout data collected after issuance of the 2011 BO, suggests that green lights, hooded lights, and re-orientation of installation lighting is not sufficient for the elimination of fallout for the Newell's Shearwater, Hawaiian Petrel, and band-rumped storm-petrel at Kōkeʻe AFS. Rather than to continue the use of green perimeter and building lights currently in place, the USAF proposes to construct a safety walking path outfitted with low level cut off lights as an alternative means to couple mission objectives and minimize impacts to seabird fallout. Prior to the implementation of final design and installation of the walking path lights, PRSC civil engineers and the USAF will share draft drawings and light models (route, ballast, bulb, and post) with the Service for comment and agreement. A similar process for Service involvement will occur for

the perimeter lighting plan. If comments are received with concerns about proposed design, the PRSC will address the concerns as appropriate, and issue a revised design with response to the Service for approval and agreement.

A notional layout for the walking path lights is depicted in Figure 2. According to the Kaua‘i Seabird Habitat Conservation Program (KSHCP) website, light models or designs using bollard type fixtures, such as those proposed by the USAF for usage at Kōke‘e AFS in Figure 3 (and Appendix C), are advised to be outfitted with yellow LED lamps. This design preference advised for usage by the KSHCP is being proposed for the Kōke‘e AFS walking path and associated light system by the 611th CES.

This illuminated walking path will function as the installation’s sole source of outdoor light during the April 1 to December 30 blackout timeframe. This illuminated path will replace the need to use the brighter and taller perimeter and exterior building lights during this period. The USAF anticipates that this conversion of lighting will reduce the attractive nature of the installation for both adult and fledgling Newell’s shearwaters, Hawaiian petrels, and band-rumped storm-petrels flying over en-route to their colony or ocean feeding areas. After the path and lights are completed, any buildings with shiny surfaces that are near the walking path will be painted to reduce potential reflection from bollard lights. The newly constructed path will be monitored annually for protected seabird presence or absence using all or a combination of the following scientific methods: night vision technology, physical observer inspections, deployment of song meters, and avian radar technology. The LED bollard lights and installed shielding are expected to eliminate light trespass in the upward direction, thus reducing the likelihood of fallout due to light attraction. The installation and use of LED bollard lighting is not expected to adversely affect adult and fledgling birds due to injury or mortality.

The seasonal blackout period will be implemented as a new conservation measure at Kōke‘e AFS and Kōke‘e MAS, however, the Federal Aviation Administration’s (FAA) required red sources of light cannot be diminished during the blackout period. FAA requirements for pole and/or radome lighting are exemptions to this blackout conservation measure and are FAA driven requirements for protection of life and safety (FAA 2000, as cited in USAF 2016). Loss of life, safety, and the protection of property may result from removal or dismantling of FAA required red colored lights already in function. Additionally, the USAF proposes in the event of an illegal incursion, emergency on the installation, or security violation occurring during the April 1 to December 30 blackout period to temporarily use existing perimeter and security lighting in order to preserve safety and mission integrity. The usage of perimeter and security lights during the blackout period would be limited to these rare instances and the duration would be minimized to the maximum extent practicable to address the security breach or emergency. Such instances will be reported to the Service within 24 hours of event.

The green bulbs already installed in perimeter and building lighting infrastructure, will continue to be used during the non-blackout period (December 31 to March 31), when birds are not transiting to and from colonies over the installation. These lights are fully shielded and directed downwards. This infrastructure will be evaluated for feasibility of alternative design.

The installations antenna, wire supports, and other installation equipment will also be evaluated for feasibility of alternative design. The feasibility study will identify whether or not new technologies and designs exist, which could replace currently situated infrastructure. During the feasibility study, engineers will identify alternative means of design, and identify those alternatives which are more bird friendly in comparison to current infrastructure. An emphasis during the feasibility study will be placed on those engineering designs and technologies which result in the placement of objects underground or within radome canopies, given that above-ground obstructions have been identified as potentially problematic to transiting seabirds.

The Kōkeʻe MAS includes an 80-foot tall antenna with four guy wires fixed to the ground to support communications and mission activities. There has been no evidence of take at Kōkeʻe MAS. It is located farther from known nesting colonies, does not appear to lie in a flight corridor, and it does not contain white or green lights that attract birds. Impacts from this antenna are not expected to rise to the level of take.

Window coverings inside of Kōkeʻe AFS buildings were also evaluated in 2015. Window coverings are an important component of light emittance reduction. Data collected in 2015 identified specific windows which are in need of repair, update, or adjustment in order to inhibit light from spilling outside the structure (PRSC 2015b, 2015c, as cited in USAF 2016). During future blackout periods the use of effective shading on all windows with connectivity to rooms possessing lights will be required and audited for completion. This conservation measure is expected to minimize effects to adult and fledgling seabirds transiting within the action area. Minimization of inside lights from building windows are not expected to adversely affect adults and fledglings.

Figure 1. Light sources at Kōkeʻe Air Force Station, Kauaʻi, 2015 (PRSC 2015b, 2015c, as cited in USAF 2016).

Legend	
Symbol	Description
▶	Building Flood Light
	Operational Perimeter Lights (A – Q)
	Non-operational Perimeter Lights
— x —	Security Fence
•	Post of Antenna Array
	Bldg. Ext. Light (green or white bulb)
RD	RADAR Dome
WT	Water Tank
DT	Diesel Tanks
GT	Gasoline Tanks and Pump Station
FFV	FASFAC Van
RW	Retaining Wall of Former RADAR
NV	Navy Van
1	BLDG 1 : Operations Building
2	BLDG 2: Generators Building
3	BLDG 3: Chlorinator Shed
5	BLDG 5: Supply Building
6	BLDG 6: HAZMAT Shed
7	BLDG 7: Gate House
10	BLDG 10: Vehicles Building
12	BLDG 12: Unoccupied Building
14	BLDG 14: Unoccupied Building

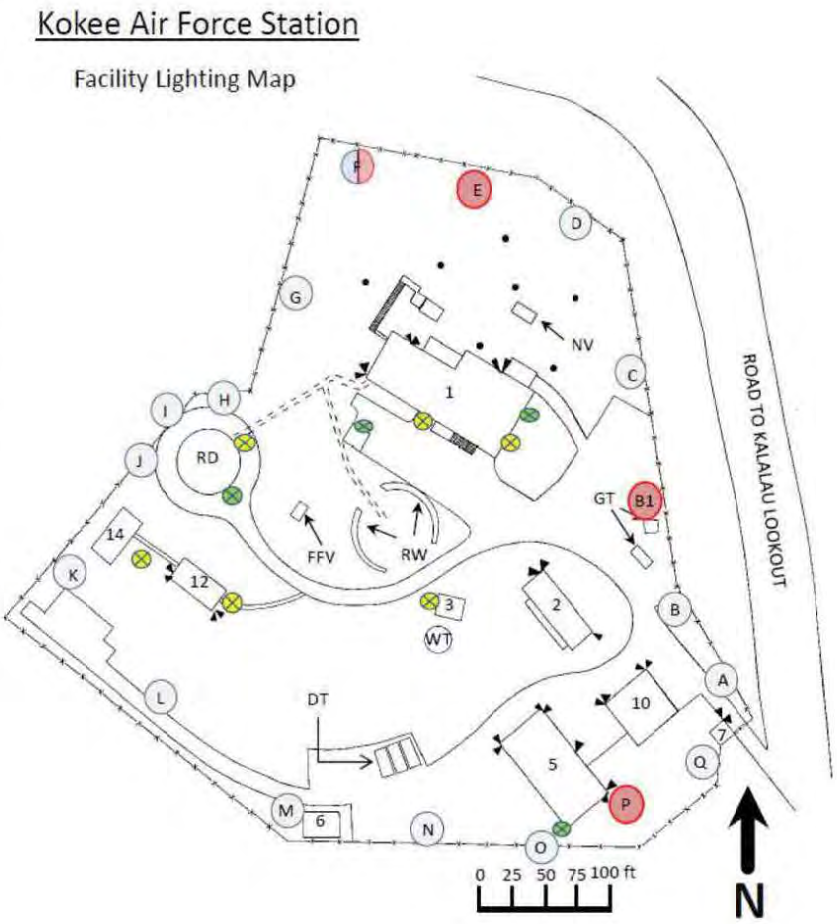


Figure 2. Proposed bollard lighting walking path at Kōkeʻe AFS.

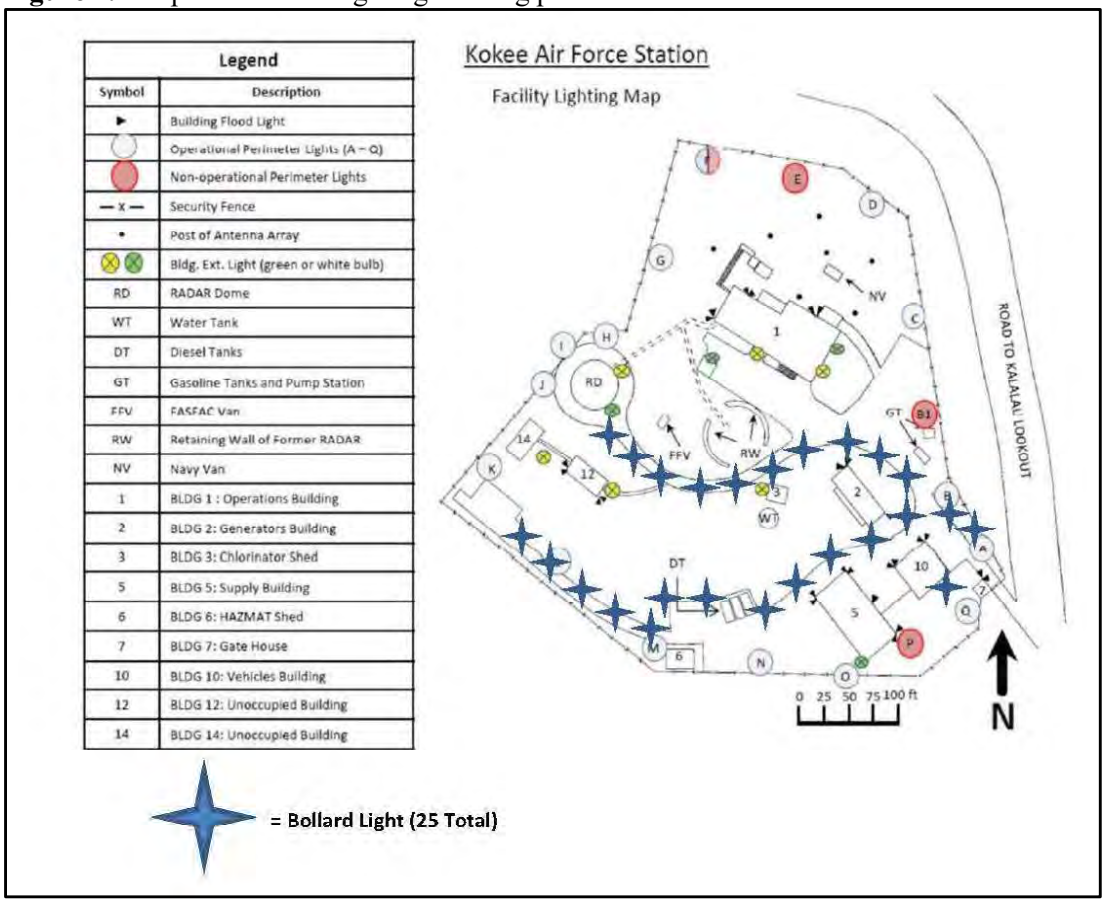
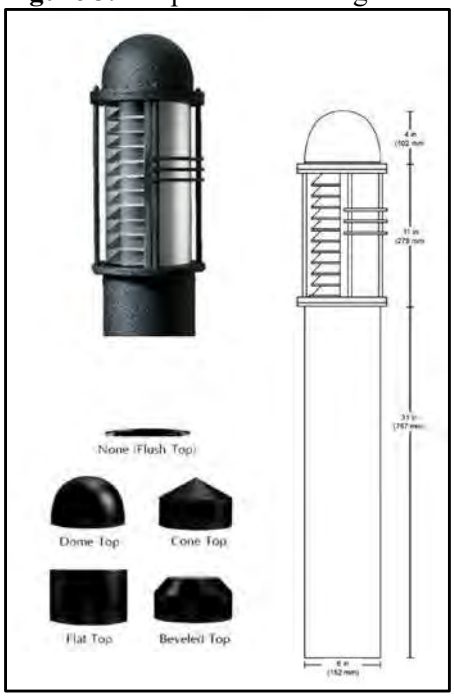


Figure 3. Proposed bollard light model.



Effectiveness Monitoring of Minimization Measures
In an effort to continue monitoring potential seabird fallout, the USAF, with support from the USACE Omaha District, funded the UH and its collaborative network of biologists from the Kauaʻi Endangered Seabird Recovery Project (KESRP) to implement avian monitoring of the site (May – December). This monitoring will allow the USAF to evaluate efficacy of the newly constructed lighting on the safety walking path. Annual monitoring of the site will include presence or absence of Newell's shearwater, Hawaiian petrel, and/or band-rumped storm-petrel, using all or a combination of the following scientific methods: night vision technology, physical observer inspections, deployment of song meters, and avian radar technology. A cooperative agreement was awarded on March 25, 2016; the associated work plan describing the conservation efforts funded by the USAF for implementation can be found within Appendix D. Avian monitoring results will be reported to the Service on an annual basis no later than October 31, of each calendar year.

Control of Predators Within Kōkeʻe AFS and Within Seabird Colonies
The USAF, with support from the USACE Omaha District, has funded the UH and its collaborative network of biologists from the KESRP to implement barn owl predator control (December 2016 to February 2017) on off-site colonies known to provide nesting habitat for the Newell's shearwater, Hawaiian petrel, and the band-rumped storm-petrel transiting over Kōkeʻe AFS. Given there is no documented nesting of Newell's shearwater, Hawaiian petrel, or band-rumped storm-petrel within Kōkeʻe AFS and Kōkeʻe MAS, the ability to improve nesting conditions, fledgling rates, or avian productivity on-site is limited (PRSC 2015d, as cited in USAF 2016) and will most effectively be implemented in off-site colony locations (e.g. Nuʻalolo ʻĀina, Nuʻalolo Kai, Honopū, Kalāheo/Kāhili, Lehua Islet; and the back of Hanalei Valley) where listed seabirds are currently benefiting from barn owl control.

These six off-site colony locations hold significant potential for seabird conservation through barn owl-specific predator control actions. Predation by non-native mammals is a constant threat to endangered seabird populations on Kauaʻi. Feral cats (*Felis cattus*), rats (both black (*Rattus rattus*) and Polynesian (*Rattus exulans*) species), cattle egret (*Bubulcus ibis*), barn owls (*Tyto alba*) and feral pigs (*Sus scrofa*) are all non-native predators that are potentially limiting the breeding success of birds within these colonies. Management for barn owls at these colony locations is expected to increase the survival rates of both adult birds and fledglings. Actions under this work plan would begin in December 2016 and extend to February 2017. Barn owl control has been previously funded by other sources, however, at the present time the only funding source for this predator control comes from the USAF's cooperative agreement (awarded on March 25, 2016); the associated work plan describing the conservation efforts funded for implementation can be found within Appendix D. This barn owl control work will be funded annually and results of the proposed barn owl predator control will be reported to the Service on an annual basis no later than October 31 of each calendar year.

Monitoring for the presence of other introduced predators around breeding sites through the recording of indirect sign (prints, scat) and seabird predation events will also be undertaken. If signs of other predators (cats, rats and cattle egret) are recorded, the control team may target these other species for control actions if time and logistics allow.

Additionally, the USAF proposes to continue predator control (primarily targeting cats, dogs, pigs, and rodents) at off-site seabird colonies. With fewer predators on the installation, grounded seabirds have an increased chance of being rescued. A combination of air and ground based predator control will be implemented.

As of February 2011, garbage cans have been secured from feral cats and rats. Securing the station's garbage cans will provide less incentive for predators to come onto station property. The previous perimeter fence was repaired after the previous consultation was completed, making it more difficult for animals to pass underneath; however, spaces under some areas along the perimeter still have the likelihood to provide access by feral cats and rats. The USAF has established a policy for not feeding feral cats, and of regularly trapping and removing them from the Kōkeʻe AFS.

Implementation of Outreach and Education
The USAF currently has an outreach and education program, in the form of briefings and posters. Implementation began on August 7, 2010, to help on-site personnel understand the importance of keeping windows and doors closed at night, of turning off lights when they are not needed, and of not feeding feral cats. Information is currently posted at Kōkeʻe AFS regarding procedures to be followed should personnel see a downed bird.

Funding Support to SOS for Kōkeʻe AFS Fallout Birds
The SOS program serves to retrieve, evaluate, rehabilitate (when needed), and release back into the wild any seabirds that become disoriented or injured in response to artificial lights, and collisions with power lines, or other man-made structures on Kauaʻi. The SOS program began in 1978 with annual records beginning in 1979.

The SOS program relies solely on members of the public to pick-up and place grounded birds into SOS aid stations, located throughout the island and monitored regularly by SOS staff. The public is encouraged to turn in all live, dead or injured seabirds directly to Kauaʻi Humane Society facilities at any time. The SOS program also accepts and handles other avian species in need. In the last five years, there has been an increase in the number of native waterfowl requiring rehabilitation and care in the SOS program.

Biologically, it is unclear if fledglings released by the SOS program have equal levels of fitness compared to fledglings that naturally leave from montane forest areas. Over the 37-year history of the program, a total of 30,552 fledgling Newell's shearwaters have been turned in to the SOS program for documentation or care. While earlier years of the program did not always include bird banding prior to release, since 1979 a total of 24 Newell's shearwaters previously banded in the SOS program as fledglings have been recovered or re-sighted as adults (Anderson 2016a, in litt.). Regardless of these low re-sight numbers, the SOS program reduces impacts to the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel by providing care, rehabilitation, and release after their injury.

The USAF proposes to provide additional measures to recover any birds discovered injured or dazed should there be a fallout event. The USAF will fund rehabilitation efforts for those birds, which are discovered on Kōkeʻe AFS or Kōkeʻe MAS on annual basis in collaboration with the

SOS. During years where fallout is detected on Kōkeʻe AFS or Kōkeʻe MAS, the USAF will issue funds for cages, food, equipment, medicines, logistical movements of birds, and other veterinarian costs associated with the husbandry and recovery of each injured or dazed bird.

Monitoring during the seabird breeding period for each species, will be used to guide whether or not each future year's fallout data will dictate the need for implementation of this conservation measure, which will only be implemented if fallout occurs. Costs accrued for the husbandry of grounded birds discovered after the issuance of the 2011 USFWS BO will be addressed by the USAF in FY17.

Action Area

The action area of a project is defined by regulation as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). The action area (Figure 4) for this formal consultation includes Kōkeʻe AFS and the western region of the island, from Waimea Canyon through the Nā Pali coast, Hanalei, and Lehua Islet due to indirect effects of the proposed actions on Newell's shearwater, Hawaiian petrel, and band-rumped-storm-petrel nesting colonies.

Kōkeʻe AFS occupies 10.6 acres of mountaintop habitat within Kōkeʻe State Park, about 3,500 feet above sea level. The station is on the Kahuamaʻa Flat of the Alakaʻi Plateau, a gently eastward-sloping plain. It is on a knoll that rises 40 feet above lower portions of the installation. About half the station is fenced, and land is used for light industry and limited landscaping. Outside the fence, the station is surrounded by native koa forest that has suffered relatively little disturbance and is part of the island's montane mesic ecosystem. The station is adjacent to (but does not include) recently designated critical habitat for montane mesic ecosystem species, including nine plant species, the Kauaʻi ʻākepa (*Loxops caeruleirostris*), and the picture-wing fly *Drosophila attigua*.

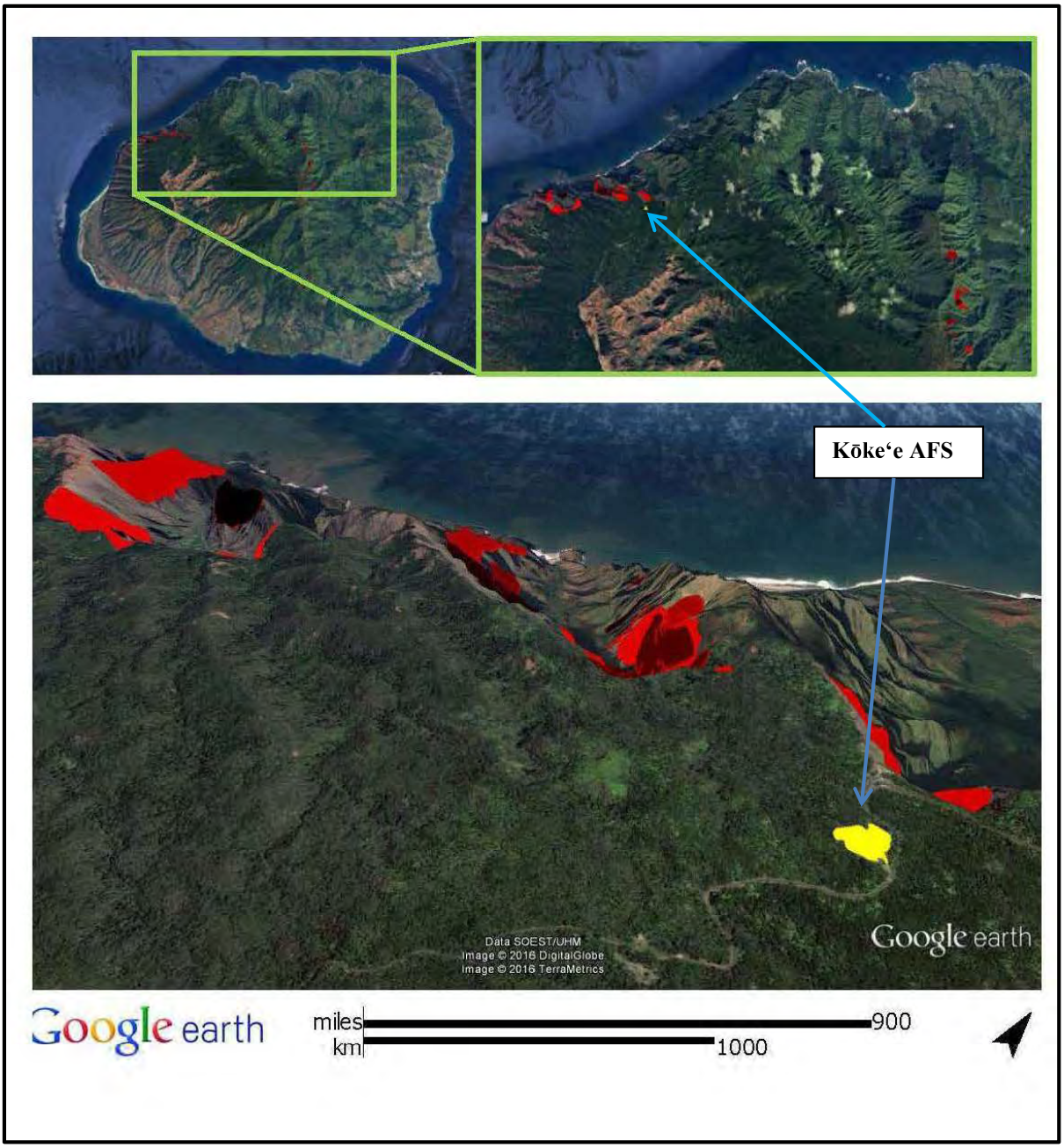
Nuʻalolo ʻĀina, Nuʻalolo Kai, and Honopū are located on the Nā Pali Coast in northwestern Kauaʻi. The Nā Pali Coast extends from Haʻena to Polihale State Park. The elevation along the coast ranges from sea level to 3,700 feet in Kōkeʻe. The Nā Pali region is characterized as a coastal cliff formation with numerous upland finger ridges, precipitous cliffs, and deeply incised valleys. The elevation in the rim areas ranges from approximately 2,700 to 3,600 feet.

Waimea Canyon is located in the western region of Kauaʻi and is bordered by Puʻu Ka Pele uplands and Nā Pali Coast to the west, Makaweli uplands to the south, and the Alakaʻi High Plateau to the north. The elevation in Waimea Canyon ranges from approximately 100 feet up to 3,700 feet at the canyon rim. The Waimea Canyon is characterized by near vertical cliffs and dramatic valleys. Several streams flow into the Waimea River in the Waimea Canyon, including Poʻomau, Waiahulu, Koaiʻe, and Waiʻalae streams. Kāhili is located in Kalāheo in the Waimea district.

Hanalei Valley is located on the North shore of Kauaʻi where cliffs range from greater than 300 meters high on the coast and the topography climbs rapidly to greater than 1,000 meters.

Lehua Islet is approximately 290 acres in size, with a maximum elevation of 710 feet, and the largest offshore islet in the main Hawaiian Islands. Lehua is part of Kaua‘i County and is located ¾ mile north of Ni‘ihau and roughly 20 miles west of Kaua‘i. Lehua is federal property administered by the U.S. Coast Guard and managed by the DOFAW as a seabird sanctuary.

Figure 4. Map of Action Area showing Kōke‘e AFS (yellow) and Newell’s shearwater breeding distribution in the Action Area.



Analytical Framework for the Jeopardy/Adverse Modification Analyses

In accordance with policy and regulation, the jeopardy analysis of this Biological Opinion relies on four components: (1) the *Status of the Species*, which evaluates the range-wide condition of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel, the factors responsible for that condition, and the survival and recovery needs of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel; (2) the *Environmental Baseline*, which evaluates the current condition of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel; and (4) *Cumulative Effects*; which evaluates the effects of future, non-Federal activities in the action area on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel.

In accordance with the policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel in the wild.

The jeopardy analysis in this Biological Opinion places an emphasis on consideration of the range-wide survival and recovery needs of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel and the role of the action area in the survival and recovery of these species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Status of the Species

<u>Status of the Newell's Shearwater</u>

Listing Status, Taxonomy, and Species Description
The Newell's shearwater was listed as a threatened species in 1975 (USFWS 1983), pursuant to the Endangered Species Preservation Act of 1966. *The Hawaiian Dark-rumped Petrel and Newell's Manx Shearwater Recovery Plan* was published in 1983 (USFWS 1983). A species five-year review was completed in 2011. The review recommended up-listing the Newell's shearwater to endangered status due to precipitous declines in the global population over the last two decades. Critical habitat has not been designated for the Newell's shearwater (USFWS 1983).

The Newell's shearwater taxonomically belongs to the *Puffinus* genus, in the *Procellariidae* family and *Procellariiformes* order, along with 20 other extant shearwaters ranging throughout the Indian, Atlantic, and Pacific oceans (Gill and Donsker 2016). Shearwaters are characterized by exhibiting a "shearing" flight pattern, dipping from side to side on stiff, straight wings with

few wing beats. Genetic analyses conducted by Martínez-Gómez *et al.* (2015) confirmed the taxonomic status of Newell's shearwaters (*P. auricularis newelli*) as a subspecies alongside the Townsend's shearwater (*P. auricularis auricularis*). These two subspecies comprise *P. auricularis*. The two subspecies exhibit minor differences in plumage patterns and breeding chronology (Martínez-Gómez *et al.* 2015, p. 1026). The Townsend's shearwater is endemic to the Revillagigedo Archipelago located off the coast of Mexico and south of Baja California Peninsula. The Townsend's shearwater's range and distribution has been significantly contracted to a single island with less than 100 breeding pairs remaining (Martínez-Gómez *et al.* 2015, p. 1032; BirdLife International 2016a).

The Newell's shearwater is approximately 12 to 14 inches long, with a wingspan of 30 to 35 inches (Berger 1972, p. 46), and weighs approximately 14 ounces (Ainley *et al.* 1997b, p. 15). Its plumage is glossy black above, and white below (Ainley *et al.* 1997b, p. 15). Newell's shearwaters have low maneuverability characterized by a fast, directional, and low to water flight pattern, due to high wing-loading. A Newell's shearwater wing-loading averages about 60 N [newtons]/m2 (± 5.3 SD) with a low aspect ratio (10.3 ± 0.45 SD); significantly different from other shearwaters or petrels (Spear *et al.* 1995; Warham 1977). Observations of Newell's shearwaters transiting over land show a distinct flight pattern characterized by an almost frantic flapping style with the wings held straight (KESRP 2017b). It has a dark gray to brown bill that is sharply hooked at the tip (Ainley *et al.* 1997b, p. 15). Its claws are well adapted for burrow excavation and climbing.

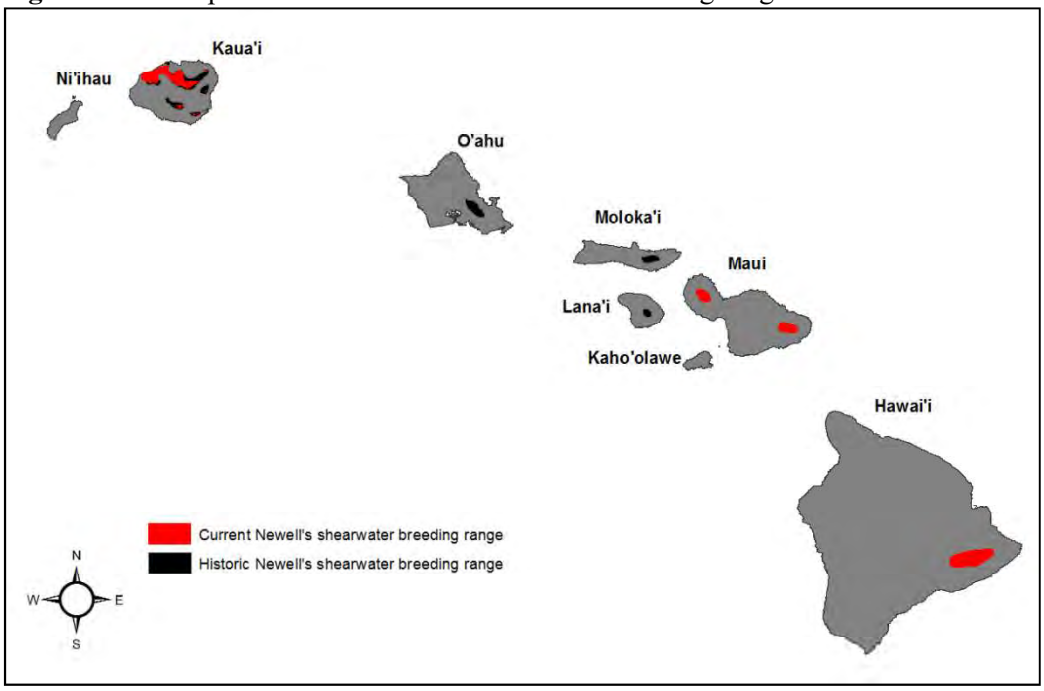
Historic and Current Distribution

The Newell's shearwater is believed to have colonized, historically, many of the southeastern Hawaiian Islands, including Hawai'i, Maui, Moloka'i, O'ahu, and Kaua'i (USFWS 1983, p. 2; Pyle and Pyle 2009, p.3). Newell's shearwaters were thought to be extinct after 1908, due largely to habitat loss and predation, but in 1954 a specimen was collected on the island of O'ahu (King and Gould 1967) and in 1967 a breeding colony was found on Kaua'i (Sincock and Swedberg 1969). Although no Newell's shearwater breeding colonies have been identified on the island of O'ahu, downed Newell's shearwaters have been recovered throughout the island since the 1950s (Pyle and Pyle 2009, p.3). Three fragmented breeding areas were identified in the Puna District on Hawai'i Island in 1993, based on nocturnal calling, visual detections of birds in flight, and two Newell's shearwater carcasses found along the highway; however no active burrows were found (Reynolds and Ritchotte 1997, p. 31). Currently, research staff at Haleakalā National Park on Maui Island consistently report Newell's shearwater ground calling within Kīpahulu Valley and along the northern slope of Mount Haleakalā near Ko'olau Gap, indicating a breeding site (NPS 2012, p. 18). However, due to sensitive resources in the area and the difficult terrain, no ground surveys have been conducted in these locations (NPS 2012, p. 19). In 2015, acoustic song meters were placed at 41 sites in remote areas of Haleakalā National Park to detect potential new seabird breeding colonies (McKown and Savage 2015, p. 1). Song meters detected Newell's shearwater ground calls in low numbers (averaging 2 ground calls per survey night) at five of the 41 sites, with only one site recording regular activity during the 30-day study period (McKown and Savage 2015, p. 15). 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 (McKown and Savage 2015, p. 3). This schedule amounted to an hour and a half of data each night. Additional longer-term acoustic and ground

surveys are needed to evaluate the extent, distribution, and viability of Newell's shearwater on Maui and Hawai'i islands.

While some knowledge gaps remain concerning its distribution, the Newell's shearwater has experienced a significant breeding range contraction and currently, all known extant breeding colonies with documented burrows are located on the island of Kaua'i (Figure 5). Estimates indicate 90 percent of the global population resides on Kaua'i (Ainley *et al.* 1997b; Griesemer and Holmes 2011).

Figure 5. A comparison of the historic and current breeding range for the Newell's shearwater.



Map shows current breeding range contraction from the historic breeding range for the Newell's shearwater within the Hawaiian Archipelago. While the Newell's shearwater may breed on Hawai'i and Maui islands, the only known breeding colonies of Newell's are located on the island of Kaua'i.

Of the Newell's shearwater breeding on the island of Kaua'i, 104 breeding pairs are being monitored and an additional 64 burrows in Upper Limahuli Preserve were monitored in 2015 but could not be identified to species (i.e., burrows were either Newell's or petrels) (Raine *et al.* 2016a; Raine *et al.* 2016c). The majority of the monitored shearwaters (82 breeding pairs) are concentrated within the Upper Limahuli Preserve (ULP), enclosed by an ungulate exclusion fence. Auditory surveys documented several additional areas of concentrated shearwater ground-calls indicating breeding activity within Lumahai Valley and Lā'au Mountain in montane habitat and within Honopū Valley along the Nā Pali coast (Banfield *et al.* 2013). However, due to inaccessible and difficult terrain, no numbers or estimates exist for shearwaters breeding in these locations.

Based on historic and current distribution of breeding sites, Newell's shearwaters prefer breeding habitat in montane wet (e.g., Hono o Nā Pali colony) to lowland wet and wet cliff (e.g., Upper Limahuli colony) habitat of 200m to 1,000m in elevation, steep to moderate slopes with thick

native understory of uluhe fern (*Dicranopteris linearis*) and open canopy of dispersed ʻōhiʻa trees (*Metrosideros polymorpha*) (Troy *et al.* 2014, p. 325). The preference for montane forested habitat beneath dense uluhe fern helps to conceal shearwater burrows from predators while dispersed ʻōhiʻa trees may provide a take-off point for shearwaters to regain flight (Troy *et al.* 2014, p. 318). The Newell's substrate preference includes rocky volcanic soils with a moderate amount of fine soil particles and suitable drainage to prevent burrow flooding (Troy *et al.* 2014, p. 324). Recent seabird surveys have resulted in the first confirmed Newell's shearwater burrows (n=3) along the Nā Pali coast, in dry cliff habitat (Raine and Banfield 2015a, p. 11).

Life History

Newell's shearwaters have a long lifespan (up to 36 years), do not reproduce until 6 years of age, lay one egg per year, and offspring require significant parental investment (Ainley *et al.* 2001). As with other k-selected species, these traits of long lifespans and low reproduction at high energetic cost define the life strategy of a species that has evolved in a stable environment (i.e., more predictable); the succession of ecosystems in the Hawaiian Islands following a period of volcanic eruptions.

Newell's shearwater breeding season begins in late March/early April when adults and sub-adults arrive to inland breeding colonies, followed by a 2-4 week exodus when breeding adults forage to build-up reserves (Raine and McFarland 2013, p. 2; Raine and McFarland 2014, p.2; Raine and Banfield 2015a, p.2). The incubation period begins in May and continues through July, and the chick provisioning stage occurs in late July through September (Raine and McFarland 2013, p. 2). Both sexes equally incubate the egg (Ainley *et al.* 1997b, p. 10). The fledging or late chick rearing stage, when young leave the nest for the first time occurs in September through December (DOFAW 2016; Raine and McFarland 2013, p. 2). Adults travel from breeding to feeding areas and return to feed their chicks irregularly every one to three nights (Ainley *et al.* 1997b). Newell's shearwaters, similar to other birds in the Order Procellariiformes, exhibit strong natal philopatry, with breeding pairs returning to the same burrow to breed each year (Bried *et al.* 2003, p. 242).

Ainley *et al.* (2001, p. 117) documented higher than expected numbers of active shearwater burrows with no egg or nestling signs present (11%-22%), indicating no breeding attempt was made. Monitoring data of shearwater colonies indicate at least 10% or more of activity within breeding colonies is comprised of non-breeding birds or sub-adults (<6 years old) prospecting for mates or excavating burrows during the breeding season (Raine *et al.* 2016a, 2016c). Ainley *et al.* (1997a, p. 11) suggested shearwaters on Kauaʻi begin returning to their breeding habitat as sub-adults at 2-3 years of age. The full shearwater breeding season is treated as March 1 to January 1 to cover the entire period when shearwaters may transit to and from the ocean and inland breeding sites (Travers *et al.* 2016, p. 5). All transit over land occurs in darkness, with a peak over land passage during the year coinciding with the late incubation and chick rearing stages (Travers *et al*. 2013, p. 35). Fledglings leaving the nest for the first time exhibit strong phototropic behavior and rely on ambient light from the moon to navigate to open ocean (Telfer *et al.* 1987, p. 410).

Newell's shearwaters are pelagic, spending much of their time foraging over deep waters where 96 percent of their diet consists of cephalopods, primarily the Ommastrephidae family of flying

squid with the remaining 4 percent consisting of flying fish (*Exocoetus* sp.) (Ainley *et al.* 2014, p. 70). Newell's shearwaters likely specialize in feeding over yellowfin tuna (*Thunnus albacares*), as both flying squid and flying fish are important in the diet of yellowfin tuna.

Current Population Demographics

At-sea surveys conducted in the central and eastern tropical Pacific between 1980 and 1994 (Spear *et al.* 1995) estimated the total Newell's shearwater population at 84,000 (95% CI = 57,000-115,000) including juveniles and sub-adults. 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 Newell's shearwater population at 27,011 (95% CI = 18,254-37,125) including juveniles and sub-adults (Joyce 2013). Given 90 percent of the global population resides on Kaua'i (Ainley *et al.* 1997b; Griesemer and Holmes 2011), the estimated population of Kaua'i is 24,310 individuals (USFWS 2017, p. 113). The percentage of the population that is breeding age (6 years of age or older) is estimated at 0.637 (Ainley *et al.* 2001, p.115), equaling an adult population size of 15,485 (approximately 7,500 pairs).

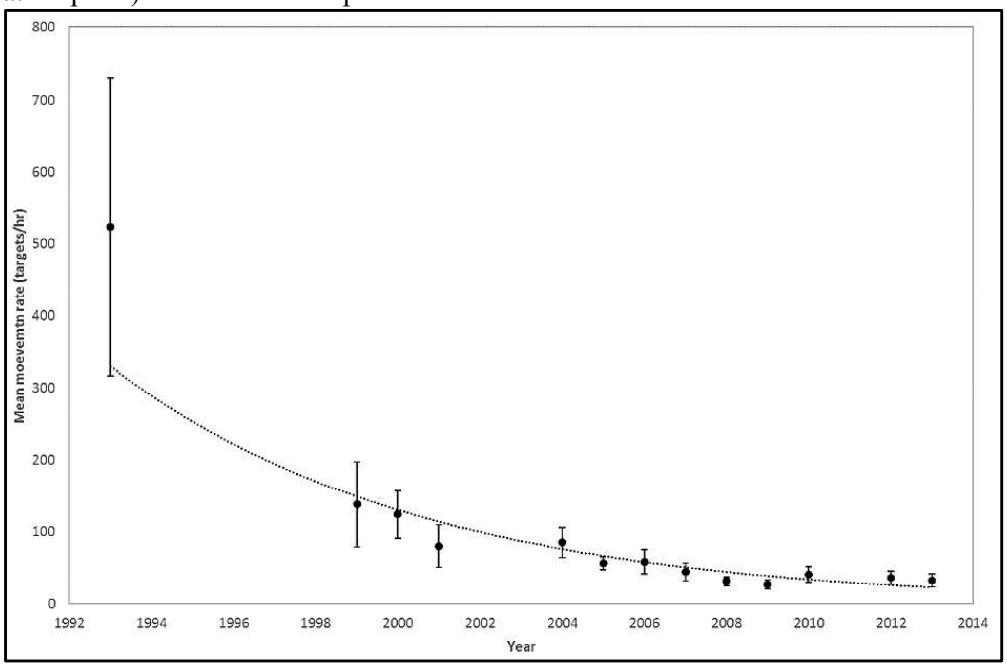
Annual survivorship and juvenile/sub-adult survivorship of the Newell's shearwater has not been studied in the field (i.e., estimated from banding efforts and recapture). Population viability modeling efforts estimate Newell's shearwater adult survivorship at 0.905 (Ainley *et al.* 2001, p. 116) to 0.920 (Griesemer and Holmes 2011, p. 20; USFWS 2017) and juvenile/sub-adult survivorship at 0.333 (Ainley *et al.* 2001, p. 116) based on long-term survivorship data of related species. The likelihood of Newell's shearwater adults (≥ 6 years of age) to breed in any one year was estimated to vary between 0.60 and 0.50 (Ainley *et al.* 2001, p. 118), which is markedly lower than the breeding probability (0.82) of other Procellariidae species. Based on a five-year monitoring study of a single Newell's shearwater colony on Kaua'i the annual reproductive success of shearwaters was estimated at 0.66 fledglings per breeding pair (Ainley *et al.* 2001, p. 117). In comparison, the Manx shearwater, a closely related species with an extensive range and a stable global population has a reproductive success of 0.70 (Brooke 1990; and Ainley *et al.* 2001, p. 117).

Based on Newell's shearwater population parameters, SOS data, and carcass searches under power lines, Ainley *et al.* (2001) estimated the global population of Newell's shearwaters are declining at least 5.9 percent per year (λ=0.941). Ainley *et al.* (2001, p. 118) found that the main factor affecting limiting the population growth rate of the Newell's shearwater was the extremely low breeding probability (0.547), which is associated with individual fitness and habitat quality. Ainley *et al.* (2001, p. 118) suggested that the low breeding probability could be the result of high mate loss due to predation or other threats affecting individual fitness. Indeed, adults that lose a mate due to predation cannot obtain a new one quickly and have been observed not to breed the following season (Ainley *et al*. 2001, p. 118; Raine 2016a, in litt.). The purpose of the Ainley *et al*. (2001) population demographic study was to evaluate the status of Newell's on Kaua'i. The study sampled an average of 65 burrows for seven seabird seasons, 1984–1985 and 1993–1994. The colony sampled was in a natural state (i.e., receiving no conservation management actions) and the sample was not constrained to only experienced breeders, but rather sought to maximize the total number of burrows monitored each season (Ainley *et al*. 2001, p. 112).

Ornithological radar data was first used to monitor populations of Newell's shearwaters and Hawaiian petrels (*Pterodroma sandwichensis*) on Kaua'i in 1992-1993 (Day *et al*. 2003, p. 670), based on methods developed to monitor Marbled murrelet (*Brachyramphus marmoratus*) populations in the Pacific Northwest (Cooper *et al*. 2001). Radar has been used to monitor the summer movement patterns of Newell's shearwaters and provide an accurate estimate of birds as they transit through the detection area at 13 sites throughout the island (Day and Cooper 1995; Raine *et al*. in press). Day *et al*. (2003) reported a mean annual rate of 11.2 percent decline in the Newell's shearwater population between 1993 and 2001, based on the analyses of ornithological radar data.

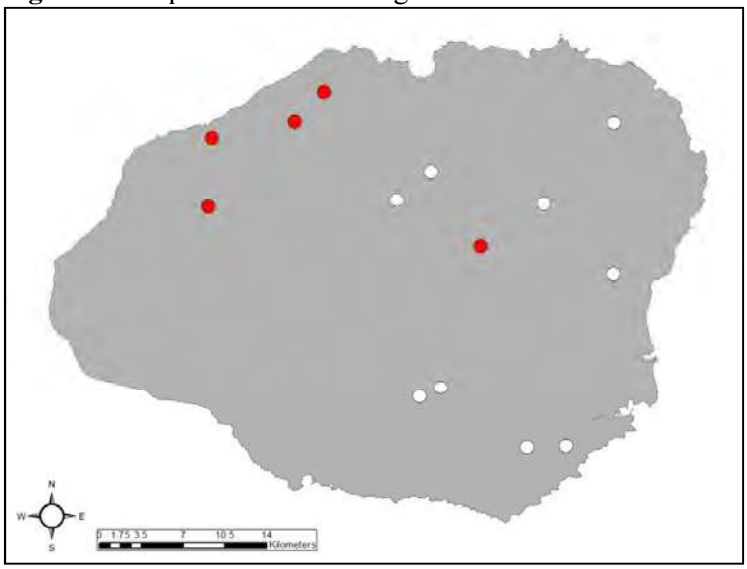
In a subsequent study, based on visual observations and marked differences in the timing of petrel and shearwater movements, radar data analysis (Day and Cooper 1995; Raine *et al*. in press) has shown an appreciable reduction in the number of shearwaters transiting to and from montane breeding colonies from 1993 to 2013 (Figure 6). Radar surveys were conducted in coastal areas of known seabird flyways in May through mid-July, during the incubation and early chick-rearing stage. Therefore, radar data are a conservative index of breeding activity. The overall mean for shearwaters across all 13 radar sites surveyed in 1993 was 523.7 ± 206.5 targets/h and in 2013 was 33.5 ± 9.2 targets/h, representing a mean decrease of 87.5% between the two periods ($t = 2.37$, $df = 24$, $P = 0.026$; Raine *et al*. in press). All of the 13 sites showed a large decrease in movement rates over the entire period, with movement rates at 11 (84.6%) out of 13 sites decreasing by more than 80 percent (Figure 6). (Raine *et al*. in press). Based on the radar data (Raine *et al*. in press) as a proxy for the breeding population, the Newell's shearwater population on the island of Kaua'i declined at a mean annual rate of 12.8 percent over the 20-year period. This updated rate of decline of the Newell's shearwater population is comparable to the mean annual rate of -11.2 percent between 1993 and 2001 reported by Day *et al*. (2003, p. 673).

Figure 6. Regression line showing mean movement rates (targets/hr) of adult Newell's shearwaters during their incubation and early chick-rearing stage for all 13 radar sites surveyed, 1993–2013 (Raine *et al*. in press). Vertical bars represent ±1 SE.



Ainley *et al*. (2001) had documented 14 shearwater breeding colonies distributed across Kaua'i (Figure 7). Currently, several of these formerly large Newell's shearwater colonies in Kalāheo, Kaluahonu, and Makaleha on the island of Kaua'i have declined dramatically in recent decades to near extirpation (Raine *et al*. in press). No population data exists for Newell's breeding on other islands.

Figure 7. Map of Kaua'i showing Newell's shearwater breeding colony locations.



Map showing Newell's shearwater breeding colony locations (n=14); unfilled circles (n=9) represent colonies near extirpation (<5 burrows) (Ainley *et al*. 2001).

In two breeding colonies on Kauaʻi, ULP and Hono o Nā Pali Natural Area Reserve (NAR), efforts are currently underway to curtail the population decline through the removal of predators. The reproduction output of the 104 monitored Newell's shearwater pairs breeding within these areas are measured in terms of their breeding or reproductive success. Since 2011, the breeding success of Newell's shearwater pairs within ULP has increased by 27 percent, from 0.692 to 0.882 in 2011 and 2015, respectively (Raine *et al*. 2016a, p. 16). This increase is a direct result of the ungulate exclusion fence completed in 2010 and intensive predator control that began in 2011. Indeed prior to these conservation efforts surveys at ULP documented a 0.545 reproductive success rate (Table 2). Newell's are less prevalent than petrels within Hono o Nā Pali Natural Area Reserve (NAR) and have not been as successful in reproducing (Table 2) due primarily to predation by cats, rats and feral pigs. In addition to the reproductive success rates from Newell's burrows listed in Table 2, there were an additional 162 burrows at ULP and Hono o Nā Pali NAR monitored in 2015 that could not be identified to species (i.e., burrows were either used by Newell's shearwaters or petrels).

Table 2. Reproductive success rates for Newell's shearwater breeding pairs (*n*).

Year	2010 (*n*)	2011 (*n*)	2012 (*n*)	2013 (*n*)	2014 (*n*)	2015 (*n*)
ULP	0.545 (11)	0.692 (15)	0.682 (34)	0.784 (46)	0.840 (59)	0.882 (82)
HNP NAR-Pōhākea	no data	no data	no data	0.571 (8)	0.375 (20)	0.667 (22)

Pairs were monitored each year (2010–2015) at Upper Limahuli Preserve and Hono o Nā Pali Natural Area Reserve's Pōhākea site. No Newell's shearwaters have been confirmed at the Pihea and North Bog sites of Hono o Nā Pali NAR.

Threats

Primary threats to the Newell's shearwater include artificial nighttime lighting (Reed *et al*. 1985; Cooper and Day 1998), collisions with power lines (Cooper and Day 1998; Podolsky *et al*. 1998), predation by introduced predators (Raine and Banfield 2015b, 2015c), and changes to breeding habitat due to introduced invasive plants (Troy *et al*. 2014). These threats to the Newell's shearwater have been steadily increasing.

Artificial light sources collectively are a significant mortality factor associated with Newell's shearwaters (Ainley *et al*. 2001; Troy *et al*. 2011). Upward projecting nighttime lighting interferes with the shearwaters ability to navigate to and from their breeding sites. Shearwaters, primarily fledglings and sub-adults are disoriented by nighttime lighting and will circle light sources until they become exhausted and fall to the ground, where these birds are vulnerable to being killed by feral cats, dogs, or vehicles (Travers *et al*. 2013, p. 81). They often fly into utility wires, poles, trees, and buildings and fall to the ground; this phenomenon is referred to as "fallout". Once these seabirds fall to the ground, they are unable to regain flight unless they have access to an area with sufficient take-off conditions to allow enough air to move under their wing to provide lift (Ainley *et al*. 2015, p.32). Since 1979, the DOFAW on Kauaʻi has supported the Save our Shearwaters (SOS) program to collect "downed" Newell's shearwaters and Hawaiian petrels (*i.e*., birds that have either collided with structures or fallen out, or have been injured or killed due to exhaustion caused by light attraction). Over a 37-year period (1979-2016), the SOS program documented a total of 30,552 Newell's shearwaters recovered, injured or killed due to artificial nighttime lighting (DOFAW 2016). In the 1980s through 1990s, an

average of 1,247 Newell's shearwaters were processed by the SOS program each year, where carcasses were documented or injured birds were rehabilitated and released (Raine *et al. in press*).

Adults and sub-adults are subject to collisions with power lines while flying between their nesting colonies and at-sea foraging areas (Cooper and Day 1998, p. 18; Podolsky *et al.* 1998, p. 21). Nestlings are indirectly affected as they rely on provisioning from both parents in order to survive, thus the loss of either parent results in nestling fatality. In 1993, in a single breeding season Podolsky *et al*. (1998, p. 30) documented deaths of at least 70 breeding adults and 280 sub-adult shearwaters over the summer months, in addition to 340 fledgling deaths in the autumn months, all as a result of collisions with power lines on Kaua'i. However, this study covered only the eastern and southern portions of the island (Podolsky *et al.* 1998, p. 30).

Based upon recent information collected from passive acoustic song meters (n=51) by the Kaua'i Island Utility Cooperative (KIUC) Underline Monitoring Program, the Service has conducted modeling to extrapolate the amount of documented take (i.e., collisions with power lines) to the entire power line system, encompassing power lines and infrastructure in the central, eastern, northern, southern, and western portions of the island (USFWS 2017). As a result of covered activities under the KIUC Short-Term Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP), the estimated annual take, including direct and indirect mortalities and direct injuries caused by power line collisions are: 3,560 dead and 4,736 injured Newell's shearwaters, across Kaua'i. The estimated number of direct mortalities ranges from 1,664 to 2,960 Newell's shearwaters. These numbers are substantially greater than what was anticipated at the time the ITP was issued. The KIUC Short-Term HCP and Incidental Take Permit authorized the annual take of up to 162 Newell's shearwaters and 2 Hawaiian petrels (adults and sub-adults) from 2011 to 2016.

Introduced predators, particularly cats, rats, feral pigs, mongoose (*Herpestes auropunctatus*), and barn owls, are a severe threat to the continued existence of the Newell's shearwater. Adults, sub-adults, and young are susceptible to predation by these introduced predators (Raine and McFarland 2013a, p. 16; Raine and Banfield 2015a, p. 38). These non-native predators occur throughout the Hawaiian Islands, with the exception of the mongoose, which its establishment is uncertain on the island of Kaua'i (Phillips and Lucey 2016).

Another threat to the Newell's shearwater is habitat loss due to invasive vegetation. Invasive plants alter the three-dimensional structure of Hawaiian forests (Asner *et al.* 2008) as well as disrupt other ecological processes. A vegetation shift in areas of Kaua'i away from native understory to invasive vegetation, including but not limited to strawberry guava (*Psidium cattleianum*) and ginger (*Hedychium gardnerianum*) has been associated with at least one abandoned Newell's shearwater colony on Kaua'i (KESRP, unpublished data). Extreme weather events such as hurricanes 'Iniki (1992) and 'Iwa (1982) have caused significant disruptions in forest habitat and, coupled with colonization of invasive plants, have resulted in permanent habitat loss for forest birds (Pratt 1994). In addition, areas of degraded habitat have facilitated the spread of invasive mammalian predators (Raine *et al.* 2016b, 2016c, 2016d). For example, in a heavily degraded habitat Ainley *et al.* (2001) counted 30 dead Newell's shearwater sub-adults and adults due to predation in one season (Ainley *et al.* 2001, p. 121).

Other threats include climate change and its affects to both seabird adult survivorship and recruitment (Sandvik *et al.* 2012) by generally affecting food availability (Oro 2014). Research by Spear *et al.* (2007) and Ainley *et al.* (2014) also indicate that Newell's shearwaters forage readily with yellowfin tuna and may be vulnerable to fishery interactions.

Survival and Recovery Needs

For purposes of this Opinion, the "survival condition" of the Newell's shearwater in the wild represents the level of reproduction, numbers, and distribution necessary to support a persistent population in the Hawaiian Archipelago that is fully protected by the ESA. For purposes of this Opinion, the "recovery condition" of the Newell's shearwater is that where the threats to the species have been addressed such that the protections of the ESA are no longer necessary to insure the survival condition of the Newell's shearwater in the wild.

The recovery plan (USFWS 1983) for the Newell's shearwater does not contain recovery criteria; rather general goals are listed that require revision due to a substantial amount of new information. For example, the recovery plan (USFWS 1983, p. 22) calls generically for reducing annual SOS collected, lighting related fallout of Newell's shearwaters to less than 100 birds, and for developing efficient predator control methods to protect nesting sites.

In 2015, the Service completed the draft *Newell's Shearwater Recovery Strategy* (USFWS 2015). The Draft Newell's Shearwater Recovery Strategy (USFWS 2015) focuses on managing and enhancing extant colonies in areas with minimal light impacts, mitigating threats at the colony, and those encountered while in transit to the colony, and creating new colonies through social attraction and translocation (USFWS 2015).

This recovery strategy relies on actions completed by Kaua‘i Island Utility Cooperative under their Short Term Habitat Conservation Plan (STHCP), including a predator-exclusion fencing feasibility study (Young and VanderWerf 2014) and the 2013–2014 Kaua‘i island-wide auditory survey reports to locate new shearwater and petrel colonies (Banfield *et al*. 2013; Raine and Banfield 2015b). The draft strategy describes general tools (i.e., manual predator control, ungulate and predator-exclusion fences) as well as translocation and social attraction activities to protect, augment, or create new breeding colonies. Removing terrestrial predators (e.g. feral cats) that depress adult and pre-breeder survival and establishing predator-free breeding habitat is required to successfully restore seabird colonies (Buxton *et al*. 2014; Jones and Kress 2012). On Kaua‘i, repeated access into the colony to conduct intensive predator control in open systems can degrade sensitive vegetation, while predator ingress and predation remains constant. In montane habitat, manual predator control should be conducted as an incremental step towards the goal of constructing a predator exclusion fence culminating with predator removal or eradication.

Predator fencing is the most effective tool against mammalian depredation at the colony, particularly for indigenous species that are highly sensitive to predation (Young *et al*. 2013; Norbury *et al*. 2014). Within the current range of Newell's shearwater, topography, streams, and remoteness limit the number of sites and size of areas that can be protected with predator exclusion fences. Preliminary surveys of eight sites known to have Newell's shearwater populations identified three as suitable for predator fencing; the other five were eliminated because of topography or streams (Young and VanderWerf 2014). Suitability for fencing at

these sites should be verified. The KESRP continues to survey areas for Newell's shearwater activity so active sites suitable for predator fencing, in addition to those identified in our USFWS 2015, could be identified in the coming years. At a minimum, the two sites recommended by Young and VanderWerf (2014) with identified Newell's shearwater burrows should be fenced. The third site identified in this study was found to have only Hawaiian petrel burrows. Other sites located independently by KESRP and verified as occupied and suitable for fencing should be fenced. These sites should be protected using manual predator control until the fences are complete. To increase recruitment once fences are complete, social attraction should be a component of the project (see below).

The draft strategy prioritizes management efforts to occur in colonies already receiving conservation management actions under the existing KIUC Short Term HCP, by relying on the concept of a 'no light conservation zone' or NLCZ to define an area which contains very little artificial nighttime lighting or light impingement. The NLCZ is based on the belief that artificial nighttime lighting is the sole factor constraining the distribution of Newell's shearwater breeding colonies and therefore colonies located in the NLCZ are more viable and should receive conservation actions. The NLCZ encompasses the northwest corner of Kaua'i and includes coastal areas as well as mountainous steep terrain with a relatively small human population, resulting in minimal artificial nighttime lighting in the area. The NLCZ contains very little nighttime lighting currently, unfortunately there are no county ordinances or other mechanisms to support or require the continued existence of an NLCZ into the future. The draft recovery strategy also calls for generally minimizing the effects from artificial nighttime lights and power lines.

In addition to this isolated area there is a need to generally address light attraction. Many sources of lights have already been modified to minimize attraction of fledging Newell's shearwater, but a standard island-wide study is needed at regular intervals to identify new locations of concern for light attraction and those that might be out of compliance. A study is needed to test the various types of LED bulbs available against the existing low pressure sodium bulbs to assess which is most suitable for seabirds. Once the Service determines what configuration has the least impact on Newell's shearwater, lights should be outfitted with these bulbs, targeting the highest impact lights first. In the interim, problematic lights should be removed, turned off during the fledging season, reduced in intensity, or fitted with shields to direct the light toward the ground to minimize impacts.

The draft strategy does not comment on any elements (e.g., habitat requirements, genetic representation, and population resiliency) that would contribute to and define the long-term health needs of the Newell's shearwater population.

Population viability modeling efforts conducted by the Service defined Newell's shearwater adult survivorship at 0.92, based on a boxplot assessment and linear regression of adult survivorship data from proxy Procellariformes (USFWS 2017, p. 122). Because the Newell's reproductive strategy has evolved to have a high adult survivorship, adult mortality is particularly harmful to the population. Left unchecked low adult survivorship (or conversely high adult mortality) will serve to depress the colony population to unsustainable numbers thereby increasing the vulnerability of these populations to invasive predators and other

stochastic events (e.g., hurricanes damaging breeding habitat or climate shifts altering food availability).

The survival and recovery needs of the Newell's shearwater are described in the succeeding paragraphs based on components from recovery documents highlighted above, as well as best currently available scientific information. The survival condition of the Newell's shearwater is the biological factors necessary for a persistent population. The survival condition of the Newell's shearwater will need to include over a generation time (i.e., 7-8 years), an annual and stable breeding probability of 0.80 and consistently high reproductive success levels of at least 0.85 fledglings per breeding pair, per season. In order to achieve these biological factors, immediate actions need to be taken to protect occupied breeding habitat from invasive predators by constructing predator-exclusion fences and concurrently increasing predator removal efforts around the two extant and accessible breeding colonies on Kaua'i (within Hono o Nā Pali and Upper Limahuli). Once a predator exclusion fence is constructed and predators are reduced or eliminated within the fence, management efforts should incorporate social attraction techniques using acoustic and visual/olfactory cues (Buxton and Jones 2012) to lure prospecting non-breeders and sub-adults into the protected breeding habitat. Current telemetry data shows that the Hono o Nā Pali and Limahuli-Mānoa colonies are minimally affected by power line collisions and artificial nighttime lighting based on actual flight paths (n = 9) to and from foraging areas and breeding habitat (Raine *et al*. 2016f, p. 24). The main land-based threats to the Hono o Nā Pali and Upper Limahuli colonies are introduced predators and invasive vegetation.

Maintaining the ecological life-support systems (i.e., habitat requirements) for the two largest Newell's shearwater breeding colonies is critical to the long-term survival. Management of breeding habitat within predator exclusion fences should include invasive vegetation control during the non-breeding season to support a native understory and canopy and biosecurity measures to prevent introductions of invasive flora and fauna. The size of the predator exclusion fences will be dictated to some extent by the terrain, however each exclusion fence should contain the extant colony, anticipate and minimize erosion, and be large enough (≥10 ha) to encompass enough breeding habitat to sustain at least 1,500 active breeding pairs and small enough to be adequately maintained in perpetuity.

Survival of the Newell's shearwater cannot be predicated solely on the existence of two neighboring breeding colonies on a single island. The survival needs of the Newell's shearwater include reducing adult mortality occurring range wide due to the attraction to artificial lights and collisions with power lines. The data gathered from Travers *et al*. (2014) and Travers *et al*. (2015) have vastly improved our knowledge of the scope of the impact of power line collisions and have identified the power line segments, of those surveyed, that have the greatest impact on seabirds. Lines along Power Line Trail in the north central region of the island were responsible for 75 percent of the documented strikes in 2014 (Travers *et al*. 2015). This stretch of lines should be prioritized to be buried, lowered in height, modified such that the top lines are removed, re-directed after appropriate studies to assess minimization effectiveness, or made visible in some manner (e.g., through the use of lasers or bird diverters, both of which are being tested by KESRP). As additional stretches of lines are monitored each year, other high-impact zones will be identified and appropriate avoidance or minimization methods should be

implemented. Reducing the impact of power lines is critically important to ensuring the continued existence of Newell's shearwater on Kaua'i.

The SOS program on Kaua'i is designed to reduce mortality of fledglings and adults that have been grounded (i.e., unable to regain flight) due to the attraction to artificial lights or collisions with power lines. The continuation of the SOS program is a clear step to reduce adult mortality.

In summary, the recovery condition of the Newell's shearwater is the necessary survival condition plus specific measures to adequately address the specific threats contributing to the species range-wide endangerment. Specific measures needed to achieve a recovery condition include the elimination or minimization of all three high collision-risk power lines (the Power Line Trail, Kīlauea, and the Central Region segments) on the island of Kaua'i. The recovery condition will need to include the creation or active management of at least two additional healthy shearwater colonies on Kaua'i and two healthy shearwater colonies on Maui. For example, the two additional colonies on Kaua'i could be any of those identified by Young and VanderWerf (2014), or other colonies located independently by KESRP. For the purposes of this Biological Opinion, a healthy Newell's shearwater breeding colony is defined as containing a: (1) minimum of 1,500 breeding pairs or active burrows, based on long-term monitoring data on the Manx shearwater (Fraser *et al*. 2013; Brooke 1990; BirdLife International 2016b); (2) suitable breeding habitat, including predator-free or low levels of predator presence adequate to sustain in perpetuity a minimum of 1,500 breeding pairs; and (3) a colony-population growth rate, λ equal to or greater than one, sustained over at least a generation time. Protecting and augmenting any existing Newell's shearwater colonies on Maui will ensure genetic representation and redundancy, allowing the Newell's shearwater to maintain an adaptability and evolutionary capacity over time.

New management actions that have occurred in the last five years include:

- Completion of the 3-hectare predator exclusion fence in 2015, at the Nihoku conservation unit within Kīlauea Point National Wildlife Refuge. Newell's shearwater nestling translocations began in 2016 and will continue over the next four years with the goal of establishing a new Newell's shearwater breeding colony within a fully protected predator-free area on Kaua'i.
- Predator control efforts to benefit Newell's shearwaters that began in June 2016 and expected to continue for the next 2-4 years, within a discrete area ($\leq$ 1 hectare) in Hono o Nā Pali Natural Area Reserve, funded by the American Bird Conservancy.
- Construction of two 1.8-hectare predator-exclusion fences (one each for Newell's shearwater and Hawaiian petrels) in West Maui to protect unoccupied Newell's shearwater breeding habitat. Upon completion of the fence in 2013, social attraction techniques including installation of artificial burrows, decoys, and auditory broadcasts calls have been implemented at the site, along with native vegetation restoration efforts. In June 2016, two prospecting Newell's shearwater adults were recorded on remote cameras (Craig 2016, p. 28).

Recommendations for Future Actions:

- Maintain support and oversight of the two 1.8-hectare Makamakaʻole Seabird Predator-Proof Fences in West Maui, constructed by First Wind, Inc. and maintained by Kaheawa Wind Power LLC, specifically to create a new Newell's shearwater breeding colony within a predator-free area on Maui. Efforts at this site should be focused on restoring native montane habitat, since this site was previously used for agricultural purposes.
- Conduct additional acoustic surveys within remote areas of Haleakalā National Park in southeast Maui, to identify the areas of Newell's breeding habitat and the relative colony population size.
- Construct predator exclusion fences to fully enclose and protect colonies within the Hono o Nā Pali NAR and the entirety of Upper Limahuli colony.
- Construct an ungulate exclusion fence to protect the Honopū seabird colony to manage depredation by pigs and habitat damage from pigs and goats. The area of Honopū where the ungulate fence would be installed is located within DLNR State Parks in northwestern Kauaʻi.
- Construct a cat-exclusion fence located in the State's Hono o Nā Pali Natural Area Reserve, enclosing the colony.
- Implement erosion control measures, best management practices (e.g., area closures) and native vegetation restoration to prevent damage to sensitive montane habitat, caused by continual access into seabird colonies.

Status of the Hawaiian Petrel

Listing Status, Taxonomy, and Species Description
The Hawaiian petrel (*Pterodroma sandwichensis*) was listed as an endangered subspecies (Hawaiian dark-rumped petrel, *Pterodroma phaeopygia sandwichensis*) in 1967 (32 FR 4001; March 11, 1967). The *Hawaiian Dark-rumped Petrel and Newell's Manx Shearwater Recovery Plan* was published in 1983 (USFWS 1983). No revisions to this plan have been made. A species five-year review was completed in 2011. The review recommended no change to the listing status.

The Hawaiian petrel is a medium-sized seabird in the Pterodromini clade known as "gadfly" petrels because of their agile and erratic flight behavior (Judge *et al*. 2014, p. 1). The *Pterodroma* genus consists of 33 distinct species of seabirds, of which 23 are extant ranging throughout the Indian, Atlantic, and Pacific oceans. The Hawaiian petrel and Galapagos petrel (*Pterodroma phaeopygia*; formerly referred to as *Pterodroma phaeopygia phaeopygia*) were commonly known as two subspecies of the dark-rumped petrel (*Pterodroma phaeopygia*) (USFWS 1983, p. 1). Based on differences in vocalizations, morphology, behavior (Tomkins and Milne 1991, p. 33; Banks *et al*. 2002, p. 898), and genetics (Browne *et al*. 1997, p. 814) *P. sandvicensis* and *P. phaeopygia* were recognized as distinct and elevated to species rank by the American Ornithologists' Union in 2002 (Banks *et al*. 2002, p. 898). Force *et al*. (2007, pp. 242-247) suggested several characters may be used to visually distinguish the birds at sea, including plumage, size, shape and manner of flight, and distribution and habitat at sea. The Hawaiian petrel, on average, has a smaller wingspan, tarsus, and bill compared to the Galapagos petrel (Brooke 2004). The black markings of the forehead are variable among Galapagos birds and are

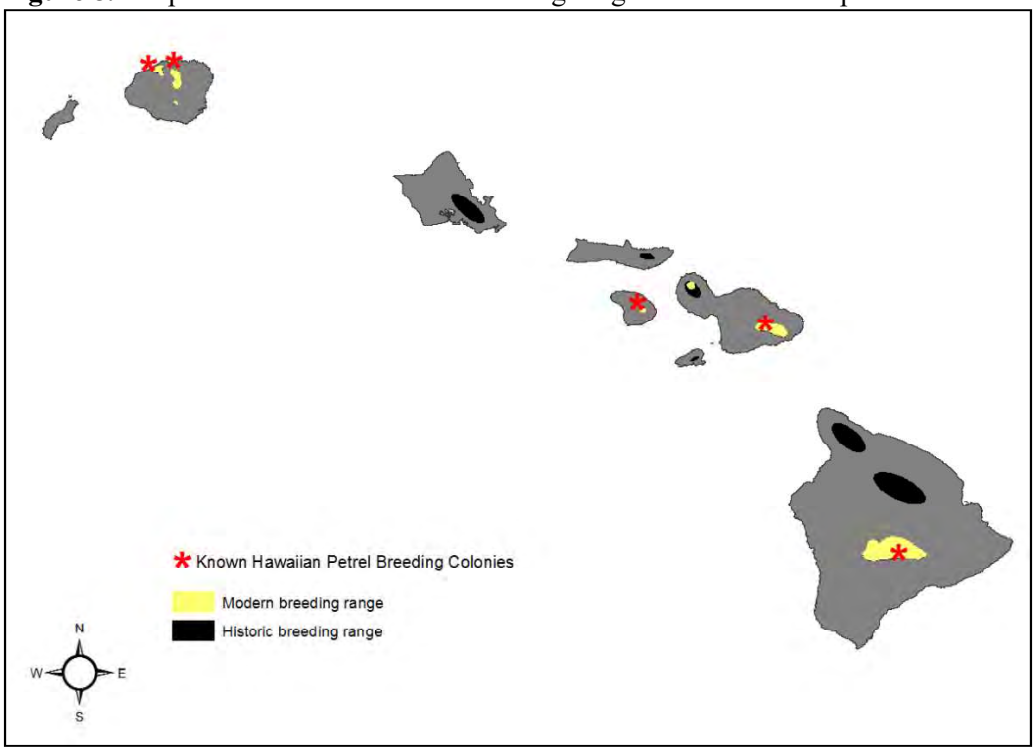
lacking in Hawaiian birds (Tomkins and Milne 1991, p. 33). Moreover, Hawaiian and Galapagos petrels are geographically separated, and do not share at-sea foraging areas (Spear *et al*. 1995, p. 633; Adams *et al*. 2009).

The Hawaiian petrel is approximately 16 inches long (40 cm) and has a wing span of about 3 ft (90 cm). It has a dark gray head, wings, and tail, and a white forehead and belly. The Hawaiian petrel has a stout grayish-black bill that is hooked at the tip, and feet that are pink and black.

Historic and Current Distribution

The Hawaiian petrel was once abundant on all southern islands of the Hawaiian Archipelago including Hawai‘i, Maui, Lāna‘i, Kaho‘olawe, Moloka‘i, O‘ahu, and Kaua‘i (USFWS 1983, p. 3; Ainley *et al*. 1997a, p. 24; KIRC 2015, p. 19). By the 1980s, the Hawaiian petrel population had experienced a significant range contraction and today breeding colonies are found only in remote or high elevation areas on the islands of Hawai‘i, Maui, Lāna‘i, and Kaua‘i (Figure 8). The known breeding habitat varies by location: on East Maui (Haleakalā) and Hawai‘i Island (Mauna Loa), petrels breed in subalpine habitat at high elevation, while on Kaua‘i and Lāna‘i they breed in lowland wet or in wet cliff habitat with dense ferns (VanZandt *et al*. 2014). The current distribution of the Hawaiian petrel is believed to be an artifact of range contraction resulting from predation and habitat destruction rather than preference (Hu *et al*. 2001). Hawaiian petrel breeding colonies are known to exist at five locations on four different islands (Figure 8), although fragmented Hawaiian petrel breeding occurrences (<10 burrows) have been reported in other areas (Simons and Hodges 1998; Spencer 2010).

Figure 8. Map of modern and historic breeding range of the Hawaiian petrel.



Map of the modern and historic breeding range of the Hawaiian petrel showing the southern islands in the Hawaiian Archipelago. Historic (black) and modern (yellow) breeding ranges are illustrated. Historic accounts from islands

outside of Maui are limited and thus the historic breeding range is likely conservative. Currently Hawaiian petrel breeding colonies exist at five locations on four different islands.

Life History

Hawaiian petrels are a *K*-selected species with a reproductive strategy most suited to a stable environment (Stearns 1977). Hawaiian petrels have a long lifespan (up to 35 years), do not reproduce until 6 years of age, lay one egg per year, and require significant parental investment for offspring (Simons and Hodges 1998). Hawaiian petrel breeding season is typically characterized into four consecutive periods: (1) prospecting or pre-laying stage begins in late February, followed by a 2-4 week exodus when breeding adults forage to build-up reserves; (2) the egg laying stage begins at the end of April with incubation through early July; (3) the nestling and chick-provisioning stage continues through early October; and (4) fledging occurs in October through mid-November (NPS 2012, p. 80; Adams 2013). This breeding chronology begins approximately 2-3 weeks later for Hawaiian petrel colonies on Kaua‘i (Judge *et al*. 2014, p. 83; KESRP 2017a). Petrel offspring require up to five months of care from both parents in order to survive. Hawaiian petrels, similar to other birds in the Order Procellariiformes, exhibit strong natal philopatry, with breeding pairs returning to the same burrow to breed each year (Bried *et al*. 2003, p. 242).

Hawaiian petrels are exclusively pelagic, spending much of their time at-sea resting or foraging for squid, small fish, and crustaceans displaced to the surface by schools of tuna (Simons 1985). Satellite telemetry studies in 2006-2008 indicate the majority of Hawaiian petrels (n=20) forage in the North Pacific with few reported south of 10°N (USGS unpublished). During the chick-provisioning stage, each adult foraged an average distance of up to 11,000 km during a 2-3 week period before returning to the nesting site (n=9; Adams *et al*. 2009). Non-breeding adults were documented traveling an average distance of 23,000 km over a six month period (n=3; Adams *et al*. 2009). All transit over land occurs in darkness, with a peak over land passage during the year coinciding with the late incubation and chick rearing stages (Travers *et al*. 2015, p. 18). Fledglings leaving the nest for the first time exhibit strong phototropic behavior and rely on ambient light from the moon and stars to navigate to open ocean (Telfer *et al*. 1987, p. 410).

Current Population Demographics

Pelagic surveys estimate the total Hawaiian petrel population at 19,000 (95% CI = 11,000-34,000) including juveniles and subadults, and an estimate of 4,500-5,000 breeding pairs (Ainley *et al*. 1997a; Spear *et al*. 1995). Croxall *et al*. (2012) estimated a global population of the Hawaiian petrel to be 9,000 to 16,000 mature individuals. Simons (1984, p. 1067) found an 89% breeding frequency of adult Hawaiian petrels (percentage of adults that attempt to breed each year) in a study of 15 accessible, undisturbed, unpredated burrows of established breeding adults. Average breeding probability for Procellariformes is estimated at 0.82 (Griesemer and Holmes 2011, p. 17). Demographic studies of long-lived seabirds have shown that breeding probability increases with age (Ainley and DeMaster 1980) and is a function of individual fitness and habitat quality (Lescroël *et al*. 2009).

Colonial breeding populations of long-lived seabird species rely on a high rate of adult survivorship. Simons (1984, p. 1067) estimated Hawaiian petrel adult survivorship to be 0.93 in the absence of predation and dropped to 0.80 or lower in years of high predation events.

Average sub-adult or juvenile survivorship for Procellariformes is 0.65 to 0.93 (Simons 1984, p. 1067).

The majority of the Hawaiian petrel global population breeds on the island of Maui within Haleakalā National Park, a location that has had the longest consistent and intensive predator control in place since the 1970s. A status of all known extant Hawaiian petrel breeding colonies and the type of active management (i.e., predator control, invasive vegetation control) if any, conducted at each location are shown in Table 3. While fledgling success in the last few years has improved for the Kauaʻi colonies, overall current trend for the Kauaʻi colonies is decreasing.

Due largely to natal and breeding philopatry as well as foraging segregation, limited gene flow occurs within seabird species populations (Friesen *et al*. 2007). Welch *et al*. (2012, p. 23) examined nuclear sequences from 164 Hawaiian petrels representing all extant island colonies and estimated the average migration rate was 0.467 to 10 migrants per generation for petrel populations breeding on different islands. Wiley *et al*. (2012, p. 124) sampled 80 Hawaiian petrels from contemporary Hawaiʻi and Kauaʻi subpopulations and found high levels of genetic differentiation between petrels nesting on Kauaʻi and Hawaiʻi islands (F_{ST}=0.50). Research conducted by Stiebens *et al*. (2013) highlights the conservation value of the Kauaʻi petrel population by demonstrating that philopatry is an evolutionary strategy to conserve a high adaptive potential at the margins of a species' distribution, while asymmetric gene flow maintains genetic connectivity with the rest of the population.

Table 3. Status of all known extant Hawaiian petrel breeding colonies.

Colony	Island	Type of active management	Population size (minimum no. known burrows)	Direction of current trend
Mauna Loa	Hawaiʻi	Predator control	Approx. 100	decreasing
Haleakalā	Maui	Predator control	2,547	increasing
Hono o Nā Pali	Kauaʻi	Predator control	240	decreasing
Limahuli-Mānoa	Kauaʻi	Predator control, invasive vegetation control	26	decreasing
Lānaʻihale	Lānaʻi	None	87	decreasing

Status is based on data from HAVO (2015), NPS (unpublished data), Raine *et al*. (2016a, 2016b, 2016c, 2016d), and VanZandt *et al*. (2014).

Threats

Primary threats to the Hawaiian petrel include predation by introduced predators (Hodges and Nagata 2001; Raine and Banfield 2015a, 2015b) particularly cats, rats, mongoose, feral pigs, and barn owls; as well as collisions with power lines (Cooper and Day 1998; Podolsky *et al*. 1998); light attraction, although at a lower rate than Newell's shearwaters (Reed *et al*. 1985; Cooper and Day 1998); and changes to breeding habitat due to introduced invasive plants (Troy *et al*. 2014). Fifty-four percent of all known Hawaiian petrel deaths at Haleakalā National Park, from 1991 to 2011 (n=532) have been due to introduced predators (NPS 2012). Other studies suggest another threat to seabirds is climate change and its affects to both seabird adult survivorship and

recruitment (Sandvik *et al*. 2012) by generally affecting food availability (Oro 2014). However, other anthropogenic impacts such as oil-spills and interactions with fisheries, as well as previously described land-based threats may confound the association between climate and seabird demography.

Survival and Recovery Needs
For purposes of this BO, the "survival condition" of the Hawaiian petrel in the wild represents the level of reproduction, numbers, and distribution necessary to support a persistent population in the Hawaiian Archipelago that is fully protected by the Act. For purposes of this BO, the "recovery condition" of the petrel is the condition where the threats to the species have been addressed such that the protections under the Act are no longer necessary to insure the survival condition of the petrel in the wild.

The recovery plan (USFWS 1983) for the petrel does not contain recovery criteria; rather general interim objectives are listed that require updating due to a substantial amount of new information. For example, the recovery plan (USFWS 1983) calls for long-term protections of the Haleakalā breeding colony the only known breeding colony at the time, and for a reduction of annual Hawaiian petrel fallout to near 0; however light attraction has not been determined to be a significant threat factor for petrels (Reed *et al*. 1985; Cooper and Day 1998).

The survival and recovery condition of the Hawaiian petrel will need to include representation across Hawai‘i, Maui, Kaua‘i, and Lāna‘i islands to ensure adequate genetic diversity to sustain the evolutionary adaptive potential for the species (Willi *et al*. 2006). Three similar petrel species endemic to their respective archipelago or island group (the Westland petrel, *Procellaria westlandica;* the Stejneger's petrel, *Pterodroma longirostris*; and De Filippi's petrel, *Pterodroma defilippiana*) share identical life histories and philopatric behaviors with the Hawaiian petrel and all exhibit a stable global population (Croxall *et al*. 2012) that includes healthy breeding colonies located on at least 50 percent or more of all islands within their respective archipelago or island group (Wood and Otley 2013; BirdLife International 2016a).

The survival condition of the Hawaiian petrel will rely on the resiliency or health of the five extant individual breeding populations to withstand stochastic events (e.g., tropical hurricanes, changes in food availability). Currently the limiting factor, and indeed the cause of poor health among the extant breeding populations is the lack of suitable breeding habitat free of invasive introduced predators. Furthermore, data from Haleakalā National Park has shown that while predators remain present at low levels due to intensive predator control, other land-based threats (e.g. power lines and artificial nighttime lighting) are highly reduced or non-existent and thus likely are contributing factors in explaining the increasing population trend in the Haleakalā breeding colony.

The recovery condition of the Hawaiian petrel will need to include redundancy in the number and distribution of breeding colony locations on each island, particularly the largest islands with extant breeding populations, including Hawai‘i, Maui, and Kaua‘i. To ensure the viability of each island representational unit and genetic connectivity of populations, the recovery condition should include a minimum of two healthy breeding colonies distributed each on Hawai‘i, Maui, and Kaua‘i islands, in addition to one healthy breeding colony on Lāna‘i. For the purposes of

this Opinion, a healthy Hawaiian petrel breeding colony is defined as (1) containing a minimum of 1,000 breeding pairs or active burrows, based on long-term monitoring data from similar petrel species; (2) suitable breeding habitat, including predator-free or low levels of predator presence adequate to sustain in perpetuity a minimum of 1,000 breeding pairs; and (3) a population growth rate, λ equal to or greater than one, sustained over at least a generation time (i.e., 7 years).

New management actions that have occurred in the last five years include:

- Construction of 5.5 miles of cat-proof fencing to protect the Mauna Loa Hawaiian petrel colony within Hawai‘i Volcanoes National Park. The project was initiated in 2013 and completed in 2016. The cat-proof fence protects 243 hectares of occupied Hawaiian petrel breeding habitat.
- Construction of two 1.8-hectare predator-exclusion fences in West Maui to protect unoccupied Hawaiian petrel breeding habitat. Upon completion of the fence in 2013, social attraction techniques including installation of artificial burrows, decoys, and auditory broadcasts calls have been conducted at the site, along with native vegetation restoration efforts. In 2015, the first prospecting Hawaiian petrel adult was recorded on remote cameras (Craig 2016, p. 26).
- Completion of a 3-hectare predator exclusion fence and successful translocation and fledging of nine Hawaiian petrel nestlings in 2015, at the Nihoku conservation unit within Kīlauea Point National Wildlife Refuge. Hawaiian petrel nestling translocations will continue over the next four years with the goal of establishing a new Hawaiian petrel breeding colony within a fully protected predator-free area on Kaua‘i.
- Predator control efforts to benefit Hawaiian petrel that began in June 2016 and expected to continue for the next 2-4 years, within a discrete area ($\leq$ 1 hectare) in Hono O Nā Pali NAR, funded by the American Bird Conservancy.
- Construction of ungulate exclusion fencing in 2017, to enclose 856 hectares at Haleakalā National Park within the new Nu‘u unit, added to the park in 2008.

Recommendations for Future Actions:

- Maintain consistent, intensive predator control within and surrounding the Mauna Loa Hawaiian petrel colony.
- Conduct strategic and low impact surveys for occupied Hawaiian petrel breeding habitat within the extensive Nu‘u unit of Haleakalā National Park in conjunction with ungulate fence construction, in order to prioritize predator control efforts in this area.
- Construct a predator exclusion fence to protect the largest extant Hawaiian petrel colony at Hono o Nā Pali, Kaua‘i while limiting the impact and restoring where possible the montane wet ecosystem of this area.
- Conduct predator control at the Lāna‘ihale Hawaiian petrel colony, in conjunction with and prior to any additional ground surveys in order to limit vegetation trampling and predator ingress.

- Conduct colony monitoring once the Mauna Loa Hawaiian petrel fence is complete and colony monitoring at the Haleakalā colony to obtain updated population demographic information and life history parameters.
- Maintain support and oversight of the 1.8-hectare Makamakaʻole Seabird Predator-Proof Fence in West Maui, constructed by First Wind, Inc. and maintained by Kaheawa Wind Power LLC, specifically to create a new Hawaiian petrel breeding colony within a protected predator-free area on Maui.

Status of the Band-Rumped Storm-Petrel

Listing Status, Taxonomy, and Species Description
The Hawaiʻi distinct population segment of the band-rumped storm-petrel (*Oceanodroma castro*) (band-rumped storm-petrel) was listed as endangered effective on October 31, 2016 (81 FR 67786). For a population to be listed under the Act as a distinct vertebrate population segment, three elements are considered: (1) the discreteness of the population segment in relation to the remainder of the species to which it belongs; (2) the significance of the population segment to the species to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing (61 FR 4722). The Hawaiʻi population of the band-rumped storm-petrel may be distinct based on geographic and distributional isolation from other band-rumped storm-petrel populations elsewhere in the Pacific and Atlantic oceans. A population also can be considered "discrete" if it is delimited by international boundaries across which exist differences in management control of the species. The Hawaiian Islands population of the band-rumped storm-petrel is the only population within U.S. borders or under U.S. jurisdiction.

The band-rumped storm-petrel is a seabird in the family Hydrobatidae (order Procellariiformes) and a member of the Northern Hemisphere subfamily Hydrobatinae (Slotterback 2002, p. 2), with some taxonomic questions unresolved. Prior to 1900, this species had been described as an unnamed petrel in the genus *Thalassidroma* (Dole 1869, 1879 *in* Stejneger 1887, p. 78), as *Cymochorea cryptoleucura* (Ridgeway 1882, pp. 337– 338), and as *Oceanodroma cryptoleucura* (Stejneger 1887, p. 78). After Henshaw's 1902 publication, the Hawaiian population was known as *O. castro cryptoleucura*, the Hawaiian storm-petrel (Harrison *et al*. 1990, p. 47). Austin (1952, pp. 395-396) examined eleven museum skins from the Hawaiʻi population and studied the taxonomy of the band-rumped storm-petrel and concluded that, although the various populations exhibited minor size differences, these differences were not significant and the populations were best considered as belonging to a single species with no separable subspecies. Since then taxonomists have typically combined the Pacific populations (Galapagos Islands, Japan, and Hawaiʻi) of the band-rumped storm-petrel into a single taxon, and currently the American Ornithologist's Union (AOU) regards the species as monotypic with no recognized subspecies (Slotterback 2002). However, some authors designate *Oceanodroma castro* as referring solely to the Madeiran storm-petrel, breeding in the Azores Archipelago and which may belong to two distinct, albeit sympatric, populations with separate breeding seasons, as well as distinctive morphologies, vocalizations and moult cycles (Monteiro and Furness 1998; Bolton *et al*. 2008). As such, del Hoyo and Collar (2014) have re-classified the band-rumped storm petrel as *Hydrobates castro*, with breeding populations in the eastern Atlantic from the Berlengas Islands and the Azores (Portugal), down to Ascension Island and Saint Helena (St. Helena to UK), and in the Pacific Ocean off eastern Japan, on Kauaʻi, Hawaiʻi (USA) and in the Galapagos Islands

(Ecuador) (del Hoyo *et al*. 1992). Moreover, Pyle *et al*. (2016, p. 59) has reported regular sightings of the Leach's storm-petrel (*Hydrobates leucorhous*) and the band-rumped storm-petrel (*Hydrobates castro*) overlapping in range and plumage coloration around Hawaiian waters, further questioning the taxonomic status of the species.

The band-rumped storm-petrel is a small seabird about 8 inches long with a wingspan of about 19 in (47 cm), and about 2 ounces (50 grams) in weight. The tail is only slightly notched and may appear almost square. Plumage is an overall blackish-brown with a white band across the "rump" (above the tail). This species typically flies with a relatively shallow wing-beat, and glides on slightly bowed wings as a regular part of flight (Slotterback 2002, p. 2). Sexes are alike in size and appearance. Vocalizations at breeding colonies can be used to further distinguish this species from other Procellariiformes seabirds (Allan 1962, p. 279; James and Robertson 1985, pp. 391–392).

Historic and Current Distribution
The band-rumped storm-petrel probably was common on all of the main Hawaiian Islands prior to Polynesians arrival about 1,600 years ago (Berger 1972, pp. 25-26; Harrison *et al*. 1990, p. 47). As evidenced by abundant storm-petrel bones found in middens on the island of Hawai‘i (Harrison *et al*. 1990, p. 47) and in excavation sites on O‘ahu and Moloka‘i (Olson and James 1982b, p. 33), band-rumped storm-petrels once were numerous and nested in sufficiently accessible sites, including coastal areas, to be used as a source of food and possibly feathers (Harrison *et a1*. 1990, p. 48). They were also known from French Frigate Shoals in the Northwestern Hawaiian Islands (Henshaw 1902, p. 118).

The band-rumped storm-petrel is found in several areas of the subtropical Pacific and Atlantic oceans (Slotterback 2002, p. 1). In the Pacific, there are three widely separated breeding populations: one in Japan, one in Hawai‘i, and one in the Galapagos (Slotterback 2002, p. 1). In Hawai‘i, band-rumped storm-petrel habitat preference is primarily wet cliff and dry cliff ecosystems. Storm petrels currently nest in remote cliff locations on Kaua‘i and Lehua Islet, and in high-elevation lava fields on Hawai‘i island (Wood *et al*. 2002, p. 17–18; VanderWerf *et al*. 2007, pp. 1, 5; Joyce and Holmes 2010, p. 3; Banko 2015, in litt.; Raine 2015, in litt.). Due to the remote and vertical nature of their nesting habitat, an active nest has yet to be discovered and only a few inactive nests have been found in the Hawaiian Islands: one on a sheer cliff in remote Pōhakuao Valley on the Nā Pali coast of Kaua‘i (Wood *et a1*. 2002), one in a small cave on Lehua Islet (VanderWerf *et a1*. 2007, p. 47), located 0.6 mi. north of Ni‘ihau, and within two known Hawaiian petrel nesting areas on Mauna Loa volcano (both in the Kīlauea region (8,000-10,000 feet) and at Kahuku (5,000-6,000 feet)) on Hawai‘i Island (Orlando 2015, in litt.). All nests were located in small caves or crevices, and were confirmed to be nests of this species by skeletal remains found in the nest. No other nests have been found (Slotterback 2002).

The at sea distribution of band-rumped storm-petrels in the Pacific Ocean is largely unknown, but birds have been seen 600 miles north of Hawai‘i, 1,000 miles south of Hawai‘i, and between Japan and Hawai‘i. The Pacific populations of the band-rumped storm petrels are not known to range near the waters of the U.S. West Coast (Howell *et al*. 2010, p. 198). Band-rumped storm-petrels in the Atlantic are known to travel immense distances (Howell *et al*. 2010, p. 198), so it is

possible that any of the Pacific records could include the Hawai‘i population of band-rumped storm petrels (KESRP 2017c).

Life History
The band-rumped storm-petrel is long-lived (15 to 20 years) and probably does not breed until its third year (Harrison *et al*. 1990, p. 48). When not at nesting sites, adults spend their time foraging on the open ocean for small fish, squid, and crustaceans. They have been observed feeding during the day, but it is likely that they also feed at night (KESRP 2017c). The band-rumped storm-petrel breeding biology in Hawai‘i is poorly known. Like most seabirds a single egg is laid per season. In Hawai‘i, eggs are laid between May and June, and nestlings fledge in October (DOFAW 2005).

Current Population Demographics
Brooke (2004) estimated the global population of band-rumped storm-petrels to number around 150,000 individuals. However, due to unresolved taxonomic questions and similarity in plumage coloration with other species, population estimates may be widely challenged. Wood *et al*. (2002) estimated 171–221 breeding pairs of band-rumped storm-petrels on Kaua‘i, based on surveys conducted in 2002 and recordings of storm-petrel ground calls. The SOS program has also documented the retrieval of fledglings. Kaua‘i likely has the largest population of band-rumped storm-petrels in the Hawaiian Islands (Harrison *et al*. 1990). During the breeding season, band-rumped storm-petrels have been heard calling in flight over the broad slopes of Mauna Loa on Hawai‘i, the summit of Haleakalā on Maui, and have been heard ground calling from very steep, rocky cliffs along the Nā Pali coast and Waimea Canyon on the island of Kaua‘i (Banfield *et al*. 2013; Raine and Banfield 2015b). Concentrated calling activity on Kaua‘i, Maui, and the Hawai‘i Island suggests breeding occurs on these islands and there is a small possibility that a remnant colony may exist on Lehua Islet (KESRP 2017c). No data exists on the population demographics of band-rumped storm-petrels in the Hawaiian Archipelago.

Threats
Introduced predators are believed to be the most serious terrestrial threats facing the band-rumped storm-petrel in Hawai‘i. Rats, cats, and barn owls are likely culprits. The band-rumped storm-petrel, like the other seabirds discussed above, lack effective predator defenses, and have a lengthy incubation and fledgling period, making adults, eggs, and young highly vulnerable to predation by introduced vertebrates. Wood *et al*. (2002) observed introduced barn owls flying along basalt cliff faces where the band-rumped storm-petrels nest in Pōhakuao, Kaua‘i.

Another impact to the band-rumped storm-petrel results from the effects of artificial lights on fledgling young and, to a lesser degree, adults. Artificial lighting along roadways, resorts, ballparks, residences, and other developed areas both attracts and confuses night-flying band-rumped storm-petrel fledglings, resulting in fallout (Harrison *et al*. 1990) and collisions with buildings and other objects (Banko *et al*. 1991). Since 1979, a total of 40 band-rumped storm petrels have been processed by the SOS program (Anderson 2015, p. 4-13), where carcasses have been documented or live birds rehabilitated and released. The majority of these birds landed on cruise ships enroute and these ships subsequently docked at Nāwiliwili Harbor, Kaua‘i and submitted injured birds to the SOS for care (Anderson 2015, p. 4-13). In 2014, a record number of three band-rumped storm petrel individuals were processed by the SOS program. The

first was a subadult After Hatch Year (AHY) bird picked up in September from Kapa‘a. The second band-rumped storm-petrel was a Hatch-Year (HY) bird attracted to the lights from a research boat offshore from the Nā Pali coast and was subsequently unable to regain flight. The third band-rumped storm-petrel was also a HY bird found at the Kaua‘i Sheraton Hotel in Kōloa, Kaua‘i in November 2014. All three band-rumped storm-petrel individuals were successfully released after rehabilitation by the SOS program.

Survival and Recovery Needs

Recovery goals have not been established for the band-rumped storm-petrel, but the Service's Regional Seabird Conservation Plan (USFWS 2005a, p. 200) contains recommended actions for the species that include controlling predators in nesting areas, assessing status of the population, locating and describing nesting areas, identifying limiting factors and developing a recovery strategy. As described above, the efforts to recover and release downed seabirds through the SOS program are expected to support the survival and recovery needs of the species. Increased surveys for band-rumped storm petrels throughout the Hawaiian Archipelago would serve to obtain needed population demographic information in order to effectively identify survival needs of the species. Based on the locations of known breeding sites along cliff faces of the shoreline and multiple occurrences of band-rump storm petrels interacting with vessels at sea, additional recovery needs would include minimization of artificial nighttime lighting while vessels are at sea near band-rumped storm petrel breeding colonies.

Environmental Baseline of the Newell's Shearwater, Hawaiian Petrel, and the Band-Rumped Storm-Petrel

Adult Newell's shearwaters, Hawaiian petrels, and band-rumped storm-petrels do not nest at Kōke‘e AFS and MAS, but do use the area to commute to and from the ocean to their high elevation nest sites in the mountains. Fledgling Newell's shearwaters, Hawaiian petrels, and band-rumped storm-petrels also fly through the area on their first trip to the sea. Seabird monitoring at Kōke‘e AFS has documented very few birds, flying high overhead, at Kōke‘e AFS (Raine 2016b, in litt.).

Lighting from artificial lights has had a negative impact on these species, in particular during the fledgling period. Nighttime lighting interferes with the birds' ability to navigate. The Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel become attracted to artificial lighting and will circle light sources until exhausted, fall to the ground or collide with structures. It was previously believed that only fledgling birds were affected by artificial lighting sources, however, as documented at Kōke‘e AFS in 2015, adult Newell's shearwaters and Hawaiian petrels are also attracted to brightly lit areas and become disoriented by them.

Grounded shearwaters were reported and turned over to the Hawai‘i Department of Land and Natural Resources in 1996, which was responsible for the SOS during that time period (EA 1996, as cited in USAF 2016). Observations from staff (Table 4) at the station were used to assess the presence of Newell's shearwater and Hawaiian petrel within Kōke‘e AFS. Observations included in the table below were gathered through e-mails and interviews with staff working on base (VanderWerf and Young 2010, p. 9). In addition to specific events documented below, staff report hearing or observing seabirds flying by the base about twice a month. Several

staff reported that up to six birds at a time had been observed circling lights and ultimately grounded approximately two weeks before surveys conducted by Pacific Rim Conservation in October 2009. There has been no evidence of take at Kōkeʻe MAS. This installation may pose less of a hazard to seabirds because it is located farther from known nesting colonies, does not appear to lie in a flight corridor, and does not contain white lights that attract birds. However, no full-time personnel are present at this site and survey efforts at Kōkeʻe MAS have been much lower.

In 2010, The USAF contracted Pacific Rim Conservation to conduct surveys at Kōkeʻe AFS and MAS in order to help assess potential impacts of USAF actions on the listed seabird species. Auditory and visual surveys for Newell's shearwaters and Hawaiian petrels were conducted at Kōkeʻe AFS and Kōkeʻe MAS for four nights and four mornings during the fledging season in October in 2009 and three nights and mornings during the adult arrival period in May 2010, for a total of seven survey nights and seven survey mornings. Four live seabirds were detected; a Newell's shearwater was heard calling at Kōkeʻe AFS on October 27, 2009, and a Hawaiian petrel and two unidentified seabirds were seen at Kōkeʻe AFS on May 25, 2010 (Table 4). Additionally, the wing of a dead Newell's shearwater was found at Kōkeʻe AFS on October 27, 2009. Staff at Kōkeʻe AFS also reported seeing birds circling lights and finding dead birds on the ground twice in 2009. The Service issued the 2011 BO to address the USAF's actions and effects on the Newell's shearwater and Hawaiian petrel and since issuance of the 2011 BO, the USAF has made efforts to avoid and minimize their take of listed species. Modifications included minimizing light attraction by angling floodlights to a downward position and replacing them with green lights; replacing unshielded outdoor building lights with shielded models or retrofitting them with shields; limiting inside building lights to be seen from the outside; conducting a seabird awareness and rescue training to staff on site at Kōkeʻe AFS; and minimizing predation on grounded seabirds by trapping predators and properly storing rubbish to avoid attracting predators.

Table 4. Known take of federally listed seabirds at Kōkeʻe AFS, prior to issuance of 2011 BO (information taken from VanderWerf and Young 2010, p. 9).

Date	Newell's shearwater*	Hawaiian petrel	Unidentified Seabird	Total
Aug 2006	1			1
July 2008	1			1
Feb 2009	1			1
April 2009	1			1
Oct 2009	7			7

* staff have only reported Newell's shearwaters, but it is possible that some of these birds were Hawaiian Petrels because it was unclear whether staff were aware of the differences between the two species.

However, in 2015, a total of 130 birds (122 Newell's shearwaters, 6 Hawaiian petrels, and 2 unidentified) were documented on the ground at Kōkeʻe AFS from August 7 through September 14 (Table 5). Seabird surveys were conducted within this time period; the main areas of fallout were all associated with very bright perimeter lights, which were orientated outwards or slightly upwards, creating a very bright glow (Raine *et al*. 2015). In some cases, the lights were also pointing at reflective surfaces, further exacerbating the problem. Weather conditions alternated

between dense fog and light rain. In the foggy conditions of the night, these combined issues created very large glows which were apparently highly attractive to the birds. Even in clear conditions, this outward and upward lighting setup would likely be attractive to birds although perhaps to a lesser degree.

Fallout was constant throughout the evening, and centered predominantly on the perimeter lights in four main areas of Kōkeʻe AFS. Many birds were found along the fence line, having landed outside the boundary of the base. All birds were adults. These lights, while being green, were very bright, not well-shielded and orientated outwards and in some cases partially upwards. The effect of turning off lights is apparent in limiting the number of Newell's shearwater and Hawaiian petrel that would be attracted when flying near Kōkeʻe AFS (Figure 9).

An additional Newell's shearwater fledgling was found at Kōkeʻe AFS during the night of November 16, 2015. The USAF had been conducting a trial since October 27, 2015, to test the green perimeter lights which had all been re-oriented in a downward facing direction.

Table 5. Known take of seabirds at Kōkeʻe AFS, after issuance of 2011 BO (data taken from information provided from the USAF downed bird log sheet and Raine 2015)

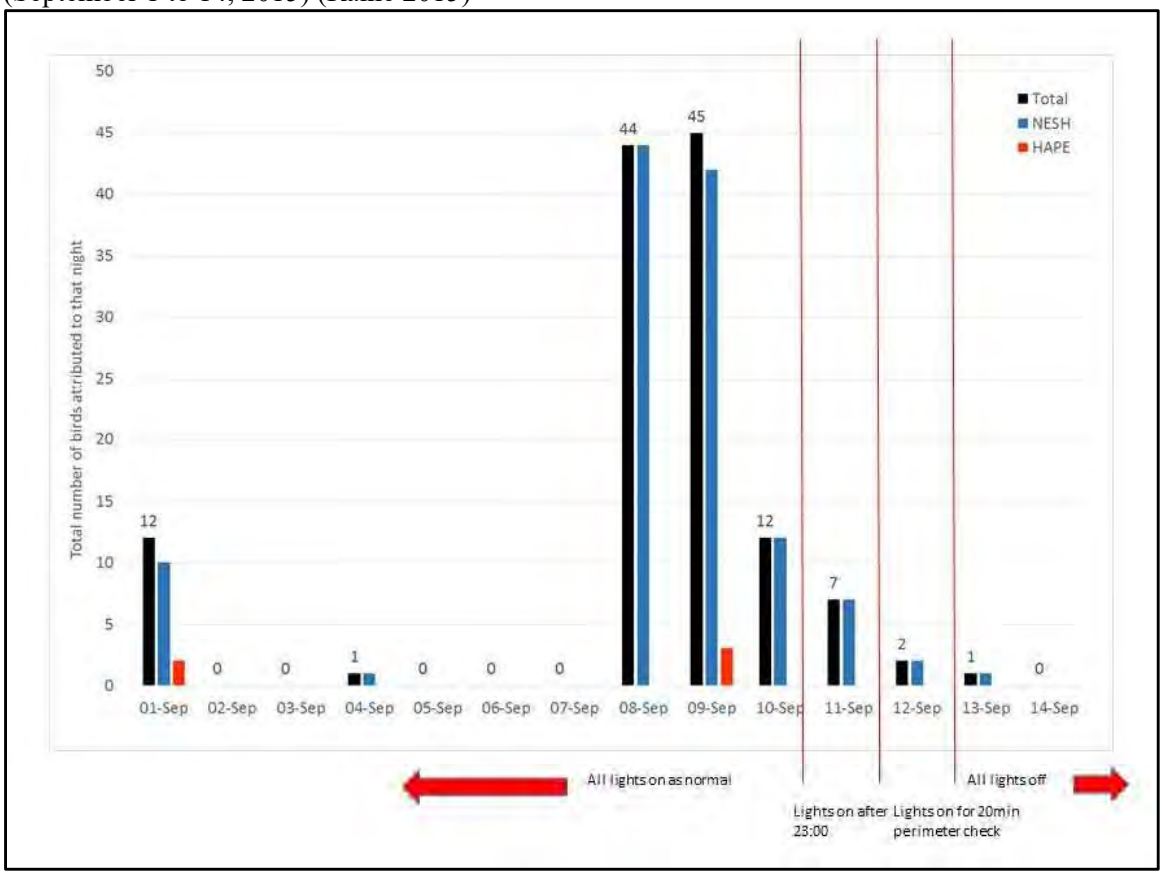
Date	Newell's shearwater	Hawaiian petrel	Unidentified Seabird[^]	Total
Nov 6, 2013	1			1
Nov 25, 2013		1		1
May 26, 2014	1			1
Nov 8, 2014		1		1
Nov 18, 2014		1		1
Nov 28, 2014	1			1
Aug 7, 2015	1			1
Aug 15, 2015[#]	1	1		2
Sept 1, 2015[#]	10	2		12
Sept 4, 2015[#]	1			1
Sept 8, 2015[#]	22			22
Sept 9, 2015[#]	43	1		44
Sept 10, 2015[#]	29	2		31
Sept 11, 2015[#]	7			7
Sept 12, 2015[#]	5		1	6
Sept 13, 2015[#]	2		1	3
Sept 14, 2015[#]	1			1
Nov 18, 2015	1			
May 8, 2016	1			
May 9, 2016	1			

[^] birds listed as 'unidentified seabird' are either Newell's shearwater or Hawaiian petrel, but due to the degraded nature of the carcass they could not be identified to species.

[#] Note data taken from Raine (2015) includes Aug 15, 2015 and afterward; and is presented as day each bird was found and not the day it was handed to the SOS program (which was predominantly the following day).

Since the 2015 fallout events, more Newell's shearwaters were documented at Kōkeʻe AFS on the nights of May 8, 2016 (one Newell's shearwater), and May 9, 2016 (one Newell's shearwater); perimeter security lights were off, but exterior building lights were on. Full blackout conditions were implemented from May 10 to December 31, 2016 and no additional birds were detected after all exterior lights were shut off. Without bright lights, very few birds were documented flying over the AFS; and those observed were high overhead (Raine 2016b, in litt.). This demonstrates that when the lights are turned off at Kōkeʻe AFS there is very little seabird activity in the immediate area (Raine 2016b, in litt.).

Figure 9. All recorded fallout on Kōkeʻe AFS, attributed to each night, since first bird reported (September 1 to 14, 2015) (Raine 2015)



Note the totals shown are both species combined, but 94.4% (n=119) were Newell's shearwater. Also, this does not include the 2 birds (1 Newell's shearwater and 1 Hawaiian petrel) found on the premises in August nor carcasses (n=3) for which date of grounding could not be determined.

There is a likelihood that without minimization of light sources during the adult prospecting and fledgling season, Newell's shearwaters, Hawaiian petrel, and band-rumped storm-petrels will continue to be drawn in from neighboring nesting colonies.

Due to the small size of the band-rumped storm-petrel, it is likely that there are missed events of observed fallout due to the removal of birds by scavengers (e.g., mice, rats, cats, etc.). However, over a 37-year period the SOS program documented a total of 32,462 individuals of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel recovered, injured or killed due to artificial nighttime lighting (Anderson 2016b, in litt.). In 2000–2015, SOS recoveries by species

varied considerably, with 96%, 3%, and 1% of the total consisting of Newell's shearwater, Hawaiian petrel, and band-rumped storm petrel, respectively (DOFAW 2016).

The predation threats described in the Status of the Species section (above) for the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel are the same within the action area. Predation by feral cats, rats, barn owls, and feral pigs are all a constant threat that are limiting the breeding success of endangered seabird populations in Hawai'i. In some areas of Kaua'i, seabird populations are mostly protected from terrestrial mammalian predators by geographic barriers such as the steep cliffs of the Nā Pali coast and off-shore islets such as Lehua that preclude easy access to colony locations. In these colony locations, aerial predators are the primary threat.

Previous Consultations in the Action Area

In September of 2014, the Service issued a non-jeopardy BO (Service File 2014-F-0066) addressing the Pacific Missile Range Facility (PMRF) Base-wide Infrastructure, Operations, and Maintenance Activities and their effects on the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*); Hawaiian moorhen (*Gallinula chloropus sandvicensis*); Hawaiian coot (*Fulica alai*); Hawaiian duck (*Anas wyvilliana*); Hawaiian goose; Hawaiian hoary bat; Hawaiian petrel; the threatened Newell's shearwater; and at the time of consultation, a candidate species, the band-rumped storm-petrel. The incidental take statement accompanying the BO authorized the take of up to an average of three Newell's shearwater per year through the foreseeable future. The no-jeopardy conclusion for the Newell's shearwater relied on provisions in the proposed action for lighting minimization and predator control measures at seabird breeding colonies to offset the impacts of incidental take and to provide a net conservation benefit to the species as a whole.

In March of 2011, the Service issued a non-jeopardy BO (Service File 01EPIF00-2010-F-0430 and 01EPIF00-2010-F-0460) for the PMRF Intercept Test Support action, which addressed the effects of Aegis Ashore Intercept Test Support construction and operation activities at Barking Sands on the Newell's shearwater, Hawaiian petrel, and the band-rumped storm petrel for a period of three years; that opinion was amended in October of 2011. The incidental take statement accompanying the amended opinion authorized the take of up to ten Newell's shearwaters, one Hawaiian petrel, and one band-rumped storm-petrel over the 3-year term of the action as a result of collision with the boresight towers or due to attraction and fallout from lighting associated with the project. The incidental take statement accompanying the amended opinion also authorized the take of up to five Newell's shearwaters eggs and/or chicks, one Hawaiian petrel egg and/or chick, and one band-rumped storm-petrel egg and/or chick over the 3-year term of the action as a result of predator control activities at shearwater breeding sites. The Service's non-jeopardy conclusion relied on provisions in the proposed action for minimization and mitigation of take impacts, including predator control within existing seabird breeding colonies and radar surveys to help assess seabird population trends on Kaua'i.

In March of 2011, the Service issued a non-jeopardy BO for the KIUC Short-term Seabird HCP and Incidental Take Permit (Service File 01EPIF00-2011-F-0113, Permit No. TE234201-0), that addressed effects from the operation of existing and new electrical utility facilities on the Newell's shearwater and Hawaiian petrel, until 2016 for the entire island of Kaua'i. The Incidental Take Permit authorized the take of up to 162 adult, sub-adult, or fledgling Newell's

shearwaters annually over the 5-year permit term as a result of attraction to, or collision with, KIUC facilities, as well as the take of up to 18 eggs and/or chicks as a result of the mortality of breeding adults. The annual take of up to two adult, sub-adult, or fledgling Hawaiian petrels was also authorized. Because of the minimization and mitigation measures implemented through the Habitat Conservation Plan, anticipated reduction in ongoing take from these measures, and implementation of conservation projects to offset unavoidable take (i.e. predator control within existing seabird breeding colonies), the Service concluded that the issuance of the Incidental Take Permit was not likely to jeopardize the continued existence of the Newell's shearwater and the Hawaiian petrel in the wild.

In October of 2011, the Service issued a non-jeopardy BO for the PMRF Advanced Hypersonic Weapons System (Service File 01EPIF00-2011-F-0385), which addressed the effects from one-time operation of existing launch facilities at the Kaua'i Test Facility on the Newell's shearwater and the Hawaiian petrel from October through mid-November of 2011. The Incidental Take Statement accompanying the BO authorized the take of up to four Newell's shearwaters and one Hawaiian petrel over the two-month term of the action caused by seabird attraction and fallout from lighting associated with the project. Because of the minimization and mitigation measures implemented under the proposed action, an anticipated reduction in ongoing seabird take as a result of these measures, and implementation of conservation projects to offset unavoidable take, the Service concluded that the proposed action was not likely to jeopardize the continued existence of the Newell's shearwater and the Hawaiian petrel in the wild.

Effects of the Action

Exposure Analysis Approach

The Service has developed an analysis framework for section 7 consultations that incorporates the general structure, primary concepts, and nomenclature of the U.S. Environmental Protection Agency's (EPA) ecological risk assessment framework (USFWS 2005b). Factors causing adverse effects are called "stressors" and beneficial effects are called benefits. In this approach, the Service determines the resources that will be exposed to the proposed action's stressors and benefits by evaluating the location, timing, duration, frequency, and intensity of potential exposure to each stressor and benefit, and identifying the physical, chemical, and biotic features that will be directly and indirectly exposed. Then the causal relationships between sources of stressors and benefits and the response of listed resources are analyzed. The exposure analysis also estimates future changes in the abundance or distribution of listed species expected to result from exposure to stressors and benefits.

The proposed action's stressors and benefits may include the following actions within the action area:

- Kōke'e AFS structures
- Kōke'e AFS installation lighting
- Implementation of outreach and education
- Control of predators within Kōke'e AFS and within seabird colonies

Each stressor and benefit is expected to have direct or indirect effects to the species. Direct effects are effects that are caused by the action affecting species at the time and location of exposure. Indirect effects are effects that are caused by the action but occur later in time or at a different location. The effects of each are explained in relation to the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel below.

Effects to Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel

Kōke'e AFS structures
Kōke'e AFS contains a large number of structures expected to have direct effects on Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel by posing a collision risk. The facilities at Kōke'e AFS include the AN/FPS-117v4 Long Range Radar, operated out of the radome on the highest point of the installation. The installation maintains ground-to-air communications through antennas; each pole is 80 feet high and connected by guy wires. The installation also contains poles that support flood lights, numerous utility lines, and several buildings. All towers are co-located and adjacent to the main building which contours to the natural topography at the lowest point within the installation. The overall orientation of structures minimizes what actually protrudes above the vegetation layer and into the air space making the collision risk less likely in the absence of the light attraction. We expect by minimizing artificial light the collision risk with structures may be reduced.

Kōke'e AFS installation lighting
The proposed action is expected to have direct effects on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel caused by the AFS green perimeter and building installation lighting which will be used December 31 to March 31. The proposed timing for green perimeter and building lights to be on at night is not likely to coincide with the adult prospecting and breeding period, or the fledgling fallout periods, thus minimizing the likelihood of large fallout events that were experienced in 2015. However, there has been documentation of fallout during this time when lights were angled upwards and not completely shielded even when birds are thought to be at their oceanic habitats. We anticipate fallout of adult and fledgling birds due to attraction to green perimeter and building lighting during the December 31 to March 31 timeframe. Additionally, eggs and chicks are indirectly affected as they rely on provisioning from both parents in order to survive, thus the loss of either parent results in nestling fatality. Therefore, we also expect adverse effects to eggs or chicks at the nest due to the loss of an adult bird no longer incubating and providing care for the egg or chick.

The proposed action is expected to have direct effects on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel due to fallout expected from the use of temporary perimeter and security lighting which would be used in an event of an illegal incursion, emergency on the installation, or security violation occurring during April 1 to December 30 blackout period. However, limited usage of light will be used in these rare instances and the duration will be minimized to the maximum extent practicable. We anticipate fallout of adult and fledgling birds due to attraction to installation lighting from such emergency situations during the December 31 to March 31 timeframe. Additionally, eggs and chicks are indirectly affected as they rely on provisioning from both parents in order to survive, thus the loss of either parent results in nestling fatality. Therefore, we also expect adverse effects to eggs or chicks at

the nest due to the loss of an adult bird no longer incubating and providing care for the egg or chick.

Implementation of outreach and education
The proposed action is expected to have an indirect effect on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel due to the USAF's current outreach and education program that will continue to inform and educate on-site staff to understand the importance and of the following actions: keeping windows and doors closed at night, turning off lights when they are not needed, and not feeding feral cats. We expect this to be an important benefit to birds by reducing lights emitted to the outside of buildings. Also, we expect the education of not feeding feral cats to on-site personnel to be an important benefit to reduce potential predation on birds should they suffer fallout.

Control of predators within Kōke'e AFS and within seabird colonies
The proposed action is expected to have direct effects on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel due to predation by feral cats, rats, barn owls, and feral pigs which are all a constant threat limiting the breeding success of endangered seabird populations within their colonies in the Hawaiian Islands.

We expect the proposed control and monitoring of predators on the station will decrease the likelihood of the affected species being killed by predators if a fallout event were to happen within fenced areas of Kōke'e AFS. Additionally, we expect the proposed barn owl control within seabird colonies will provide a benefit for the reproduction and survivorship of birds at their colonies, which will help to protect and enhance the productivity and reproductive success. We expect this will provide a benefit to adult and fledgling birds, as well as their eggs and chicks. Additionally, we expect the benefits of barn owl control to apply to all three species discussed in this BO.

Quantifying effects of the action
We are not using the number of birds lost from Kōke'e AFS actions before 2011 to estimate the likelihood of birds attracted to installation lighting in our analysis. Conservation measures were not in place prior to 2011 and it is likely that the change of actions implemented at that time most resembles the actions proposed for this BO. We are also not using the number of birds lost in the 2015 light entrapment event, due to lights directed upwards coupled with environmental conditions that created an unusually high number of fallout. We expect this is not a likely event that will be repeated due to implementation of conservation measures proposed in this BO. Therefore, the number of birds estimated in our analysis as a result of the USAF proposed actions are based on data taken from 2013, 2014, one fallout event in 2015 (November 28), and data from 2016 which is used as the baseline data set for this analysis.

The highest known observed level of take of the Newell's shearwater at Kōke'e AFS within the baseline data set was two birds in 2014 and two birds in 2016. We anticipate up to 2 Newell's shearwaters adults or fledglings per year will likely be taken in the form of injury or death.

Based on a model developed by the Service to assess the predation effects on Newell's shearwater, we estimated that the probability of any two adults mating is approximately 88

percent. We also estimated that the combination of that probability and the survivorship from age 0 to 1 is approximately 47 percent (Vorsino 2016). By multiplying the probability that any two adults will mate (88 percent) and the survivorship of their offspring (47 percent) we estimate that a breeding pair will likely produce 0.41 chicks that survive to fledgling. We applied this number to our 2 anticipated adults lost and calculated that 0.82 eggs or chicks would be lost per year. Therefore, we estimate that up to 1 egg or chick per year would be taken in the form of death due to the injury or death of any 2 adult Newell's shearwater adults likely to be breeding and successfully producing a chick.

The highest known observed level of take of the Hawaiian petrel within the baseline data set was also 2 birds in 2014. Although, the number is the same for Newell's petrel that same year, Hawaiian petrels are impacted by the threat of light attraction at a lower rate than Newell's shearwaters (Reed *et al*. 1985; Cooper and Day 1998). Data from the baseline data set documented 6 Newell's shearwaters and 3 Hawaiian petrels downed at Kōkeʻe AFS. We used this ratio to estimate that for every 1 Newell's sheawater is 0.5 Hawaiian petrel (3/6 = 0.5). We expect 2 adult Newell's shearwaters taken every year, therefore, we can expect 1 adult Hawaiian petrel would be taken every year (2 Newell's per year = (0.5)(2)). Therefore, we estimate that up to 1 Hawaiian petrel adult or fledgling per year would be taken in the form of injury or death due to the proposed action.

The Service has not yet developed a model to assess the predation effects of the barn owl on the Hawaiian petrel, therefore, we used the juvenile survivorship of Procellariforms (0.65 to 0.93) and averaged that number ((0.65 + 0.93)/2 = .79) to estimate the likelihood of eggs or chicks to survive to juvenile age. Multiplying that number by the breeding frequency (89 percent) of adult Hawaiian petrels allowed us to estimate the probability of adults to be breeding and produce an egg or chick to the juvenile age class to be approximately 70 percent ((0.89)(0.79) = 0.70). Therefore, we estimate the mortality of 1 adult Hawaiian petrel is likely to result in the loss of up to 1 egg or chick every per year due to the proposed action.

The environmental baseline of the band-rumped storm-petrel within the action area is poorly understood, however, effects of artificial lighting cannot be discounted. SOS recoveries of the band-rumped storm-petrel from 2000 – 2015 accounted for only one percent of all downed and retrieved seabirds (96 percent and 3 percent for Newell's shearwater and Hawaiian petrel, respectively; DOFAW 2016). This is likely an underestimate of total fallout events for the band-rumped storm-petrel due to fallout not observed or documented as well as the delay in bird carcass retrieval prior to the removal by scavengers. Therefore, we used data from auditory detections to proportion the population estimate of band-rumped storm-petrels to Newell's shearwaters for our analysis of effects. Based on that information we estimate that the band-rumped storm-petrel population is equivalent to approximately 5 percent of the total Newell's shearwater population estimate. We multiplied the 5 percent to the estimated number of 2 adult Newell's shearwaters to be taken by the action to calculate an estimated take of approximately 0.1 band-rumped storm petrel per year ((0.05)(2) = 0.1). Using this estimate we anticipate that up to 1 adult band-rumped storm-petrel will likely be taken in the form of injury or death every 10 years as a result of the proposed action ((0.1)(10) = 1).

We do not have sufficient information to estimate the breeding frequency of adult band-rumped storm-petrels, however, we can assume that the loss of one adult will likely lead to the indirect mortality of a nest within that 10 year period that an adult would have reached breeding age. Therefore, we can expect the take in the form of death of up to 1 band-rumped storm-petrel egg or chick every 10 years due to the proposed action.

Using the number of barn owls sited versus those actually removed in a predator control application conducted by RCUH (RCUH 2015, as cited in Vorsino 2016) efficacy of current barn owl control techniques was determined to be ~50% in the areas outlined on Kauaʻi (Vorsino 2016). We did not factor in the possible benefit scenario from barn owl control to populations on Lehua due to insufficient information regarding population size estimates for the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel on Lehua. Additionally, Newell's shearwaters and Hawaiian petrels were not documented when conducting auditory surveys in 2015 on Lehua (Raine *et al*. 2016e).

We created a model (Vorsino 2016) to analyze and approximate the beneficial effects of the proposed barn owl control on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel. Populations were projected for areas known to be occupied by the Newell's shearwater using the methodology outlined in Vorsino (2016) which partitions the most current Newell's shearwater population projection (Joyce 2013) between all known Newell's shearwater colonies. These colonies were then subset by locations on Kauaʻi identified previously to be amenable to barn owl control (Raine 2016), specifically: Nualolo, Honopū, Kalāheo/Kāhili, and Hanalei. Sub-setting the meta-population by these colonies allowed the projection of an initial population size affected by the proposed Barn Owl control work (Raine 2016).

The estimated impact of barn owl control on the individuals this conservation measure would impact, for each predation scenario applied, is estimated in Table 6. Predation offset was estimated using the difference between the population of individuals with all predators present, and a population with Barn Owl Mitigation with 50% efficacy of control. Offset is here used to describe the net gain of the applied Barn Owl mitigation given the current population size at the sites to be mitigated. Adults were defined as those birds age 6 and up and chicks are age 0 to fledglings.

Table 6: Estimated predation offset.

Predation Scenario	Chick Offset	Adult Offset
Predation Estimate Low	5.7	4.3
Predation Estimate Medium	7.4	5.6
Predation Estimate High	9.1	6.9

Predation offset was estimated using the difference between a population of individuals with all predators present, and one in which a subset of predators have been mitigated for. For this assessment Barn Owl control was applied at an efficacy level of 50% per scenario (Vorsino 2016).

This model is based on the current projected population size and does not take into consideration that every year the population will continue to decrease until effective recovery actions are implemented. This estimate is likely the net benefit for the next couple of years and will be used for our analysis to determine the beneficial effects of the proposed action. We anticipate beneficial effects to adults and chicks due to the implementation of proposed barn owl control.

As shown in the table 6 above, we estimate that 4 adult seabirds (this includes all seabirds within the three species discussed in this BO) and 5 chicks (of the three species discussed in this BO) per year would be offset from barn owl control.

Therefore, in summary, we anticipate take in the form of injury or death of up to 2 adult or fledgling Newell's shearwaters every year; up to 1 adult or fledgling Hawaiian petrel every year; and up to 1 band-rumped storm-petrel every 10 years as a result of the proposed action. We anticipate take in the form of death of up to 1 Newell's shearwater egg or chick every year; up to 1 Hawaiian petrel egg or chick every year; and up to 1 band-rumped storm-petrel egg or chick every 10 years that would likely not survive as a result of its parent being taken as a result of the proposed action. We anticipate beneficial effects that would likely produce 4 adults and 5 chicks of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel (combined) every year.

Cumulative Effects

Cumulative effects include the effects of future non-Federal actions that are reasonably certain to occur within the action area subject to consultation. Future federal actions will be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative for the proposed action. The Service is unaware of any foreseeable actions within the action area.

Conclusion

After reviewing the current status, the Environmental Baseline, the Effects of the Action, and the Cumulative Effects, it is the Service's Biological Opinion that the proposed continuing operations at Kōkeʻe AFS and MAS discussed herein is not likely to jeopardize the continued existence of the Newell's shearwater, Hawaiian petrel, or band-rumped storm-petrel. As stated in the Effects section above, the adverse effects result in take in the form of injury and death for up to 2 Newell's shearwater adults or fledglings per year; 1 Newell's shearwater egg or chick per year; 1 Hawaiian petrel adult or fledgling per year; 1 Hawaiian petrel egg or chick per year; 1 band-rumped storm-petrel adult or fledgling every 10 years; and 1 band-rumped storm-petrel egg or chick every 10 years as a result of the proposed action. And the beneficial effects of barn owl control within seabird colonies will offset the loss of 4 adult seabirds and 5 chicks every year. Overall, taken all these effects together, there will not be a significant change in the reproduction, numbers, or distribution of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel that will reduce appreciably the likelihood of both the survival and recovery of these species in the wild.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations promulgated pursuant to section 4(d) of the Act prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by

significantly impairing behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, hut arc not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the USAF so that they become binding conditions for the exemption in section 7(o)(2) to apply. If the USAF (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USAF must report the progress of the action and its impact on the species to the Service as specified in this incidental take statement and reporting requirements below [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Based on our analysis presented in this Biological Opinion, the Service anticipates the following take may occur for as long as the Kōkeʻe AFS and Kōkeʻe MAS are operating and in place:

1) Up to 2 Newell's shearwater adults or fledglings and 1 associated egg or chick every year over the life of the project due to mortality as a result of the proposed action.
2) Up to 1 Hawaiian petrel adult or fledgling and 1 associated egg or chick every year over the life of the project due to mortality as a result of the proposed action.
3) Up to 1 band-rumped storm-petrel adult or fledgling and 1 associated egg or chick every 10 years over the life of the project due to mortality as a result of the proposed action.

Effect of the Take
In this Biological Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the continued existence of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel based on the information provided in this document.

Reasonable and Prudent Measures
The reasonable and prudent measures given below, with their implementing term and conditions, are designed to minimize the impacts of incidental take that might otherwise result from the proposed actions. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. In addition, the action that caused the taking must cease; the action agency must immediately provide an explanation of the causes of the taking; and must review with the Service the need for possible modification of the reasonable and prudent measures. The following reasonable and prudent measures are necessary and

appropriate to minimize the effect of take on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel.

1. The USAF shall minimize the loss of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel.

Terms and Conditions
In order to be exempt from the prohibitions of section 9 of the Act, the USAF must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary.

In order to implement the reasonable and prudent measure #1 above, the following terms and conditions apply:

1. The USAF shall investigate and consider ways to turn off all perimeter and exterior building lights year round on the installation.
2. The USAF shall monitor and report on the levels of take that occur on an annual basis.
    a. The annual reports will document the effectiveness of all avoidance and minimization measures. The written reports will summarize annual minimization measures implemented and success of those measures. The methods and results of the monitoring efforts will also be included in annual reports.
    b. The reports will be submitted by February each calendar year to the Service's Pacific Islands Fish and Wildlife Office (300 Ala Moana Blvd., Room 3-122, Honolulu, Hawai'i 96850).
    c. The Service will be notified by telephone and email within 24 hours upon the discovery of an injured or dead bird. A written summary of the incident should be provided to the Service within 72 hours of incident.
    d. Should there be a mortality, the depository designated to receive specimens of any Newell's shearwaters, Hawaiian petrels, or band-rumped storm-petrels that are found is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawai'i, 96817 (telephone: 808/847-3511). If the B.P. Bishop Museum does not wish to accession the specimens, contact the Service's Division of Law Enforcement in Honolulu, Hawai'i (telephone: 808/861-8525; fax: 808/861-8515) for instructions on disposition.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs all Federal agencies to use their authority to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The term "conservation recommendations" has been defined as suggestions from the Service regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's 7(a)(1) responsibility for the species.

1. The USAF should hire or fund a trained seabird biologist, familiar with doing Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel surveys, to provide nightly monitoring at Kōke'e AFS as well as outside the perimeter of the installation during the non-blackout period (December 31 to March 31) to evaluate the effectiveness of shielded perimeter and security lights.
2. The USAF should hire or fund a trained seabird biologist, familiar with doing Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel surveys, to provide opportunistic monitoring at Kōke'e MAS to document any unobserved or undocumented seabirds attracted to red lights associated with the communication tower.
3. The USAF should fund the construction of predator exclusion fences to fully enclose and protect Newell's shearwater colonies within the Hono o Nā Pali NAR and the entirety of Upper Limahuli colony.
4. The USAF should fund the construction of a predator exclusion fence to protect the largest extant Hawaiian petrel colony at Hono o Nā Pali, Kaua'i, while limiting the impact and restoring where possible the montane wet ecosystem of this area.
5. The USAF should fund the construction of an ungulate exclusion fence to protect the Honopū seabird colony to manage depredation by pigs and habitat damage from pigs and goats. The area of Honopū where the ungulate fence should be installed is located within DLNR State Parks in northwestern Kaua'i.

REINITIATION-CLOSING STATEMENT

This concludes formal consultation on this action. As required in 50 CFR §402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operation causing such take must cease pending reinitiation.

We appreciate your efforts to conserve protected species. If you have any questions concerning this biological opinion, please contact Jiny Kim of the USFWS Pacific Islands Fish and Wildlife Office at (808) 792-9400.

Sincerely,

Mary M. Abrams, Ph.D.
Field Supervisor

LITERATURE CITED

Adams, J. 2013. At-sea distribution of satellite tagged Hawaiian petrel (*Pterodroma sandwichensis*) nesting on Haleakalā and Lanaʻi and attendance patterns measured using RF-ID to calibrate ornithological radar surveys (Draft Interim Summary Report for E-145562-3). U.S. Geological Survey, Western Ecological Research Center, Moss Landing, California.

Adams, J., D. G. Ainley, J. F. Penniman, and H. B. Freifeld. 2009. Summer movements of ʻUaʻu (Hawaiian Petrel; *Pterodroma sandwichensis*) nesting on Haleakalā, Maui and Lānaʻi: can we use satellite tracking to gain new information and advise conservation management? (Draft Interim Summary Report for TE-145562-2). U.S. Geological Survey, Western Ecological Research Center, Moss Landing, California.

Ainley, D. G., and D. P. DeMaster. 1980. Survival and Mortality in a Population of Adélie Penguins. Ecology 61(3): 522–530.

Ainley, D. G., R. Podolsky, L. DeForest, and G. Spencer. 1997a. New insights into the status of the Hawaiian petrel on Kauaʻi. Colonial Waterbirds 20(1): 24-30.

Ainley, D. G., T. C. Telfer, and M. H. Reynolds. 1997b. Townsend's and Newell's shearwater *Puffinus auricularis*. *In* The Birds of North America, No. 297. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Ainley, D. G., R. Podolsky, L. DeForest, G. Spencer, and N. Nur. 2001. The status and population trends of the Newell's shearwater on Kauaʻi: insights from modeling. Studies in Avian Biology 22: 108-123.

Ainley, D. G., Walker, W. A., Spencer, G. C., and N. D. Holmes. 2014. The prey of Newell's shearwater *Puffinus newelli* in Hawaiian waters. Marine Ornithology 44: 69-72.

Ainley, D. G., E. Porzig, D. Zajanc, and L. B. Spear. 2015. Seabird flight behavior and height in response to altered wind strength and direction. Marine Ornithology 43: 25-36.

Allan, R. G. 1962. The Madeiran storm petrel *Oceanodroma castro*. Ibis 103b: 274–295.

Anderson, T. 2015. Save Our Shearwaters Program, 2014 Annual Report. Kauaʻi Humane Society prepared for Kauaʻi Island Utility Cooperative. 52 pp.

Asner, G. P., R. F. Hughs, P. M. Vitousek, D. E. Knapp, T. Kennedy-Bowdoin, J. Boardman, R. E. Martin, M. Eastwood, and R. O. Green. 2008. Invasive plants transform the three-dimensional structure of rain forests. Proceedings of the National Academy of Sciences 105: 4519-4523.

Austin, O. L. 1952. Notes on some petrels of the North Pacific. *In* Bulletin of the Museum of Comparative Zoology at Harvard College, vol. 107, no. 7, Cambridge. Pp. 391–407.

Banfield, N. K., A. F. Raine, and B. McFarland. 2013. Auditory surveys for endangered seabirds on Kaua‘i. Kaua‘i Endangered Seabird Recovery Project. Hawai‘i Division of Forestry and Wildlife. Unpublished report.

Banko, W. E., P. C. Banko, and R. E. David. 1991. Specimens and probably breeding activity of the band-rumped storm-petrel on Hawai‘i. Wilson Bulletin 103: 650–655.

Banks, R. C., C. Cicero, J. L. Dunn, A. W. Kratter, P. C. Rasmussen, J. V. Remsen, JR., J. D. Rising, and D. F. Stotz. 2002. Forty-third supplement to the American ornithologists' union check-list of North American birds. The Auk 119: 897-906.

Berger, A. 1972. *Hawaiian birdlife.* University of Hawai‘i Press, Honolulu, Hawai‘i.

BirdLife International. 2016a. Species factsheet: *Puffinus auricularis*. Downloaded from http://www.birdlife.org on 08/19/2016, accessed 1 August 2016.

BirdLife International. 2016b. Species factsheet: *Puffinus puffinus*. Downloaded from http://www.birdlife.org on 08/19/2016, accessed 1 August 2016.

Bolton, M., A. L. Smith, E. Gómez-Diaz, V. L. Friesen, R. Medeiros, J. Bried, J. L. Roscales, and R. W. Furness. 2008. Monteiro's Storm-petrel *Oceanodroma monteiroi*: a new species from the Azores. Ibis 150: 717-727.

Bried, J., D. Pontier, and P. Jouventin. 2003. Mate fidelity in monogamous birds: a re-examination of the Procellariiformes. Animal Behaviour 65: 235-246.

Brooke, M. 1990. *The Manx shearwater*. London: A & C Black Publishers Ltd. 264 pp.

Brooke, M. de L. 2004. *Albatrosses and petrels across the world*. Oxford: Oxford University Press. 499 pp.

Browne, R. A., D. J. Anderson, and J. N. Houser. 1997. Genetic diversity and divergence of endangered Galapagos and Hawaiian petrel populations. The Condor 99: 812-815.

Buxton, R. T., and I. L. Jones. 2012. An experimental study of social attraction in two species of storm-petrel by acoustic and olfactory cues. The Condor 114: 733-743.

Buxton, R. T., C. Jones, H. Moller, and D. R. Towns. 2014. Drivers of seabird population recovery on New Zealand islands after predator eradication. Conservation Biology 28: 333-344.

Cooper, B. A., and R. H. Day. 1998. Summer behavior and mortality of dark-rumped petrels and Newell's shearwaters at power lines on Kaua‘i. Colonial Waterbirds 21(1): 11-19.

Cooper, B. A., M. G. Raphael, and D. E. Mack. 2001. Radar-based monitoring of marbled murrelets. The Condor 103(2): 219-229.

Craig, M. 2016. Kaheawa Wind Power I Habitat Conservation Plan, Annual Report: FY 2016. Kaheawa Wind Power I, LLC. Wailuku, Hawai‘i. 50 pp.

Croxall, J. P., S. H. M. Butchart, B. Lascelles, A. J. Stattersfield, B. Sullivan, A. Symes, and P. Taylor. 2012. Seabird conservation status, threats and priority actions: a global assessment. Bird Conservation International 22: 1-34.

Day, R. H. and B. A. Cooper. 1995. Patterns of movement of dark-rumped petrels and Newell's shearwaters on Kaua‘i. Condor 97: 1011-1027.

Day, R. H., B. A. Cooper, and R. J. Blaha. 2003. Movement patterns of Hawaiian petrels and Newell's shearwaters on the island of Hawai‘i. Pacific Science 57: 147-159.

del Hoyo, J., A. Elliot, and J. Sargatal. 1992. *Handbook of the birds of the world, vol. 1: ostrich to ducks*. Lynx Edicions, Barcelona, Spain.

del Hoyo, J., N. J. Collar, D. A. Christie, A. Elliott, and L. D. C. Fishpool. 2014. *HBW and BirdLife International Illustrated checklist of the birds of the world*. Lynx Edicions BirdLife International.

[DOFAW] Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife. 2005. Hawai‘i's comprehensive wildlife conservation strategy. 734 pp.

[DOFAW] Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife. 2016. Kaua‘i Save Our Shearwater data 1979-2016. Summarized by the Service Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

Force, M. P., S. W. Webb, and S. N. G. Howell. 2007. Identification at sea of Hawaiian and Galapagos petrels. Western Birds 38(3): 242-249.

Fraser, G. S., J. Russell, G. J. Robertson, R. Bryant, and D. A. Fifield. 2013. Prospects for the Manx shearwater colony on Middle Lawn Island, Newfoundland, Canada. Marine Ornithology 41: 137-140.

Friesen, V. L., T. M. Burg, and K. D. McCoy. 2007. Mechanisms of population differentiation in seabirds. Molecular Ecology 16: 1765–1785.

Gill, F. and D. Donsker (eds.). 2016. *Loons, penguins, petrels* at World Bird List Version 6.3. International Ornithologists' Union. http://www.worldbirdnames.org/bow/loons/, accessed 1 August 2016.

Griesemer, A. M. and N. D. Holmes. 2011. Newell's shearwater population modeling for Habitat Conservation Plan and Recovery Planning. Technical Report No. 176. The Hawai‘i-Pacific Islands Cooperative Ecosystem Studies Unit & Pacific Cooperative Studies Unit, University of Hawai‘i, Honolulu, Hawai‘i. 68 pp.

Harrison, C. S., T. C. Telfer, and J. L. Sincock. 1990. The status of Harcourt's storm-petrel (*Oceanodroma castro*) in Hawai'i. Elepaio 50: 47-51.

Henshaw, H. W. 1902. *Oceanodroma castro* (Harcourt). Ake-ake. Hawaiian stormy petrel. *In* Birds of the Hawaiian Islands being a complete list of the birds of the Hawaiian possessions with notes on their habits, published by Thos. G. Thrum Honolulu. Pp. 118-119.

Hodges, C. S. N., and R. J. Nagata. 2001. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. *In* Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A vanishing avifauna. (J. M. Scott, S. Conant, and C. Van Riper, III, eds.) Studies in Avian Biology No. 22. Cooper Ornithological Society, Camarillo, California. Pp. 308-318.

Howell, S. N. G., J. B. Patteson, K. Sutherland, and D. T. Shoch. 2010. Occurrence and identification of the band-rumped storm-petrel (*Oceanodroma castro*) complex off North Carolina. North American Birds 64(2): 196-207.

Hu, D., C. Glidden, J. S. Lippert, L. Schnell, J. S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian dark-rumped petrels on Mauna Loa, Hawai'i. *In* Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A vanishing avifauna. (J. M. Scott, S. Conant, and C. Van Riper, III, eds.) Studies in Avian Biology No. 22. Cooper Ornithological Society, Camarillo, California. Pp. 234-242

James, P. C. and H. A. Robertson. 1985. The calls of male and female Madeiran storm-petrels (*Oceanodroma castro*). The Auk 102: 391-393.

Jones, H. P. and S. W. Kress. 2012. A review of the World's active seabird restoration projects. The Journal of Wildlife Management 76: 2-9.

Joyce, T. W. 2013. Abundance estimates of the Hawaiian petrel (*Pterodroma sanwichensis*) and Newell's shearwater (*Puffinus newelli*) based on data collected at sea, 1998 – 2011. Scripps Institution of Oceanography, La Jolla, California.

Joyce, T. and N. Holmes. 2010. Band-rumped storm-petrel *Oceanodroma castro* on Kaua'i: submission to Fish and Wildlife Service for 2010 species assessment and endangered species listing priority. 3 pp.

Judge, S. W., D. Hu, and C. N. Bailey. 2014. Comparative analysis of Hawaiian petrel *Pterodroma sandwichensis* morphometrics. Marine Ornithology 42: 81-84.

[KIRC] Kaho'olawe Island Reserve Commission. 2015. A business plan for the restoration of Hawaiian bird life & native ecosystems on Kaho'olawe, Kaho'olawe Island Seabird Restoration Project. 125 pp.

[KESRP] Kaua‘i Endangered Seabird Recovery Project. 2017a. Hawaiian petrel factsheet. Retrieved from http://kauaiseabirdproject.org/index.php/the-birds/hape-fact-sheet/, accessed 1 August 2016.

[KESRP] Kaua‘i Endangered Seabird Recovery Project. 2017b. Newell’s shearwater factsheet. Retrieved from http://kauaiseabirdproject.org/index.php/the-birds/nesh-fact-sheet/, accessed 1 August 2016.

[KESRP] Kaua‘i Endangered Seabird Recovery Project. 2017c. Band-rumped storm-petrel factsheet. Retrieved from http://kauaiseabirdproject.org/index.php/the-birds/banp-fact-sheet/, accessed 1 August 2016.

King, W. B., and P. J. Gould. 1967. The status of Newell’s race of the Manx shearwater. The Living Bird 6: 163-186

Lescroël, A., K. M. Dugger, G. Ballard, and D. G. Ainley. 2009. Effects of individual quality, reproductive success and environmental variability on survival of a long-lived seabird. Journal of Animal Ecology 78: 798–806.

Martínez-Gómez, J. E., N. Matías-Ferrer, R. N. M. Sehgal, and P. Escalante. 2015. Phylogenetic placement of the critically endangered Townsend’s Shearwater (*Puffinus auricularis auricularis*): evidence for its conspecific status with Newell’s Shearwater (*Puffinus a. newelli*) and a mismatch between genetic and phenotypic differentiation. Journal of Ornithology 156: 1025-1034.

McKown, M., and D. Savage. 2015. Exploratory acoustic surveys for Hawaiian petrel, Newell’s shearwater, and barn owl in East Maui, Hawai‘i. Conservation Metrics Inc. Prepared for Maui Nui Seabird Recovery Project. 25 pp.

Monteiro, L. R., and R. W. Furness. 1998. Speciation through temporal segregation of Madeiran storm petrel (*Oceanodroma castro*) populations in the Azores? Philosophical Transactions of the Royal Society of London B 353: 945-953.

[NPS] National Park Service. 2012. Information for programmatic Section 7 consultation, Haleakalā National Park. Makawao, Maui, Hawai‘i. 171 pp.

Norbury, G., A. Hutcheon, J. Reardon, and A. Daigneault. 2014. Pest fencing or pest trapping: A bio-economic analysis of cost-effectiveness. Austral Ecology 39: 795-807.

Olson, S. L. and H. F. James. 1982. Prodromus of the fossil avifauna of the Hawaiian Islands. Smithsonian Contributions to Zoology 365: 1-59.

Oro, D. 2014. Seabirds and climate: knowledge, pitfalls, and opportunities. Frontiers in Ecology and Evolution 2(79): 1-12.

Phillips, R. and B. Lucey. 2016. Kauaʻi mongoose standard operating procedures to conduct and island-wide status assessment and early detection rapid response. U.S. Fish and Wildlife Service and Kauaʻi Invasive Species Committee. 25 pp.

Podolsky, R., D. G. Ainley, G. Spencer, L. Deforest, and N. Nur. 1998. Mortality of Newell's shearwaters caused by collisions with urban structures on Kauaʻi. Colonial Waterbirds 21(1): 20-34.

Pratt, H. D. 1994. *Avifaunal change in the Hawaiian Islands, 1983-1993.* Studies in Avian Biology No. 15: 103-118. Cooper Ornithological Society, Camarillo, California.

Pyle, R. L. and P. Pyle. 2009. *The birds of the Hawaiian Islands: occurrence, history, distribution, and status.* B. P. Bishop Museum, Honolulu, Hawaiʻi.

Pyle, P., D. L. Webster, and R. W. Baird. 2016. White-rumped dark storm-petrels in Hawaiian island waters: the quandary of Leach's vs. band-rumped storm-petrels throughout the world. Birding 47(1): 58-73.

Raine, A. F. 2015. Site visits to Kōkeʻe Air Force Base – 11th – 13th September 2015. Kauaʻi Endangered Seabird Recovery Project (KESRP), Pacific Cooperative Studies Unit, University of Hawaiʻi and Division of Forestry and Wildlife (DOFAW), State of Hawaiʻi Department of Land and Natural Resources, Hawaiʻi, USA. 7 pp.

Raine, A. and B. McFarland. 2013. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2012. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA.

Raine, A. and B. McFarland. 2014. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2013. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA.

Raine, A. and N. Banfield. 2015a. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2014. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 52 pp.

Raine, A. F., and N. Banfield. 2015b. Auditory surveys for endangered seabirds on Kauaʻi, annual report 2014. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 46 pp.

Raine, A. F., and N. Banfield. 2015c. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve II : Pōhākea, annual report 2014. Kauaʻi Endangered Seabird Recovery Project. 54 pp.

Raine, R. F., M. Travers, A. Griesemer. 2015. Site visit to Kōkeʻe Air Force Base – 9th September 2015. 10 September 2015. Unpublished report. 12 pp.

Raine, A., Vynne, M., McFarlin, M., and M. Massie. 2016a. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 47 pp.

Raine, A. F., M. Vynne, M. McFarlin, and M. Massie. 2016b. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve (Part I): Pihea, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 46 pp.

Raine, A. F., M. Vynne, M. McFarlin, and M. Massie. 2016c. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve (Part II): Pōhākea, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 50 pp.

Raine, A. F., M. Vynne, M. McFarlin, and M. Massie. 2016d. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve (Part III): North Bog, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 41 pp.

Raine, A. F., M. Vynne, M. McFarlin, M. McKown, and D. Savage. 2016e. Monitoring of endangered seabird colonies on Kauaʻi: implementation of Kahuku Wind Power and Kawailoa Wind Power Habitat Conservation Plan Seabird Mitigation Actions. Annual Report 2015. 36 pp.

Raine A. F., J. Adams, M. Boone, M. Vynne, M. McFarlin, and M. Travers. 2016f. Study of daily movement patterns of NESH and HAPE in relation to power line collisions (Draft Report). Kauaʻi Endangered Seabird Recovery Project, Hanapepe, Hawaiʻi. 33 pp.

Raine, A. F., N. Holmes, M. Travers, B. A. Cooper. *In Press*. Twenty-year population trends for Hawaiian petrel and Newell's shearwater on Kauaʻi Island, Hawaiian Islands.

Reed, J. R., J. L. Sincock, and J. P. Hailman. 1985. Light attraction in endangered Procellariiform birds: reduction by shielding upward radiation. The Auk 102: 377-383.

[RCUH] Research Corporation of the University of Hawaiʻi. 2015. Predator control of Newell's shearwater on Kauaʻi; Kahuku Wind Power Habitat Conservation Plan. Progress Report.

Kaua‘i, Hawai‘i: University of Hawai‘i at Mānoa Pacific Cooperative Studies Unit, Division of Forestry and Wildlife State of Hawai‘i.

Reynolds, M. H., and G. L. Ritchotte. 1997. Evidence of Newell's shearwater breeding in Puna district, Hawai‘i. Journal of Field Ornithology 68(1): 26-32.

Ridgeway, R. 1882. Description of a new flycatcher and a supposed new petrel from the Sandwich Islands. Proceedings of the United States National Museum 337-338.

Sandvik, H., K. E. Erikstad, and B. Saether. 2012. Climate affects seabird population dynamics both via reproduction and adult survival. Marine Ecology Progress Series 454: 273-284.

Simons, T. R. 1984. Population model of the endangered Hawaiian dark-rumped petrel. The Journal of Wildlife Management 48(4): 1065-1076.

Simons, T. R. 1985. Biology and behavior of the endangered Hawaiian dark-rumped petrel. The Condor 87: 229-245.

Simons, T. R. and C. N. Hodges. 1998. Dark-rumped petrel (*Pterodroma phaeopygia*). *In* Birds of North America, No. 345 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, Pennsylvannia.

Sincock, J. L., and G. E. Swedberg. 1969. Rediscovery of the nesting grounds of the Newell's Manx shearwater (*Puffinus puffinus newelli*) with initial observations. Condor 7: 69-71.

Slotterback, J. W. 2002. Band-rumped storm-petrel, *Oceanodroma castro*. *In* The Birds of North America, No. 673, A. Poole and F. Gill (eds.), Philadelphia. Pp. 1-28.

Spear, L. B., D. G. Ainely, and W. A. Walker. 2007. Foraging dynamics of seabirds in the Eastern Tropical Pacific Ocean. Studies in Avian Biology 35: 1-99.

Spear, L. B., D. G. Ainley, N. Nur, and S. N. G. Howell. 1995. Population size and factors affecting at-sea distributions of four endangered Procellariids in the tropical Pacific. Condor 97: 613-638.

Spencer, G. 2010. 2009 Makamaka‘ole seabird mitigation activities, final report under Kaheawa Wind Power Habitat Conservation Plan. Kaheawa Wind Power, LLC. 8 pp.

Stearns, S.C. 1977. The evolution of life history traits: a critique of the theory and a review of the data. Annual Review of Ecology and Systematics 8: 145-171.

Stejneger, L. 1887. Birds of Kaua‘i Island, Hawaiian archipelago, collected by Mr. Valdemar Knudsen, with descriptions of new species. Proceedings of the United States National Museum. Pp. 75-102.

Stiebens, V. A., S. E. Merino, C. Roder, F. J. J. Chain, P. L. M. Lee, and C. Eizaguirre. 2013. Living on the edge: how philopatry maintains adaptive potential. Proceedings of the Royal Society B 280: 20130305.

Telfer, T. C., J. L. Sincock, G. V. Byrd, and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: conservation efforts and effects of moon phase. Wildlife Society Bulletin 15: 406-413.

Tompkins, R. J. and B. J. Milne. 1991. Differences among dark-rumped petrel (*Pterodroma phaeopygia*) populations within the Galapagos archipelago. Notornis 38:1-35.

Travers, M., S. Theis, and A. F. Raine. 2013. Underline monitoring project annual report 2012. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA.

Travers, M., A. Shipley, M. Dusch, and A. F. Raine. 2014. Underline monitoring project annual report – 2013 field season. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA.

Travers, M., D. Golden, A. Stemen, and A. F. Raine. 2016. Underline monitoring project annual report – 2015 field season. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA. 48 pp.

Troy, J. R., N. D. Holmes, J. A.Veech, A. F. Raine, and M. C. Green. 2014. Habitat suitability modeling for the Newell’s shearwater on Kaua‘i. Journal of Fish and Wildlife Management 5(2): 315-329.

Travers, M., A. Shipley, M. Harris, D. Golden, N. Galase, and A. F. Raine. 2015. Underline monitoring project annual report – 2014 field season. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA.

Troy, J. R., N. D. Holmes, and M. C. Green. 2011. Modeling artificial light viewed by fledgling seabirds. Ecosphere 2(10): 109.

[USAF] U.S. Air Force, Pacific Air Forces Regional Support Center, 611 Civil Engineer Squadron. 2016. Biological Assessment for the Continuing Operations at Kōke‘e Air Force Station and Microwave Antenna Site, Kaua‘i. 11 August 2016. 104 pp.

[USFWS] U.S. Fish and Wildlife Service. 1983. Hawaiian dark-rumped petrel and Newell's Manx shearwater recovery plan. Portland, Oregon. 57 pp.

[USFWS] U.S. Fish and Wildlife Service. 2005a. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, Oregon. 264 pp.

[USFWS] U.S. Fish and Wildlife Service. 2005b. Study guide for the analytical framework, Section 6: in Advanced Interagency Consultation for Endangered Species, unpublished course notebook, National Conservation Training Center, Shepherdstown, West Virginia.

[USFWS] U.S. Fish and Wildlife Service. 2015. Draft Newell's shearwater (NESH) recovery strategy. Portland, Oregon. 25 pp.

[USFWS] U.S. Fish and Wildlife Service. 2017. Appendix II. Modelling methods and results used to inform the Newell's shearwater landscape strategy. Draft Newell's shearwater (NESH) recovery strategy. Portland, Oregon.

VanderWerf, E. and L. Young. 2010. Surveys of endangered Procellariformes and recommendations to minimize potential take, effects of radar transmission on Hawaiian hoary bat activity, and invasive weed control at Kōkeʻe Air Force Station and Microwave Antenna Site. Final report prepared for the U.S. Air Force and Air National Guard. 34 pp.

VanderWerf, E. A., K. R. Wood, C. Swenson, and M. LeGrande. 2007. Avifauna of Lehua Islet, Hawaiʻi: conservation value and management needs. 14 pp.

VanZandt, M., D. Delparte, P. Hart, F. Duvall, and J. Penniman. 2014. Nesting characteristics and habitat use of the endangered Hawaiian petrel (*Pterodroma sandwichensis*) on the island of Lānaʻi. Waterbirds 37(1): 43-51.

Vorsino, A. 2016. Description of analysis performed to inform the Biological Opinion concerning proposed seabird mitigation to offset minimized take from Kōkeʻe Air Force Station. Unpublished report. 4 pp.

Warham, J. 1977. Wing loadings, wing shapes, and flight capabilities of Procellariiformes. New Zealand Journal of Zoology 4: 73-83.

Welch, A. J., R. C. Fleischer, H. F. James, A. E. Wiley, P. H. Ostrom, J. Adams, F. Duvall, N. Holmes, D. Hu, J. Penniman, and K. A. Swindle. 2012. Population divergence and gene flow in an endangered and highly mobile seabird. Heredity 109: 19-28.

Wiley, A. E., A. J. Welch, P. H. Ostrom, H. F. James, C. A. Stricker, R. C. Fleischer, H. Gandhi, J. Adams, D. G. Ainley, F. Duvall, N. Holmes, D. Hu, S. Judge, J. Penniman, and K. A. Swindle. 2012. Foraging segregation and genetic divergence between geographically proximate colonies of a highly mobile seabird. Oecologia 168: 119-130.

Willi, Y., J. V. Buskirk, and A. A. Hoffmann. 2006. Limits to the adaptive potential of small populations. Annual Review of Ecology, Evolution, and Systematics 37: 433-458.

Wood, G. C., and H. M. Otley. 2013. An assessment of the breeding range, colony sizes and population of the Westland petrel (*Procellaria westlandica*). New Zealand Journal of Zoology 40: 186-195.

Wood, K. R., D. Boynton, E. VanderWerf, L. Arnold, M. LeGrande, J. W. Slotterback, and D. Kuhn. 2002. The distribution and abundance of the band-rumped storm-petrel (*Oceanodroma castro*): a preliminary survey on Kauaʻi, Hawaiʻi. Final report prepared for the Pacific Islands Fish and Wildlife Office, Honolulu, Hawaiʻi.

Young, L. and E. VanderWerf. 2014. Feasibility assessment of predator exclusion fencing to protect Newell's shearwater and Hawaiian petrel nesting locations on Kauaʻi. Pacific Rim Conservation. Honolulu, Hawaiʻi. 38 pp.

Young, L. C, E. A. VanderWerf, M. T. Lohr, C. J. Miller, A. J. Titmus, D. Peters, and L. Wilson. 2013. Multi-species predator eradication within a predator-proof fence at Kaʻena Point, Hawaiʻi. Biological Invasions 15: 2627-2638.

Personal Communications and in Litt.

Anderson, T. 2016a, in litt. Email regarding recapture NESH, July 27, 2016.

Anderson, T. 2016b, in litt. Email regarding question on total no. of listed seabird fallout, August 19, 2016.

Banko, P. 2015, in litt., Comments on proposed endangered status for the band-rumped storm-petrel, November 4, 2015.

Orlando, C. 2015, in litt., National Park Service comments on plant species proposed for listing that occur in Hawaiʻi Volcanoes National Park. November 9, 2015.

Raine, A. 2015, in litt., Project manager for the Kauaʻi Endangered Seabird Recovery Project's comments on the band-rumped storm-petrel, proposed for listing. November 2015.

Raine, A. 2016a, in litt. Telephone call regarding KIUC implementation and the issue of predation and mate loss, May 26, 2016.

Raine, A. 2016b, in litt., Email regarding results of seabird monitoring at Kōkeʻe AFS, December 11, 2016.

THIS PAGE IS INTENTIONALLY BLANK

Appendix A.

Informal Consultation for the Hawaiian hoary bat and Hawaiian goose

Not Likely to Adversely Affect Determination for the Hawaiian Hoary Bat and Hawaiian Goose

This Appendix is in response to your request for our concurrence with your determination that the proposed continuing operations at Kōkeʻe Air Force Station (AFS) and Microwave Antenna Site (MAS) as described above, may affect, but are not likely to adversely affect the federally endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) and endangered Hawaiian goose (*Branta sandvicensis*). The findings and recommendations in this consultation are based on information provided in: (1) the August 11, 2016, Biological Assessment (BA) for your proposed project; (2) email and verbal communication between the USAF staff and our office; (3) survey and reports; and (4) other information available to us. A complete administrative record is on file in our office. This response is in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq*.).

Project Description
The project description and action areas are the same as described above for the formal consultation.

Conservation Measures
The following conservation measures identified in your Biological Assessment and other correspondence will be implemented at the project site to avoid and minimize effects to the Hawaiian hoary bat and Hawaiian goose. These conservation measures are considered part of the project description. Any changes to, modifications of, or failure to implement these conservation measures may result in the need to reinitiate this consultation.

- No woody plants over 15 feet tall will be removed, cut, or trimmed during the sensitive bat pup-birthing and rearing season of June 1 to September 15.
- A biological monitor will conduct Hawaiian goose and nest surveys at the project site prior to any project initiation.
- Any documented nests or broods within the project vicinity will be reported to the Service within 48 hours.
- A biological monitor will be present on the project site during all construction or earth moving activities to ensure that the Hawaiian goose and nest are not adversely impacted.
- Any trenching for conduit work will be closed to avoid birds from falling into holes
- Driving within the Kōkeʻe AFS site is limited to a couple hundred feet of asphalted access pavement and parking spaces. All vehicles will drive less than 5 MPH on site.
- Garbage cans on Kōkeʻe AFS will be regularly inspected to ensure they remain secured from feral cats and rats.
- Trapping and removal of feral cats from Kōkeʻe AFS will continue.
- Outreach and education will be conducted so that base personnel understand that the Hawaiian goose should not be harassed or harmed and that they should not feed the geese or feral cats.

Hawaiian bats

The Hawaiian hoary bat has been documented foraging within the proposed project area. Additionally, bats may utilize the existing forest habitat located within and immediately surrounding the Kōkeʻe AFS site. The proposed project may impact the Hawaiian hoary bat if juvenile bats not capable of flying are roosting in a tree that is cut or trimmed. By incorporating the above conservation measures juvenile bats being injured or killed due to tree cutting or trimming is not probable and, therefore, discountable. Because effects from the action are discountable, the proposed project is not likely to adversely affect the Hawaiian hoary bat.

The Kōkeʻe AFS perimeter fence is approximately 0.3297 miles in length with 3 strands of barbed wire and surrounded by forest habitat. The proposed project may impact the Hawaiian hoary bat if, while foraging, a bat becomes entangled on barbed wire fencing. However, habitat features surrounding the project are important in evaluating take of Hawaiian hoary bats.

We analyzed the probable impacts of the Kōkeʻe AFS perimeter fence to the Hawaiian hoary bat using the Service's formula for barb wire fence incidental take (shown below).

An estimated 0.013 Hawaiian hoary bats are killed per mile of fence per year, where habitat is mostly pasture grasses (Data from Haleakala National Park).

[Miles of fence] x [Number of strands of barbed wire] = Total barb wire assessed

[0.3297] x [3] = 0.9891

[Total barb wire] x [0.013 Bats killed per mile of fence per year] x [Anticipated life of fence] = Estimated bat take

[0.9891] x [0.013] x [30] = 0.385749

We estimate the Kōkeʻe AFS perimeter fence is likely to take 0.39 Hawaiian hoary bats within 30 years (the estimated life of a high quality fence). The Service has determined that any amount less than one, over the life of a project, is not considered take of the bat. The Service has determined that effects to the Hawaiian hoary bat as a result of the use of barbed wire for the Kōkeʻe AFS fence over the life of the project is considered discountable. Based on the formula results, it is unlikely that take of at least one Hawaiian hoary bat will occur over the life of the project. Therefore, the Service concurs with your determination that the proposed project at Kōkeʻe AFS may affect, but is not likely to adversely affect the Hawaiian hoary bat. Additionally, because the site is situated within forested habitat, we expect that Hawaiian hoary bats are less vulnerable to the barbed wire fences at Kōkeʻe AFS.

Hawaiian goose

The Hawaiian goose has been known to forage and utilize the habitat within the Kōkeʻe AFS site. The proposed project may impact the Hawaiian goose if nests are present and the parents are flushed from the nest for extended periods of time causing the nest to fail (e.g., exposed to

predation) or eggs or goslings are crushed by humans or equipment during construction. By incorporating the above conservation measures for the Hawaiian goose, crushed eggs or goslings, and adults leaving nests for extended periods or nests failing are not probable, and therefore discountable. Because effects from the action are discountable, the proposed project is not likely to adversely affect the Hawaiian goose.

Summary

Based upon the above, the Service concurs that the proposed project may affect, but is not likely to adversely affect, the Hawaiian hoary bat and Hawaiian goose. Unless the project description changes, or new information reveals that the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to section 7 of the Act is necessary.

Appendix B.

Building Exterior and Perimeter Lighting Inventory at Kōkeʻe AFS, 2015

Kokee Air Force Station, Kauai

Building Exterior Lighting Inventory

13 Nov 2015 – Final

Prepared by

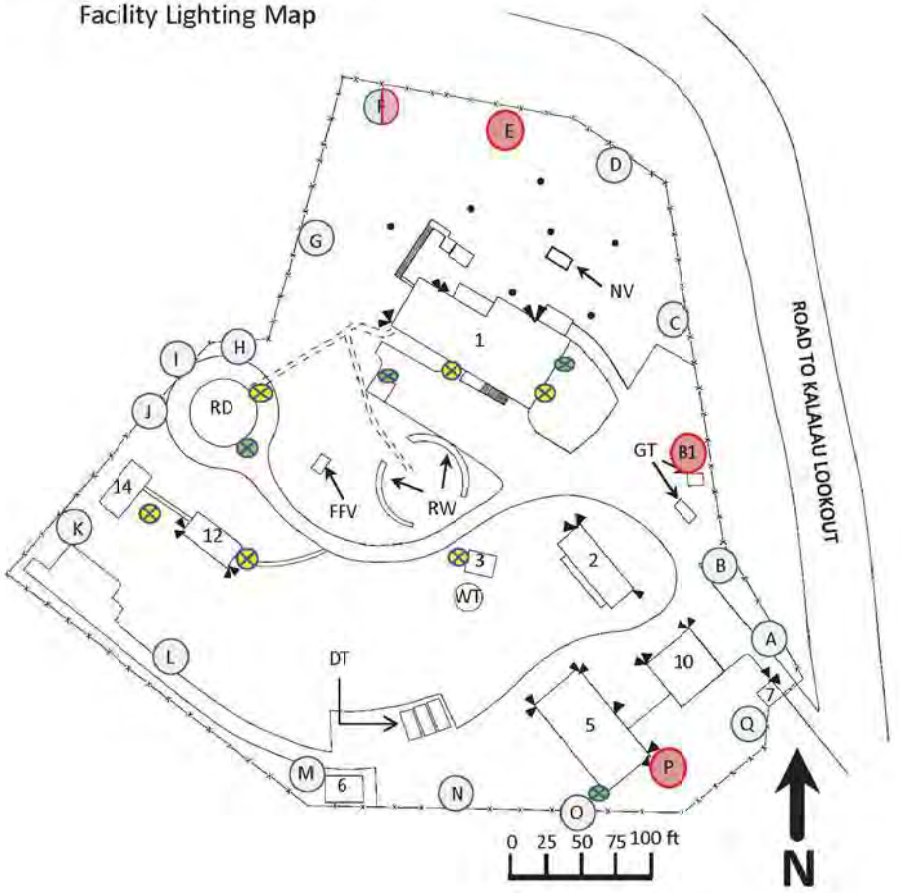
Center for Environmental Management
MILITARY LANDS
Colorado State University

Legend	
Symbol	Description
▶	Building Flood Light
○	Operational Perimeter Lights (A – Q)
●	Non-operational Perimeter Lights
— x —	Security Fence
•	Post of Antenna Array
⊗ ⊗	Bldg. Ext. Light (green or white bulb)
RD	RADAR Dome
WT	Water Tank
DT	Diesel Tanks
GT	Gasoline Tanks and Pump Station
FFV	FASFAC Van
RW	Retaining Wall of Former RADAR
NV	Navy Van
1	BLDG 1 : Operations Building
2	BLDG 2: Generators Building
3	BLDG 3: Chlorinator Shed
5	BLDG 5: Supply Building
6	BLDG 6: HAZMAT Shed
7	BLDG 7: Gate House
10	BLDG 10: Vehicles Building
12	BLDG 12: Unoccupied Building
14	BLDG 14: Unoccupied Building

611 CES/CEIE_13 Nov 2015

Kokee Air Force Station

Facility Lighting Map



Kokee Air Force Station - Building Exterior Lights

Building	Location	Type of Light	No. Lights	Comment	Photo No
BLDG 1	North corner	Flood Light	2	Green bulbs with motion detection	Bldg1_FL1, Bldg1_FL1a
BLDG 1	Northwest corner	Flood Light	2	Green bulbs with motion detection	Bldg1_FL2, Bldg1_FL2a
BLDG 1	Northwest side	Flood Light	2	Green bulbs with motion detection	Bldg1_FL3
BLDG 1	Southwest-facing side	Entryway Light	1	2nd floor, entryway over door, no green bulb, no shielding and no motion detection	Bldg1_EL1, Bldg1_EL1a
BLDG 1	Southeast-facing side	Entryway Light	1	1st floor, entryway over door, no green bulb, no shielding and no motion detection	Bldg1_EL2, Bldg1_EL2a
BLDG 1	Southeast-facing side	Entryway Light	1	1st floor, entryway over door, one green bulb, no shielding or motion detection	Bldg1_EL3
RADAR Twr	Southeast-facing side	Entryway Light	1	One green bulb in entryway, doorway is well blocked by three wall	RdrTwr_EL1
RADAR Twr	Northeast-facing side	Entryway Light	1	One white bulb in entryway, no shielding and no motion detection	RdrTwr_EL2
BLDG 2	Southeast corner	Flood Light	1	Green bulb with no shielding or motion detection	Bldg2_FL1
BLDG 2	North-facing side	Flood Light	2	Two green bulbs, with shielding and motion detection over the doorway	Bldg2_FL2, Bldg2_FL2a
BLDG 3	North-facing side	Building Exterior Light	1	One white bulb, with no shielding or motion detection	Bldg3_BEL1
BLDG 5	N/E corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg5_FL1
BLDG 5	N/W corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg5_FL2
BLDG 5	S/E corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg5_FL3
BLDG 5	Northeast-facing side	Flood Light	1	One green bulb, with no shielding and no motion detection	Bldg5_FL4
BLDG 5	S/W corner	Flood Light	1	One green bulb, with no shielding and no motion detection	Bldg5_BEL1
BLDG 7	North corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg7_FL1
BLDG 10	N/W corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg10_FL1&2

Kokee Air Force Station - Building Exterior Lights

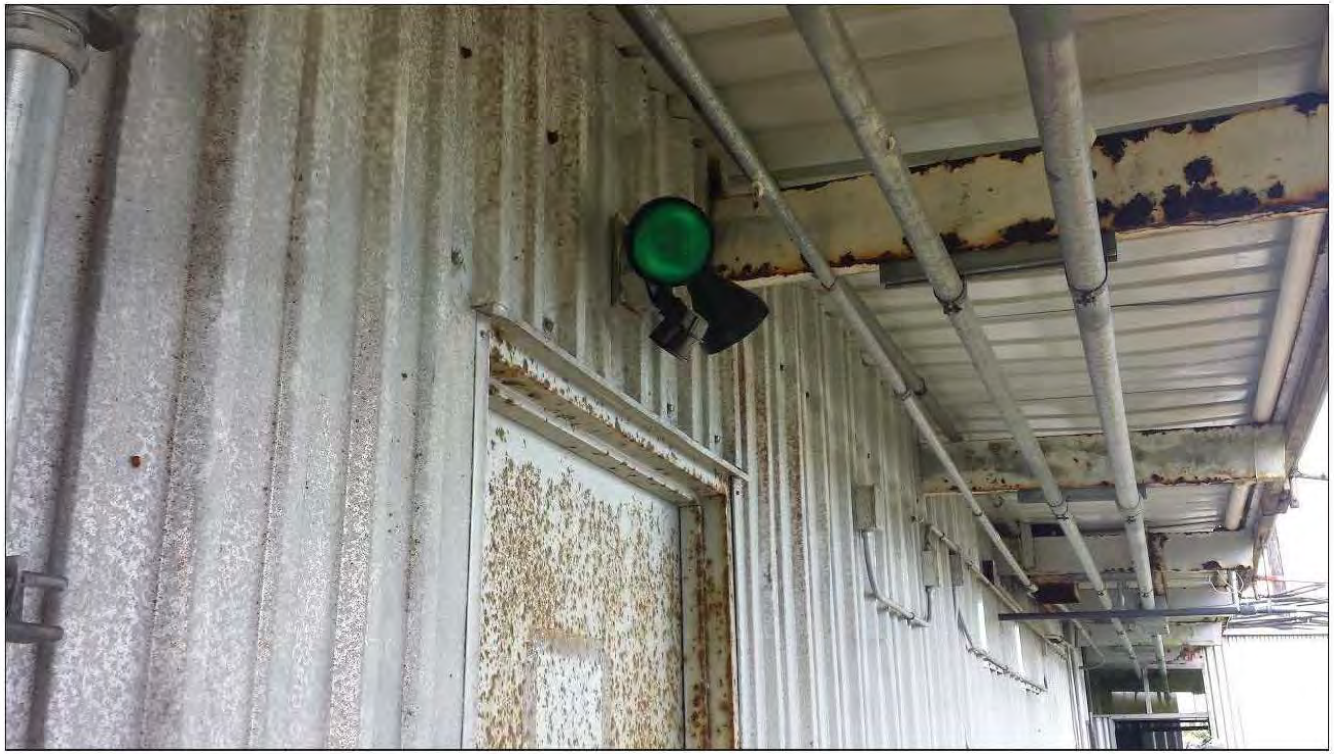
BLDG 10	N/E corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg10_FL1&2
BLDG 12	N/W corner	Flood Light	2	Two white bulbs with shielding and no motion detection (BLDG appears not in use, light appears non functional)	Bldg12_FL1
BLDG 12	Southeast-facing side	Flood Light and Entryway Light	3	Three white bulbs, all with shielding and no motion detection	Bldg12_FL2&EL1
BLDG 14	South-facing side	Entryway Light	1	One white bulb, with minor shielding and no motion detection	Bldg14_EL1
PwrShed	Northeast-facing side	Entry Light	1	One green bulb, with no shielding and no motion detection	PwrShed_EL1
		Total	**36**		

Building 1_Flood Light 1: Two green bulbs with motion detection (close up).

Building 1_Flood Light 1: Two green bulbs with motion detection.

Building 1_Flood Light 2: Two green bulbs with motion detection located on the northside of the building.

Building 1_Flood Light 2: Two green bulbs with motion detection (close-up).



Building 1_Flood Light 3: Two green bulbs with motion detection (close-up)

Building 1_Entryway Light 1: One white bulb, no shielding and no motion detection, 2nd floor.

Building 1_Entryway Light 1: One white bulb, with no shielding and no motion detection (close-up), 2nd floor.

Building 1_Entryway Light 2: One white bulb, with no shielding and or motion detection, 1st floor southeast-facing.

Building 1_Entryway Light 2: One white bulb, no shielding and no motion detection (close-up), 1st floor, southeast – facing.

Building 1_Entryway Light 3: One green bulb with no shielding or motion detection, 1st floor, southeast facing.

RadarTower_Entryway Light 1: One green bulb with no shielding or motion detection (however the doorway is well blocked by three walls).

RadarTwr_Entryway Light 2: One white bulb with no shielding and no motion detection.

Building 2_Flood Light 1: One green bulb with no shielding or motion detection.

Building 2_Flood Light 2: Two green bulbs, both with shielding and motion detection, facing north.

Building 2_Flood Light 2: Two green bulbs, both with shielding and motion detection, facing north (close up).

Building 3_Building Exterior Light 1: One white bulb with no shielding and no motion detection, facing northwest.

Building 5_Flood Light 1: Two green bulbs both with shielding and motion detection.

Building 5_Flood Light 2: Two green bulbs, both with shielding and motion detection.

Building 5_Flood Light 3: Two green bulbs, both with shielding and motion detection.

Building 5_Flood Light 4: One green bulb with no shielding and no motion detection, bulb is facing northeast and mounted onto of the top of the building.

Building 5_Building Exterior Light 1: One green bulb with no shielding and no motion detection .

Building 7_Flood Light 1: Two green bulbs, both with shielding and motion detection.

Building 10_Flood Lights 1 and 2: Two green bulbs each, both with shielding and motion detection.

Building 12_Flood Light 1: Two white bulbs each with shielding and no motion detection (building appears to no longer be in use).

Building 12_Flood Light 2 and Entryway Light 1: Three white bulbs each with shielding and no motion detection (building appears to no longer be in use).

Building 14_Entryway Light 1: One white bulb with no shielding and no motion detection, southeast facing.

Power Shed (no building number)_Entryway Light 1: One green bulb with no shielding and no motion detection.

Kokee Air Force Station, Kauai

Facility Perimeter Lighting Inventory

13 Nov 2015 – Final

Prepared by

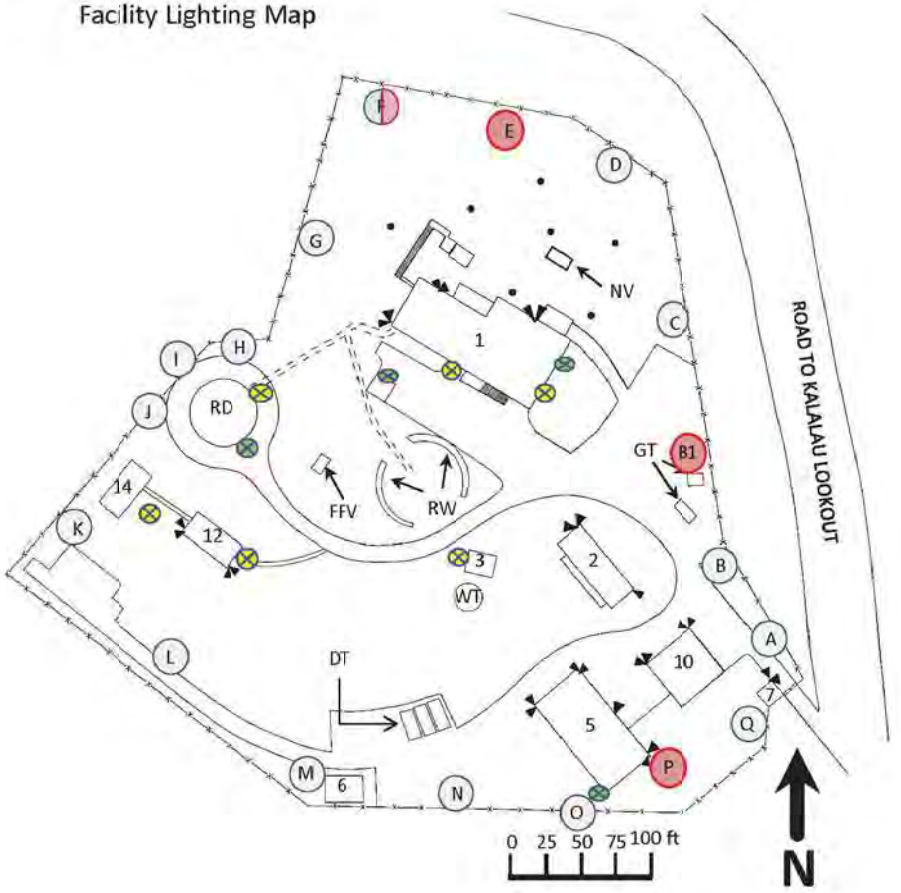
Center for Environmental Management
MILITARY LANDS
Colorado State University

Legend	
Symbol	Description
▶	Building Flood Light
○	Operational Perimeter Lights (A – Q)
●	Non-operational Perimeter Lights
— x —	Security Fence
•	Post of Antenna Array
⊗ ⊗	Bldg. Ext. Light (green or white bulb)
RD	RADAR Dome
WT	Water Tank
DT	Diesel Tanks
GT	Gasoline Tanks and Pump Station
FFV	FASFAC Van
RW	Retaining Wall of Former RADAR
NV	Navy Van
1	BLDG 1 : Operations Building
2	BLDG 2: Generators Building
3	BLDG 3: Chlorinator Shed
5	BLDG 5: Supply Building
6	BLDG 6: HAZMAT Shed
7	BLDG 7: Gate House
10	BLDG 10: Vehicles Building
12	BLDG 12: Unoccupied Building
14	BLDG 14: Unoccupied Building

611 CES/CEIE_13 Nov 2015

Kokee Air Force Station

Facility Lighting Map



Kokee Air Force Station - Perimeter Lighting Inventory

Light Location ID	No. Lights	No. of Lights Operable	Comments	Photo No
A	2	2	Two green bulbs, located across from guard shack (bldg. 7), both lights are tilted downward toward the ground (both with full shielding)	PL_A1, PL_A2 and PL_A3
B	1	1	Single green bulb, along east fenceline (with full shielding)	PL_B, PL_B2, and PL_B3
B1	1	0	One green bulb, along east fenceline, immediately next to gas tanks (light is inoperable)	PL_B1 and PL_B1 (wide view)
C	1	1	One green bulb, immediately north of the Coast Guard monopole (with full shielding)	PL_C (before lighting realignment) and PL_C (after lighting realignment)
D	1	1	One green bulb, along the north fenceline	PL_D
E	1	0	One green bulb (with full shielding)	PL_E, PL_E (close up), and PL_E (side view)
F	2	1	Two green bulbs (both with full shielding), located in the most northern corner of the installation	PL_E & F and PL_F
G	2	2	Two green bulbs (both with full shileding), located north of buidling 1	PL_G
H	1	1	One green bulb, with full shielding mounted to the northeast side of the Radar Tower	PL_H
I	1	1	One green bulb, with full shielding mounted to the north side of the Radar Tower	PL_I & J
J	1	1	One green bulb, with full shielding mounted to the north side of the Radar Tower	PL_I & J
K	2	2	Two green bulbs, with full shileding, located in the northwest corner of the installation	PL_K and PL_K & L
L	1	1	One green bulbs with full shielding located along the western fenceline	PL_K & L
M	2	2	Two green bulbs with full shielding, located immediately west of building 6	PL_M

Kokee Air Force Station - Perimeter Lighting Inventory

N	2	2	Two green bulbs, with full shielding	PL_N
O	1	0	One green bulbs with full shielding located on the southwest corner of bldg. 5	PL_O
P	1	0	One green bulbs with full shielding located on the southeast corner of bldg. 5	PL_P
Q	2	2	Two green bulbs with full shielding, located immediately to the southwest of the guard shack	PL_Q
	25	**20**		

Perimeter Lights_A and B: All green bulbs, with full shielding.

Perimeter Light_A: Two green bulbs, with full shielding, northeast of guard shack.

Perimeter Light_A: Two green bulbs, with full shielding (green lights on), northeast of guard shack.

Perimeter Light_A: Two green bulbs, with full shielding (close up).

Perimeter Light_B: One green bulb, with full shielding, along the eastern fenceline.

Perimeter Light_B: One green bulb, with full shielding (close up).

Perimeter Light_B: One green bulb, with full shielding and green light illuminated.

Perimeter Light_B1: One green bulb, with full shielding (light is currently not functioning).

Perimeter Light_B1 (broad view): One green bulb, with full shielding (light is currently nonfunctional).

Perimeter Light_C: One green bulb, with full shielding (photo taken before the light was realigned in a downward position).

Perimeter Light_C: One green bulb, with full shielding (photo taken after the light was realigned in a downward position).

Perimeter Light_D: One green bulb, with full shielding (moon is visible in the background).

Perimeter Light_E (broad view): One green bulb, with full shielding.

Perimeter Light_E (close up): One green bulb, with full shielding, light is currently not functioning.

Perimeter Light_E : One green bulb, with full shielding.

Perimeter Light_E : One green bulb, with full shielding (circle on the right)

Perimeter Light_F: Two green bulbs, with full shielding (circle on the left)

Perimeter Light_F: Two green bulbs, with full shielding.

Perimeter Light_G: Two green bulbs, with full shielding, north of building 1.

Perimeter Light_H: One green bulb, with full shielding, mounted to the Radar Tower building.

Perimeter Light_I: One green bulb, with full shielding (circle on the left)

Perimeter Light_J: One green bulb, with full shielding (circle on the right)

Perimeter Light_K: Two green bulbs, with full shielding, located in the most western corner of the installation.

Perimeter Light_K: Two green bulbs, with full shielding (circle on the left).

Perimeter Light_L: One green bulb, with full shielding (circle on the right).

Perimeter Light _M: Two green bulbs, with full shielding, immediately west of building 6.

Perimeter Light _N: Two green bulbs, with full shielding, along the south fenceline.

Perimeter Light_O: One green bulb, with full shielding, mounted on the southwest corner of building 5.

Perimeter Light_P: One green bulb, with full shielding, light is mounted to the southeast corner of building 5.

Perimeter Light _Q: Two green bulbs, with full shielding, located immediately southwest of the guard shack.

Appendix C.

Walking Path Bollard Light Model Design proposed by the USAF for usage at Kōkeʻe AFS

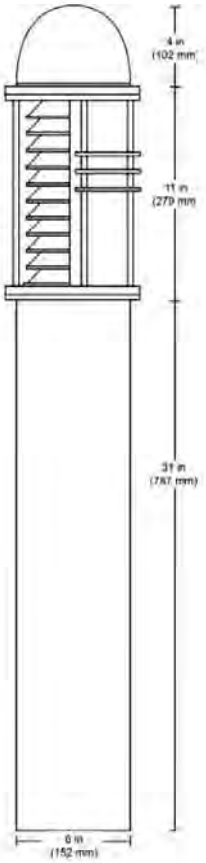
Type: _____ Model: _____

Project: _____

intrigue lighting LED

TURTLE

Amber (590nm) LED Bollard



None (Flush Top)

Dome Top

Cone Top

Flat Top

Beveled Top

General Description: LED bollard utilizing 270° shielding (external to lens) provides pedestrian safety while eliminating light trespass. High-impact look includes extreme durability and corrosion-resistant construction.

Construction: Low-copper content, marine grade, cast aluminum top and mounting gear. Housing is extruded aluminum. Stainless steel external hardware protects against corrosion.

Lens: Cylindrical lens shall be clear acrylic. Acrylic lens shall be UL recognized.

Internal Louvers: Aluminum interior reflector louvers shall have bead blasted top surface and acid etched inside surface.

House-side Shield: Corrosion resistant, high purity aluminum standard with 270° house-side shield.

LED Light Engine: LED module located in lower portion of bollard head offering 33 nominal input watts. Amber LED board providing color wavelength of 590nm.

Driver: Constant current LED driver; input voltage of 120v to 277v, mounted internal to fixture.

Heat Sink: Supplied with 6" cylindrical heat sink; powder coat finish; providing an overall heat-sinking surface area of 384 square inches.

Decorative Top: Five (5) top styles available: Beveled, Cone, Dome, Flat, and None (flush).

Mounting: Base is secured to concrete footing (by others) using provided mounting template and 1/2" anchor bolt kit (4 bolts). A 2.0" (51mm) diameter conduit opening is provided in the base for wiring.

Finish: Textured polyester powder coat finish available in Black, Bronze, Gray, White, Silver, and Verde Green. Contact factory for custom color/woodgrain options.

Gaskets: EPDM and silicone gaskets are standard.

Listings: UL Listed 1598 for Wet Locations. Indoor/Outdoor listed for use in Canada.

c UL us LISTED

Made in USA

www.intrigueled.com N60 W14592 Kaul Avenue Menomonee Falls, WI 53051
P (877) 965 0005 F (262) 436 1745

Type: _____ Model: _____

Project: _____

intrigue lighting LED

SERIES	DIAMETER	MOUNTING	SOURCE	LED COLOR	TOP STYLE	LENS	SHIELD	OPTIONS	HEIGHT	FINISH
TB	6	B	33LED	AML		CA	270HSS			

FIXTURE DETAIL

SERIES ☐ **TB** Turtle Series

DIAMETER ☐ **6** 6" Diameter

MOUNTING ☐ **B** Bollard Mount

WATTS ☐ **33LED** 33 Watts

Nominal Watts	Nominal Lumens	Lumens/Watt (LPW)	Nanometers	Rated Life (L85)	Drive Current (mA)	Output Voltage
33	2,000	61	590	50,000 hrs	700mA	48V

LED COLOR ☐ **AML** Amber LED (590nm)

TOP STYLE
- ☐ **B** Beveled
- ☐ **C** Cone
- ☐ **D** Dome
- ☐ **F** Flat
- ☐ **N** None (Flush)

LENS ☐ **CA** Clear Acrylic Lens

SHIELD ☐ **270HSS** 270° House Side Shield *(external to lens)*

OPTIONS
- ☐ **GFI** Cast outlet box with cover for GFI receptacle (by others)
- ☐ **MS** PIR Motion Sensors (3)
- ☐ **NR** No Rings
- ☐ **TRH** Tamper Resistant Hardware

HEIGHT
- ☐ **35** 35" overall height
- ☐ **46** 46" overall height

FINISH

☐ **BLK**	Black	☐ **VGN**	Verde Green
☐ **BRZ**	Bronze	☐ **WHT**	White
☐ **GRY**	Grey	☐ **WGF**	Woodgrain finish – consult factory
☐ **SIL**	Silver	☐ **CC**	Custom Color – consult factory

Made in USA

Content of specification sheets is subject to change. Please consult website for current product detail.

www.intrigueled.com N60 W14592 Kaul Avenue Menomonee Falls, WI 53051
P (877) 965 0005 F (262) 436 1745

Type: _____ Model: _____

Project: _____

intrigue lighting LED

BOLLARD DETAILS

RECEPTACLE BOX ☐ **GFI**

Outlet box mounted 16" on center from bottom of bollard tube. Cast aluminum outlet box internally welded and sealed with gasketed spring-loaded hinge cover.

Cover shall be die cast metal construction with finish to match bollard. Typical cover will be lockable, single-gang weatherproof receptacle cover (Bell #MX10505 or similar). *(for wet and damp locations when cover is closed)*

Electrical receptacle not supplied due to variations in municipal electrical codes.

MOTION SENSOR ☐ **MS**

Motion Sensor option includes (3) passive infrared (PIR) sensors to detect motion. When motion is not detected for a 3-1/2 minute period, luminaire will automatically dim to 20% power and light. Once motion is again detected, luminaire immediately ramps up to 100% power and light output until motion is not detected for another 3-1/2 minute period.

Top View

www.intrigueled.com N60 W14592 Kaul Avenue Menomonee Falls, WI 53051
P (877) 965 0005 F (262) 436 1745

Appendix D.

Seabird Monitoring and Predator Control Work Plan

Monitoring of seabirds on Kokee Air Force Station (KAFS) & off-site Predator Control

USAF Project: YGFZOS167778

Work Plan 2016

Dr. André F. Raine

April 2016

Kaua'i Endangered Seabird Recovery Project (KESRP), Pacific Cooperative Studies Unit (PCSU), University of Hawai'i and Division of Forestry and Wildlife (DOFAW), State of Hawai'i Department of Land and Natural Resources, Hawai'i, USA

In collaboration with : USAF Pacific Regional Support Center, 611 Civil Engineer Squadron

1.0 Introduction

In September 2015, Kauai Endangered Seabird Recovery Project (KESRP) staff were asked to visit the Kokee Air Force Station to consider a recent fall-out incident at the station. A large number of Newell's Shearwaters (as well as Hawaiian Petrels) were found to have been attracted to the lights at the station and become grounded. These were all adults, the majority of which were breeding adults.

Over the next few weeks KESRP staff, along with staff from KSHCP (Kauai Seabird Habitat Conservation Plan), DOFAW (Division of Forestry & Wildlife) and US Fish & Wildlife (USFWS), assisted the USAF in monitoring the site on a nightly basis. KESRP staff provided advice on how to prevent further fall-out and over the next few days the USAF put these measures in place. After the first few nights of fall-out and following new lighting protocols at the station, the presence of grounded birds significantly deceased to near-zero. A total of 129 seabirds (of which 121 were Newell's Shearwater, 6 were Hawaiian Petrel and 2 unidentified) were located within or associated with Kokee Air Force Station between 1st and 14th September of 2015.

KESRP will again monitor seabird activity, fallout and collision incidents at Kokee Air Force Station in 2016, although this time monitoring will be undertaken throughout the seabird season.

A second component of this project in 2016 will be off-site predator control, with a special focus paid to non-native avian species, in particular introduced owls. Non-native invasive species control is a known method for reducing predation of seabirds, in particular for burrow and crevice nesting species. Predation by non-native mammals is a constant threat to endangered seabird populations on Kaua'i. Feral cats (*Felis cattus*), rats (both Black (*Rattus rattus)* and Polynesian (*Rattus exulans*) species), Cattle Egret (*Bubulcus ibis*), Barn Owls (*Tyto alba*) and feral pigs (*Sus scrofa*) are all non-native predators that are potentially limiting the breeding success of birds within these colonies. The above predators have been identified as preying on or likely to prey on Newell's Shearwater (*Puffinus newelli*) and Hawaiian Petrel (*Pterodroma sandwichensis*). Arguably one of the most serious introduced predators of threatened seabirds within certain areas on Kaua'i is the Barn Owl. This is particularly true for those colonies where breeding birds are protected from mammalian predators due to topography (i.e., steep cliffs).

As part of this project, funds will be allocated to the Non-native Avian Predator Control team which has been actively working to reduce the number of non-native avian predators impacting Kauai's endangered seabirds since March 2015. The team is run by the Division of Forestry & Wildlife (DOFAW) with the two staff members hired through the Pacific Studies Co-operative Unit. Funding will be used to pay for three months of time for this team, using methodologies also detailed in this work plan.

2.0 Methodologies

2.1 On-site seabird monitoring

The main issue of seabird fallout at KAFS in 2015 revolved around the fall-out of adult birds. This is a relatively unique scenario, as seabird fallout on Kauai predominantly involves fledglings. It is

presumed that the location of the Air Force Station, in very close proximity to large seabird colonies in the Kalalau Valley, Na Pali coast (particularly Honopu and Nualolo Aina) and Hono o Na Pali NAR is the main reason for this. Due to the fact that fallout appears to be mainly adults, monitoring will therefore need to commence at the site as soon as possible – the first breeding birds return in late April, and following an exodus in May, begin egg-laying and incubation in June. Monitoring will therefore commence no later than June.

2.1.1 Outside observations

From June to end of November, a team of two seabird biologists will conduct auditory surveys and nocturnal observations at the station facilities. Surveys will be conducted for four consecutive nights once a month over this period and follow standardised KESRP auditory survey methodology as outlined below.

Surveys will be conducted during weeks when there is no full moon, which is when the fall-out phenomenon is most pronounced. Surveys will consist of a team of two KESRP seabird biologists stationed at two static points within the AFS with the best field of view of the overall area. Static observation points will be selected prior to the start of the season after a field visit by the KESRP Co-ordinator and will also be based on fallout hotspots identified in 2015. Surveys will commence at sunset, and run for 3 hours, with a further two hours of observations before sunrise.

Prior to the start of each survey, field staff will conduct a thorough search of the AFS grounds to look for downed seabirds from the night before. Searches will cover the entirety of the AFS, with specific attention paid to areas adjacent to the fenceline and any areas where there are crawl spaces which downed birds could hide under. A number of these were identified in 2015.

After the search has been completed they will then set up at their stations to begin surveying. Evening surveys will start at sunset (sunset/sunrise times taken from USNO website - http://www.usno.navy.mil/USNO) and last for four hours. Field staff will use night vision to watch for all seabirds. All seabirds will be recorded to species (wherever possible), with data also collected on bats and any other bird species of interest.

Surveys are split into 30-minute sessions, with 5 minutes allotted for the collection of weather data, 25 minutes for auditory surveying, and 5-10 minutes for concurrent night vision. Surveyors record all seabird calls (classified as a single unbroken note or series of notes) heard during the survey period and any bird actually seen during each period (either by eye or through night-vision equipment). For each record, data will be collected on time of observation, species, direction from observer, distance to observer, height of bird, behaviour of bird (with particular attention paid to circling behaviour), direction of flight path (if possible) and elevation, along with any additional comments that the observer feels are relevant. The final fate of the bird will also be recorded. Data will be recorded on standardized data sheets in the field and digitized after surveys have been completed.

If any bird is grounded, it will be immediately collected and put in a carrier box until the end of the survey. At the end of the survey period, the two field staff will conduct another thorough search of the AFS grounds to look for downed seabirds that may have come down during the survey period. The

exact location of all downed seabirds will be marked on a standard map, and they will be aged using standard ageing techniques for the two species. All uninjured seabirds will be banded and released at the Kalalau lookout after the survey has ended (if a licensed bander is present within the team). All injured seabirds will be passed over to the Save Our Shearwaters program for rehabilitation and release. Whenever a downed bird is found by KESRP, KESRP will notify USAF, who will in turn follow BO stipulations regarding notification of downed ESA species.

2.1.2 Ground searches

As well as the nightly searches detailed above, KESRP staff will also thoroughly search the ground immediately outside the station once a month to look for additional signs of grounded seabirds. Particular attention will be paid to areas identified in 2015 as fallout hotspots. Staff will carefully and thoroughly search surrounding uluhe beds and forested areas for seabird sign (either fresh or old). Any seabirds located will be photographed, and removed. Live birds will be taken to SOS. Dead birds will be bagged and taken to the KESRP office for further examination.

2.1.3 Perimeter searches when KESRP staff are not present

When KESRP field staff are not conducting surveys, AFS staff will conduct a search of AFS grounds twice each day – once 2hrs after sunset and once first thing in the morning. As above all downed seabirds will be collected, their location marked on a standard map, and they will be passed over to SOS for rehabilitation. When on-site USAF staff identify down seabirds they will notify their proper chain of command, collect the bird's location on a standard map, and birds will be placed in a box until KESRP staff can get the animal to SOS for rehabilitation. At the beginning of the season (early June), the USAF 611 CES and KESRP staff will conduct an identification and protocol training session with all AFS staff on site.

2.1.4 Acoustic Monitoring

KESRP monitors endangered seabird collisions with powerlines around Kauai using acoustic recording devices (Song Meter 2+ and Song Meter 4 from Wildlife Acoustics). The units record during the night at peak movement periods and identify collisions from the sound of the birds striking the wires. It seems probable that seabirds flying around the Kokee Air Force Station – especially those attracted to lights at the facilities – may come into contact with guy wires located on the station, particularly on the east side of the area. A song meter will be placed in the middle of this area, and will be set to record throughout the night (12 hrs a night).

A second song meter will be set up on the fence line to the west of the radar site where fence collisions were noted with regularity during monitoring in 2015. Tests will be undertaken at the beginning of the season to confirm whether or not birds hitting the lines and fence will make an audible sound that can be picked up by the song meters. This will be carried out by tapping the lines with a stick to simulate a bird collision.

Data will be recorded on SD cards in the units, and will then be sent to Conservation Metrics for analysis. Conservation Metrics, based in California, currently analyse all acoustic data for KESRP. They

do this by running it through computer software that uses a Deep Neural Network (DNN) to identify signature sounds of seabirds or collisions. All identified sounds are then listened to by staff members at CM to verify that they are seabirds or collisions.

Data from the song meter will be used to assess collision rates, as well as the presence of Hawaiian Petrel, Newell's Shearwater and Band-rumped Storm-petrel via their calls. Final outputs of the analysis will include (i) new collision model and total collision sounds (if any), (ii) nightly patterns of seabird activity and (iii) seasonal patterns of seabird activity.

2.1.5 Camera monitoring

10 Reconyx Hyperfire PC900 cameras will be purchased and deployed at the station. *These are not wirelessly transmitting cameras and are not capable of real-time monitoring.* Cameras will be placed at key fallout hotspots around the station, as identified in 2015. They will be used to record grounded seabirds moving along the fenceline, and under the fence, as well as the presence of introduced predators (cats, dogs, pigs) that may be present and which are known to predate on endangered seabirds.

SD cards will be removed each time a monitoring team visits the site, and data digitised back at the KESRP office. Staff will review photos for signs of seabirds and predators, with data entered into the KESRP Access database.

2.2 Off-site predator control

This portion of the work plan addresses the need to reduce overall predation rates within a number of identified seabird colonies, specifically related to Barn Owls and secondarily to cats, rats and Cattle Egret. Management for Barn Owls at these sites is expected to increase the survival rates of both adult birds and fledglings.

Six sites are currently benefiting from Barn Owl control: (1) Nualolo Aina; (2) Nualolo Kai; (3) Honopu; (4) Kalaheo/Kahili; (5) Lehua Islet; and (6) the back of Hanalei Valley. It is expected that these six areas hold significant potential for seabird conservation through Barn Owl-specific predator control actions. Actions under this work plan would continue these control activities for a further **three months** from the current date that funding for the team expires (December 2016 to February 2017).

2.2.1 Barn Owl control

During the three month period of funding identified under the Scope of Work, the Non-native Avian Predator Control team will utlilise the following methods for Barn Owl control. Targeted Barn Owl hunts will be undertaken at all six sites identified in the preceding paragraph. Access to these sites will be either by helicopter, on foot or – in the case of Lehua – by boat. Targeted hunts will occur at each site over a week period, at least once every other month. Barn Owls are lured into the area using tape lures broadcasting calls of seabirds, Barn Owls or distressed mice. Once within range, Barn Owls are then spot-lighted and shot by licenced and trained hunters. All visual sightings of Barn Owls as well as sign of Barn Owls are also noted during trips. Monitoring for the presence of other introduced

predators around breeding sites through the recording of indirect sign (prints, scat) and seabird predation events is also undertaken. If other predator sign is recorded, the control team may target these other species if time and logistics allow.

All control work is undertaken primarily using targeted hunts and complies with Institutional Animal Care and Use Committee (IACUC) as required by the University of Hawaii. Care will be taken to ensure that the owl is a Barn Owl and not the endemic Pueo (*Asio flammeus sandwichensis*), before any control action is undertaken. Protocols and methodologies may be adapted during the field season, as agreed to by all parties, to best meet project goals, logistical considerations or to address unexpected circumstances.

3.0 Reporting Requirements

Email updates will be sent out monthly between KESRP, the Non-native Avian Predator Control Project and the USAF to keep all parties updated on progress within both facets of this project. In the case of downed seabirds at the radar station, all downed seabirds recovered by the project will be reported to USAF, DOFAW and USFWS the following day, regardless of the scale of the event.

In accordance with the dates as outlined in the initial Scope of Work, a final report will be produced, covering the results of both the seabird monitoring and three months of predator control funded by this project. For seabird monitoring, the report shall provide all necessary information as requested by the Biological Opinion. A draft version of the seabird monitoring report will be provided within four weeks of the end of the field season (**due on January 23rd 2017**). The end of the field season will be considered to be the end of the third week of December, when a final check of the AFS grounds will be conducted by KESRP staff to look for downed Hawaiian Petrels (which fledge later than Newell's Shearwaters, with the last birds fledging in the final weeks of December). The final report will then be provided within two weeks of receiving comments from USAF. The seabird monitoring report will also display how current operations (post green-light implementation) are impacting listed seabirds at the Installation and shall include a list of new potential innovative prevention measures to be implemented at the Installation.

Furthermore a draft Annual Report (including both the seabird monitoring and off-site predator control work) shall be submitted within four weeks of completing the off-site predator control work. The government will provide KESRP and DOFAW with comments on the draft document, which will then be revised as necessary based on government comments. Once comments have been addressed completely, the contractor shall submit a Final Annual Report, in addition to separate responses to each comment on a separate comment matrix independent of the final report.

The data belong to both parties jointly, as this is a cooperative agreement. UH agrees to seek approval from the USAF 611 CES before releasing data, making any media statements, or communication with regulators, as both parties recognize that the data and features of the installation captured in the data could be sensitive if taken out of context. USAF 611 CES will utilize 11 AF Public Affairs for media communication and 611th CES/CEIE will manage communication with state and federal regulators. In the event of a FOIA, 673 CS/SCXK will be responsible for handling FOIA requests, in the event they result during the project or after its completion. UH may wish to publish the results

in peer-reviewed scientific literature and would give USAF an opportunity to comment on the draft manuscript prior to submission to the journal review body. The USAF supports academic publications, but 11 AF Public Affairs office reserves the right to approve the contents of the draft manuscript prior to release outside UH project team, the ACOE, and USAF.

4.0 Breakdown of Cost & Field Supplies and Materials List

This section covers the budget for this project, and is presented in the same way as it was initially presented in the submitted Scope of Work agreed upon by all parties. Note no seabird materials will be purchased for Air Guard Staff. Boxes will be provided to Air Guard Staff by the Save Our Shearwaters project to allow for the safe transport of downed seabirds located when KESRP staff are not present on site.

TASK 1 & 2

Category	Item	Unit	Cost	Total
Salaries	1 x co-ordinator - co-ordination and set-up	0.25	$ 5,067.00	$ 1,266.75
	1 x co-ordinator - report writing	0.25	$ 5,067.00	$ 1,266.75
	1 x Crew Leader	0.5	$ 3,400.00	$ 1,700.00
	2 x Field technicians	16	$ 540.00	$ 8,640.00
Fringe	1 x co-ordinator - co-ordination and set-up			$ 506.70
	1 x co-ordinator - report writing			$ 506.70
	1 x Crew Leader			$ 510.00
	2 x Field technicians			$ 2,592.00
Services - Fee	Analysis of song meter data by Conservation Metrics			$ 5,783.00
Materials & Supplies	Vehicle - Fuel (unit = approx fuel cost for one trip to Kokee)	24	$ 40.00	$ 960.00
	Song meters - SM4	2	$ 849.00	$ 1,698.00
	Microphone for SM4 (4 per unit, replacements)	8	$ 50.00	$ 400.00
	32GB SD cards for SM2 (4 per unit)	8	$ 20.00	$ 160.00
	Song Meter - D batteries (1unit*4*7)	28	$ 0.92	$ 25.85
	Reconyx PC900 Hyperfire Camera	10	$ 649.99	$ 6,499.90
	Thunderbolt mounting block	10	$ 29.99	$ 299.90
	Lithium AA batteries (3 sets per camera)	30	$ 34.99	$ 1,049.70
	SanDisk 8GB SDHC Memory Card (2 per cam)	20	$ 8.11	$ 162.20
	LaCie d2 Quadra v3 4TB External Hard Drive	2	$ 297.62	$ 595.24
	Night Vision - 3 pair	3	$ 3,795.00	$ 11,385.00
Other	Shipping			$ 288.21
	Contingency Costs			$ 3,460.10
Direct Costs Total				**$ 49,756.00**
UH Indirect Costs	CESU 17.5% rate			$ 8,707.00
TOTAL				**$ 58,463.00**

TASK 3

Category	Justification	Monthly Cost	Units (month)	Total Cost
Salaries		$ 5,685.00	3	$17,055.00
Fringe		$ 1,705.00	3	$ 5,115.00
Travel (domestic)	Intra-Island	$ 528.00	3	$ 1,584.00
	Boat Travel	$ 140.00	3	$ 420.00
Services - Fee	Helicopter	$ 2,200.00	3	$ 6,600.00
Materials & Supplies	Field Equipment Maintenance/ Purchase	$ 125.00	3	$ 375.00
	Trapping Equipment Maintenance/ Purchase (ammunition, batteries, etc)	$ 200.00	3	$ 600.00
	Vehicle fuel	$ 45.00	3	$ 135.00
	Office supplies	$ 50.00	3	$ 150.00
Utilities & Communications	Cell phone plan	$ 99.00	3	$ 297.00
	Sat phone plan	$ 62.00	3	$ 186.00
Repairs	Vehicle maintenance	$ 125.00	3	$ 375.00
Other	Contingency Costs			$ 2,459.00
Direct Cost Total				**$35,351.00**
UH Indirect Costs				$ 6,186.00
Total				**$41,537.00**

Appendix 1. Proposed Fieldwork Schedule for seabird monitoring (subject to change based on weather and logistical considerations)

Month	Week	Notes
Jan	1	
Jan	2	
Jan	3	
Jan	4	
Feb	1	
Feb	2	
Feb	3	
Feb	4	
Mar	1	
Mar	2	
Mar	3	
Mar	4	
Apr	1	
Apr	2	
Apr	3	
Apr	4	
May	1	Conduct song meter test at Kokee AFS
May	2	
May	3	
May	4	
June	1	Auditory Surveys
June	2	
June	3	
June	4	
July	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
July	2	
July	3	
July	4	
Aug	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Aug	2	
Aug	3	
Aug	4	
Sept	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Sept	2	
Sept	3	
Sept	4	
Oct	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Oct	2	
Oct	3	
Oct	4	
Nov	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Nov	2	
Nov	3	
Nov	4	
Dec	1	Remove all equipment
Dec	2	
Dec	3	Conduct final search at Kokee AFS for downed birds, to coincide with end of HAPE breeding season
Dec	4	

Appendix 2. Proposed Fieldwork Schedule for off-site predator control (subject to change based on weather and logistical considerations)

Month	Week	Notes
Jan	1	
Jan	2	
Jan	3	
Jan	4	
Feb	1	
Feb	2	
Feb	3	
Feb	4	
Mar	1	
Mar	2	
Mar	3	
Mar	4	
Apr	1	
Apr	2	
Apr	3	
Apr	4	
May	1	
May	2	
May	3	
May	4	
June	1	
June	2	
June	3	
June	4	
July	1	
July	2	
July	3	
July	4	
Aug	1	
Aug	2	
Aug	3	
Aug	4	
Sept	1	
Sept	2	
Sept	3	
Sept	4	
Oct	1	
Oct	2	
Oct	3	
Oct	4	
Nov	1	
Nov	2	
Nov	3	
Nov	4	
Dec	1	Targeted Barn Owl hunt & incidental predator control
Dec	2	Targeted Barn Owl hunt & incidental predator control
Dec	3	Targeted Barn Owl hunt & incidental predator control
Dec	4	
Jan	1	Targeted Barn Owl hunt & incidental predator control
Jan	2	Targeted Barn Owl hunt & incidental predator control
Jan	3	Targeted Barn Owl hunt & incidental predator control
Jan	4	
Feb	1	Targeted Barn Owl hunt & incidental predator control
Feb	2	Targeted Barn Owl hunt & incidental predator control
Feb	3	Targeted Barn Owl hunt & incidental predator control
Feb	4	