National Park Service
U.S. Department of the Interior
Kaloko-Honokōhau National Historical Park
Kailua-Kona, Hawai'i

Mālama 'Aimakapā

'Aimakapā Fishpond Wetlands Restoration Management Plan and Environmental Assessment

November 2015

Table of Contents

List of Figures 2
List of Tables 2
Executive Summary 3
Abbreviations and Acronyms 6
Notes on Terms and Analysis 6
Chapter 1: Introduction 7
Purpose of and Need for Action 9
Relationship to Other Laws, Plans and Policies 15
Public Participation 15
Impact Topics Retained for Further Analysis 16
Impact Topics Dismissed from Further Analysis 16
Chapter 2: Alternatives 18
Alternative 1 (No Action). Continue Existing Management and Programs 18
Alternative 2 (NPS Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control. 21
Alternative Action Components Considered but Dismissed from Further Analysis 34
Chapter 3: Affected Environment 37
Park Setting 37
Geology 38
Water Resources 43
Special Status Species 49
Wildlife 59
Vegetation 62
Cultural Resources 64
Visitor Experience & Safety 70
Climate Change 71
Chapter 4: Environmental Consequences 73
Methodology 73
Cumulative Impact Analysis 75
Impact Analysis 77
Conclusions 89
List of Preparers 90
Preparers 90
Contributors 90

Agencies, Organizations, and Persons Consulted 91
Appendix A: National Historic Preservation Act Section 106 Terms 93
Appendix B: Planning Document Excerpts Relevant to ‘Aimakapā Fishpond Management 94
Appendix C: Coordinated Management Actions 96
Appendix D: Vegetation Palette 98
Appendix E: Avian Disease Monitoring & Response 101
Appendix F: Hawaiian Coot and Hawaiian Stilt Reproductive Success at ‘Aimakapā Fishpond 2002-2014 103
References 104

List of Figures

Figure 1. Kaloko-Honokōhau National Historical Park and Area of Potential Effect (APE) under the National Historic Preservation Act. 14
Figure 2. ‘Aimakapā Fishpond and Wetlands Restoration Project Area, priority management areas, and primary staging areas. 23
Figure 3. Map of Kaloko-Honokōhau National Historical Park (KAHO) showing three distinct flows from Hualālai Volcano of ages between approximately 1,500 and 10,000 years Before Present (BP) overlain on an aerial photo. Modified U.S. Geological Survey graphic from Gibbs et al. (2007). 40
Figure 4. A photo of a plug of paspalum roots (dense, fibrous belowground biomass) that extends down to the surface of the bedrock. This sample has a one-inch A-horizon of mucky peat (10YR 2.1), the B-horizon is peat that extends from one inch down to the bedrock at 9.4 inches 42
Figure 5. Historical aerial photographs of ‘Aimakapā Fishpond showing gradual reduction of open water and mudflat habitats and encroachment by exotic invasive vegetation. 46
Figure 6. Honokōhau Beach fronting ‘Aimakapā Fishpond. Debris lines show partial overtopping of the berm (from Vitousek et al. 2010). 73

List of Tables

Table 1. Threatened, endangered, and candidate species at Kaloko-Honokōhau NHP.... 55
Table 2. Birds protected under MBTA, state recognized as indigenous, and commonly observed at Kaloko-Honokōhau NHP. 56
Table 3. Environmental Consequences 78

U.S. Department of the Interior
National Park Service
Kaloko-Honokōhau National Historical Park, Hawai‘i
Mālama ‘Aimakapā: ‘Aimakapā Fishpond Wetlands Restoration and Management
Environmental Assessment
November 2015

Executive Summary

The National Park Service (NPS) proposes to adopt and implement a restoration and management plan for the ‘Aimakapā Fishpond and wetland habitat and establish a programmatic framework for future actions to improve wetland ecosystem integrity, recover native plants and endangered waterbird populations, protect cultural resources, and interpret the fishpond’s ecology and Hawaiian cultural history. A programmatic approach to managing ‘Aimakapā enables the NPS to take action in an effective, efficient, and timely manner that achieves the Park’s mission and NPS mandates.

This *‘Aimakapā Fishpond Wetlands Restoration and Management Plan / Environmental Assessment* (Management Plan/EA) assesses the impacts that could result from continuation of current management of ‘Aimakapā (the “no-action” alternative) or implementation of the Proposed Action alternative to establish a framework under which the NPS will restore and manage the ‘Aimakapā wetland at Kaloko-Honokōhau National Historical Park on the island of Hawai‘i. This Management Plan/EA tiers from the 1994 *Kaloko-Honokōhau National Historical Park General Management Plan / Final Environmental Impact Statement*, which approved restoration of the ‘Aimakapā Fishpond wetland habitat and control of nonnative species. This Management Plan/EA is intended to have a 15-year life span, from 2015 to 2030 at which time it will be reviewed and adapted as needed.

This document is programmatic in nature, which means that it provides a framework for taking a range of management actions at ‘Aimakapā Fishpond. Some actions would require additional, more site-specific or action-specific analyses in order to be implemented. Further analysis would be required in cases where this EA has not analyzed all relevant conditions present, or where conditions have changed from those analyzed in this EA. If additional analyses are required, environmental compliance including compliance with the National Historic Preservation Act would be completed. Two alternatives are evaluated:

Alternative 1. (No Action, Continue Existing Management and Programs): This alternative would continue the existing management framework established under the1994 *Kaloko-Honokōhau National Historical Park General Management Plan / Final Environmental Impact Statement*. The NPS would continue to treat infestations of nonnative plants and animals at ‘Aimakapā Fishpond and wetlands on an *ad hoc* basis as available funding sources allow. Methods to control vegetation would continue to be

primarily manual (hand tools, chain saws and other gas-powered tools), and chemical control would remain an option for use.

Alternative 2. (NPS Proposed Action): Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control The Proposed Action would apply a systematic approach that would prioritize wetland areas and nonnative plants for treatment; improve predator control efficiency; monitor effects of restoration treatments on nonnative plants and park resources, and use the results to adjust treatment methods to reach the desired future condition of treated areas. Community involvement, stewardship, and resource interpretation programs would increase. This alternative includes active native plant restoration program to enhance the return of native species in high priority areas, and would ultimately incorporate control activities for aquatic invasive species. A separate environmental analysis for specific methods to control invasive fishes will tier from this EA. The effectiveness of efforts to control nonnatives and increase native habitat would increase as a result of increased planning and monitoring, and the selective use of machinery (e.g., mini-excavator, mini-tractor, or remote access vehicle).

This EA has been prepared to satisfy the requirements of the National Environmental Policy Act (NEPA) of 1969 as amended, including the Council on Environmental Quality regulations found at 40 CFR 1500 et seq., and the National Historic Preservation Act of 1966 as amended as well as a variety of other federal laws enacted to protect cultural and natural resources.

Impacts of the ʻAimakapā restoration and management alternatives on park resources were evaluated in accordance with procedures for implementing NEPA described in *NPS Director's Order 12: Conservation Planning and Environmental Impact Analysis* (NPS 2011). This Management Plan/EA provides a decision-making framework that

- analyzes the Proposed Action and No Action alternatives in terms of their context, duration, and intensity that meet the objectives of the proposal to manage and restore ʻAimakapā wetland;

- evaluates potential issues and derives impact topics from these issues to evaluate the extent to which ʻAimakapā Fishpond and wetlands would be improved, or not, by the actions of a particular alternative (the environmental consequences of the alternative); and

- identifies measures to avoid or lessen the degree or extent of adverse impacts to Kaloko-Honokōhau National Historical Park's resources and values.

Resource topics analyzed in this document are geology, soils, and topography; water resources and wetlands; special status species; wildlife; vegetation; cultural resources; visitor experience and safety; and climate change. Resource topics and environmental

consequences are presented in Table 3, *Environmental Consequences*. The analysis considered a 15-year period from the end of 2015 through 2030.

Public scoping was conducted to facilitate the development of this document, and consultation under Section 106 of the National Historic Preservation Act was simultaneously initiated with native Hawaiian organizations, community members, the Advisory Council on Historic Preservation, and the State of Hawai‘i Historic Preservation Division. Information responsive to scoping and consultation comments were included the appropriate sections of the document. Public scoping responses supported the following components of restoration and management actions at ‘Aimakapā Fishpond: the restoration of native plant populations, protecting and improving habitat for endangered waterbirds and indigenous wildlife, increased community involvement, increased cultural use of the pond, and the removal of invasive plant and animal species including Mozambique tilapia. Several proposed components were considered but dismissed from further analysis.

For Further Information, Contact:
Superintendent
Attn: Mālama ‘Aimakapā Plan/EA
Kaloko-Honokōhau National Historical Park
73-4786 Kanalani Street, Unit 14
Kailua-Kona, HI 96740
Fax: 808-329-2597

Public Comment: If you wish to comment on this Environmental Assessment, you may submit comments online at http://parkplanning.nps.gov/kaho, or mail, hand deliver, of fax comments to Superintendent, Attn: Mālama ‘Aimakapā Plan/EA, at the address above. This EA will be on public review for 30 days. All comments must be postmarked, transmitted, or logged online no later than 30 days from notice of the public review period.

Abbreviations and Acronyms

APE	Area of Potential Effect
BMP	Best Management Practice
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CWA	Clean Water Act
DAR	Division of Aquatic Resources (Hawai‘i)
DLNR	Department of Land and Natural Resources (Hawai‘i)
DO	NPS Director’s Order
DOH	Department of Health (Hawai‘i)
EA	Environmental Assessment
ESA	Endangered Species Act
GPS	Global Positioning System
GMP	General Management Plan
IUCN	International Union for Conservation of Nature
MBTA	Migratory Bird Treaty Act
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NPDES	National Pollution Discharge Elimination System
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NOAA	National Oceanographic and Atmospheric Administration
RAV	Remote Access Vehicle (amphibious)
SHPD	State Historic Preservation Division (Hawai‘i)
SOP	Standard Operating Procedure
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTV	Utility Vehicle

Notes on Terms and Analysis

The words “effect” and “impact” are synonymous in the Council on Environmental Quality (CEQ) regulations (40 CFR 1508.8(b)), which implement the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.). In accordance with the CEQ regulations and NPS *Director’s Order 12, Conservation Planning, Environmental Impact Analysis, and Decision-making* (DO-12), NEPA documents must consider “beneficial” effects and impacts as well as “adverse” effects and impacts (see 40 CFR 1508.8(b) and 40 CFR 1508.27(b)(1)). Therefore, use of the words “effect” and “impact” under NEPA can refer to both adverse and beneficial environmental changes. Conversely, the term “effect” has different meaning in the context of other environmental laws, such as the

Endangered Species Act (ESA) and the National Historic Preservation Act (NHPA). Specific language relevant to the implementing regulations for these laws will be called out with quotation marks when applicable. See Appendix A for definition of terms used in Section 106 of the National Historic Preservation Act.

Environmental Assessments (EAs) are intended to provide a concise and clear overview of environmental analyses relevant to the Proposed Action. Therefore, some discussions of issues generally summarize larger bodies of data used in this environmental analysis. The *References Section* of this document provides a list of data sources for those who wish to conduct their own detailed study of topics discussed here.

Chapter 1: Introduction

ʻAimakapā is the largest natural pond and wetland system (~30 acres; 12 ha) on Hawaiʻi Island's Kona Coast and is located at the *makai* (seaward) edge of the Honokōhau *ahupuaʻa* (traditional land division, typically mountain to sea) in Kaloko-Honokōhau National Historical Park (Figure 1). ʻAimakapā is a *loko puʻuone*, a pond separated from the ocean by a sand berm that runs parallel to the sea. The pond formed naturally, fed by fresh groundwater springs, and waters are brackish; about 30% saltwater. Modified for use by Hawaiians to hold and grow fish, the pond contains a variety of internal rock-wall partitions and was an active Hawaiian aquaculture pond until the 1950's. Historic properties (e.g., rock walls, platforms, modified pools) exist in the wetland along the pond margins and shorelines.

In the Pacific, the development of fishpond aquaculture was unique to Hawaiʻi (Apple and Kukuchi 1975) and fishpond management remains an important cultural practice in Hawaiʻi today. Fishpond culture was extremely important to the ancient Hawaiian way of life in the Kaloko and Honokohau *ahupuaʻa*. As such, ʻAimakapā Fishpond is an integral feature of the Honokohau Settlement National Historic Landmark (NHL), registered on October 15, 1966. The Landmark was made a unit of the National Park System on November 10, 1978 when the U.S. Congress established Kaloko-Honokōhau National Historical Park ("Park" or "National Park") "to provide a center for the preservation, interpretation, and perpetuation of traditional native Hawaiian activities and culture, and to demonstrate historic land use patterns as well as provide needed resources for the education, enjoyment, and appreciation of such traditional native Hawaiian activities and culture by local residents and visitors." (PL 95-625) The Park's establishment was based on a 1974 congressional study report entitled *Spirit of Ka-loko Hono-kō-hau: a proposal for the establishment of a Ka-loko Honokōhau National Cultural Park, Island of Hawaiʻi, State of Hawaiʻi* ("*Spirit Report*"). The report describes the area's past and proposed future in the compelling words of the 14 Native Hawaiians who comprised the15-member Hono-kō-hau Study Advisory Commission. In creating the Park, Congress stated that "[t]he Secretary shall administer the park . . . generally in accordance with the guidelines provided in the [*Spirit Report*]." 16 U.S.C. Section 396d(c). These guidelines include recommendations for park development,

preservation of natural ecosystems and historical and cultural integrity, interpretation of the Park and the traditional Hawaiian relationship between human and nature, management of the Park, and research opportunities. The *Spirit Report* guidelines specific to ʻAimakapā Fishpond are included in Appendix B.

ʻAimakapā Fishpond was recognized as exceptional waterbird habitat that provided vital foraging and breeding habitat on an island with few such resources (Engilis and Pratt 1993, Morin 1998, USFWS 2011b). The pond is also a significant stopover and wintering site for migratory waterfowl and shorebirds. The wetland complex and its associated anchialine pools also provide habitat for native plants including *kaluha*/*makaloa* sedges (*Bolboschoenus maritimus/Cyperus laevigatus*) and candidate species invertebrates such as the *oʻpae ula (*red anchialine pool shrimp, *Metabetaeus lohena)* and *pinaoʻula* (orange-black Hawiian damselfly, *Megalagrion xanthomelas*) (Foote 2015, pers. comm.)

ʻAimakapā Fishpond is one of only two natural wetlands on the Kona Coast that has supported large numbers of endangered waterbirds in the past; and its environs are identified by the U.S. Fish and Wildlife Service (USFWS) as "core wetland" habitat necessary for the recovery of the endangered *aeʻo* (Hawaiian stilt) and the endangered ʻ*alae keʻokeʻo* (Hawaiian coot) (USFWS 2011b). "Core wetlands" are defined as: *"areas that provide habitat essential for supporting larger populations of Hawaiian waterbirds that comprise the bulk of the numbers prescribed for recovery. It is crucial for wetlands at these sites to be secure from conversion to non-wetland condition and to have sufficient enduring management to recover Hawaii's waterbirds*." (USFWS 2011b). Because Hawaiʻi Island is a young volcanic island (~500,000 years old) it sustains few wetlands and only three core wetlands exist on the island. ʻAimakapā is the only core wetland on the leeward (west) side.

Over the years, however, ʻAimakapā pond and wetlands have degraded. Nonpoint source pollution in the form of nutrients and contaminants originating from urban activities upslope is carried into the pond in the groundwater and affects water quality (Hoover and Gold 2005). Changing climate conditions (e.g., lower rainfall) and location of water supply wells upslope of the park can affect the quantity of groundwater available to the ʻAimakapā ecosystem (Oki et al. 1999).

Endangered waterbird populations have plummeted at ʻAimakapā due to loss of suitable habitat (see Chapter 3, *Special Status Species*, and Appendix F). Avian botulism disease broke out in the pond in the mid-1990s killing many waterbirds (Morin 1996a). Botulism type C of the bacterium *Clostridium botulinum* is a natural toxin commonly found in the soil that does not affect humans but is deadly for native and migratory waterbirds.

In the early 1990's, the NPS completed large-scale removal projects of the nonnative red mangrove (*Rhizophora mangle*) and *kiawe* (*Prosopis pallida*) from the margins of the pond. Invasive, nonnative plants, primarily pickleweed (*Batis maritima*) and paspalum grass (*Paspalum* sp.) have displaced emergent wetland (e.g., *akulikuli*; *Sesuvium portulacastrum* , ʻ*aeʻae*; *Bacopa monieri*). Nonnative plants have covered open mudflat

habitat important to waterbirds, and threaten the historic integrity of the pond and its associated archaeological and cultural sites. Nonnative fishes including guppies (*Poecilia sp*.) and the aggressively invasive tilapia (*Oreochromis mossambicus*) are present in large numbers. These fish degrade water quality, outcompete and prey on native fishes and invertebrates, and disturb and increase sediments. A systematic approach to ʻAimakapāʼs restoration, maintenance, and stewardship is necessary to efficiently and effectively restore the pond and wetland system as a vibrant cultural site and endangered species habitat.

Purpose of and Need for Action

Purpose of the Plan

The National Park Service (NPS) proposes to adopt and implement a restoration and management plan for the ʻAimakapā Fishpond and wetland habitat, and establish a programmatic framework for future actions to improve wetland ecosystem integrity, recover native plants and endangered waterbird populations, protect cultural resources, and interpret the fishpond's ecology and Hawaiian cultural history. The ʻAimakapā Fishpond Wetlands Restoration and Management Plan / Environmental Assessment (Management Plan/EA) proposes a range of strategies to restore, manage, and maintain the cultural and natural resources of ʻAimakapā Fishpond. A programmatic approach to managing ʻAimakapā enables the NPS to take action in an effective, efficient, and timely manner that achieves the Park's mission and NPS mandates. This plan is intended to have a 15-year life span, from 2015 to 2030 at which time it will be reviewed and adapted as needed.

The Management Plan/EA:

- Provides a programmatic plan to prioritize and guide actions to restore, manage, maintain, and interpret the ʻAimakapā Fishpond and wetland habitats in Kaloko-Honokōhau National Historical Park.
- Identifies appropriate actions to stabilize and protect the cultural features and historic properties of ʻAimakapā while restoring and managing the biological features of the water and wetlands for the benefit of native wildlife.
- Promotes restoration and recovery of native fish, invertebrates, wildlife, plant species, and habitat conditions in an ecosystem that has been invaded by nonnative plants and animals.
- Protects park resources and values from adverse effects resulting from the presence of nonnative plants and animals and control activities.
- Provides reasonable, scientifically-grounded guidance for restoring the fishpond's habitats and preparing for the long-term effects due to climate change, for the long-term conservation of native plants and animals, and for the maintenance of the wetland/pond system integrity.

This Management Plan/EA evaluates a reasonable alternative for restoring and managing ʻAimakapā over the next 15 years and identifies and analyzes environmental consequences for the two alternatives. The two alternatives presented address the major issues and relevant mandates identified in the EA process, and are consistent with principles of sound resource management. For details on the specific components and actions comprising the alternatives, see Chapter 2.

This Management Plan/EA has been prepared in compliance with the National Environmental Policy Act of 1969 (NEPA) and CEQ regulations (40 CFR1508.9), NPS *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision Making* (NPS 2011), *NPS Management Policies 2006* (NPS 2006) and all other applicable requirements.

Need for Action

In Hawaiʻi, coastal habitats are undergoing significant environmental change due to land-use changes, urban development and its associated effects, climate change, and the invasion of introduced nonnative plants and animals. Approximately 31 percent of coastal plain wetlands habitat have been lost in the last 120 years (Mitchell et al. 2005). For the purpose of this Management Plan/EA the term "nonnative" is used throughout and is defined as species that are "…*nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health*" (Executive Order 13112). Nonnative plant species that are historically important or relatively benign, such as certain Polynesian-introductions, are not included as "harmful" under this definition.

The mild tropical climate and lack of natural predators enables invasive, nonnative species to thrive to the detriment of Hawaiʻi's native wetland plants and animals. There is a need to efficiently control nonnative organisms at ʻAimakapā because they threaten Kaloko-Honokōhau NHP's natural and cultural resources through

- alteration of cultural landscapes via excessive and damaging plant growth that threatens the integrity and stability of historic and cultural sites and structures, and the cultural function of the fishpond

- modification to the aquatic habitats and ecosystem, which destroys the native ecological balance between plants, animals, soil, and water that has evolved over thousands of years and results in declines in habitat condition and food sources, including core habitat for endangered species

- aggressive competition for physical resources, which displaces native plants by robbing them of moisture sunlight, and nutrients

- predation on native species, particularly threatened and endangered species

- interbreeding with native species, which dilutes native gene pools

There is also a need to respond to foreseeable consequences of sea level rise through appropriate planning. As sea level changes occur, all coastal wetlands will alter and migrate. Implementation of the restoration management plan will enhance both local and statewide breeding populations of endangered waterbirds as well as rare anchialine pool fauna and increase their resiliency to withstand future climate-driven habitat shifts.

Kaloko-Honokōhau NHP's founding document *The Spirit of Ka-loko Hono-kō-hau* (*Spirit Report*) (Hono-kō-hau Study Advisory Commission 1974) sets the stage for taking action to restore 'Aimakapā Fishpond, calling for protection of Kaloko-Honokōhau's remnant Hawaiian ecosystems from further depreciation and competition from nonnative plants and animals, preservation of the natural environment, and maintenance of the ecological balance of the area. Moreover, the *Spirit Report* calls for the establishment of a program to restore the Park's historic fishponds "*as nearly as possible to their original appearance for the function they fulfilled*" and that restoration at 'Aimakapā "*will not have an adverse effect on the wildlife that presently inhabits the pond*" (Hono-kō-hau Study Advisory Commission 1974).

In 1994 the NPS finalized and approved the *General Management Plan /Environmental Impact Statement* (GMP) that sets out the programmatic direction for managing Kaloko-Honokōhau National Historical Park based on the recommendations in the *Spirit Report*. 'Aimakapā restoration and management was approved by the GMP. References relevant to management of 'Aimakapā' are quoted fully in Appendix B.

In addition to accomplishing Park management goals, this Management Plan / EA will support the recovery effort of the state's endangered waterbirds and other proposed and candidate endangered species in the wetlands. The *Recovery Plan for Hawaiian Waterbirds* identifies 'Aimakapā Fishpond as a core wetland necessary for the recovery of the Hawaiian stilt and Hawaiian coot (USFWS 2011b). The USFWS's ultimate recovery goal for Hawaiian waterbirds is to "*restore and maintain multiple self-sustaining populations within their respective historical ranges, which will allow them to be downlisted to 'threatened' status and eventually removed from the Federal List of Endangered and Threatened Wildlife and Plants*" (USFWS 2011b:v). Downlisting criteria for the stilt and coot include that all (100%) core wetlands are protected and managed in accordance with the management practices outlined in the *Recovery Plan for Hawaiian Waterbirds* (USFWS 2011b). These management practices include developing a written Management Plan and taking the following actions

- secure water sources
- manage water levels
- manage vegetation
- control predation
- monitor waterbird populations and reproductive success
- minimize human disturbance
- monitor and control avian diseases and environmental contaminants.

This Management Plan/EA incorporates by reference applicable management actions proposed in the *Recovery Plan for Hawaiian Waterbirds* and other species protection and wetland-related planning documents (Appendix C) and provides for the broad-scale management and restoration of ʻAimakapā Fishpond habitats and wildlife over the next 15 years. This Management Plan/EA considers treatment methods (physical, mechanical, and chemical) for nonnative plant and predation control that may be used in the foreseeable future. See "Alternatives" Chapter 2 for a description of treatment methods. Individual treatments, or combinations of those treatments, would continue to be implemented as appropriate to control nonnative species and restore the wetlands habitat.

Objectives in Taking Action

The Management Plan goals and objectives were developed with the input of local and federal agencies, partners, and the public based on information obtained during the EA scoping phase. These objectives guided the preparation of this Management Plan/EA and describe what must largely be accomplished for the Management Plan to be considered successful. The objectives are organized under the following six goals.

Goal: Engage Native Hawaiians, neighboring communities, visitors, and partners

- Interpret the fishpond, its Hawaiian cultural history, and biota to the local community and visitors.
- Continue to expand understanding of historic fishpond practices at ʻAimakapā through discussion with *kupuna* and local community members.
- Promote environmental and cultural education opportunities for local schools.
- Increase public awareness of the impacts nonnative species have on native habitat and cultural resources, and build community and Native Hawaiian partnerships and volunteer base to be stewards of ʻAimakapā.
- Expand understanding of Hawaiian waterbird and wetland ecology through scientific research with university and agency partnerships.

Goal: Restore ʻAimakapā Fishpond ecosystems and habitats, and ensure long-term preservation and maintenance.

- Establish management priorities and guide NPS management of ʻAimakapā Fishpond wetland to its ultimate restoration as a functioning wetland system.
- Restore ʻAimakapā to its pre-disturbance habitat composition (native emergent vegetation, mud flat habitat, and open water) and maintain the system at that successional stage.
- Identify strategies to improve wetland functioning and water quality.
- Establish wetlands monitoring and make recommendations for potential management actions regarding climate change.

Goal: Restore ‘Aimakapā’ Fishpond’s cultural landscape and cultural practices.

- Preserve the historic integrity of ‘Aimakapā’ Fishpond and stabilize historic properties.
- Restore ‘Aimakapā’ for future traditional fishpond activities to the extent that activities will not have an adverse effect on endangered wildlife.
- Preserve plants and wildlife valued by Native Hawaiians while reducing the spread of nonnative species.

Goal: Restore and maintain ‘Aimakapā’s native plant communities.

- Establish and prioritize long-term vegetation management goals to guide management of ‘Aimakapā wetland.
- Prioritize treatment areas for control of nonnative plants (particularly where vegetation removal will immediately improve wetland functioning and waterbird habitat and stabilize cultural resources).
- Prioritize nonnative plant species to be treated.
- Identify strategies for control of nonnative plants.
- Protect existing native wetlands plants and restore native plants in ways that allow natural processes, function, and cycles to be re-established and maintained.

Goal: Restore and maintain ‘Aimakapā’s native wildlife communities.

- Aid the recovery of endangered Hawaiian waterbirds and protection of migratory shorebirds and waterfowl.
- Prioritize nonnative animal species (fish, predators) to be controlled.
- Identify strategies for control of nonnative animals.
- Inhibit conditions that may lead to avian botulism.
- Establish strategies for managing botulism outbreaks.

Goal: Use operational efficiency to control nonnative species.

- Carry out the Management Plan so that it is continually monitored and improved, environmentally safe, uses best management practices, and supports and is supported by science and research.
- Minimize unintended impacts of removal and control measures on Park resources, employees, visitors, and the public.
- Use federal resources with increased efficiency.
- Use equipment and tools that increase restoration efficiency while protecting park resources.

Figure 1. Kaloko-Honokōhau National Historical Park and Area of Potential Effect (APE) under the National Historic Preservation Act.

Relationship to Other Laws, Plans and Policies

Alternatives developed and actions analyzed in this document are subject to an array of legal, policy, and administrative considerations. These constraints help to shape the basis for alternatives and provide a framework for analysis of the impacts within this document. Listed below are the key laws, executive orders, NPS management guidelines and policies, and park plans that serve to shape the alternatives and analysis.

Laws

- National Park Service Organic Act (1916)
- National Parks and Recreation Act (1978) (Establishment of Kaloko-Honokōhau NHP)
- National Park Service General Authorities Act (1970 as amended
- The Redwood Act (1978)
- National Environmental Policy Act (1969, as amended)
- National Historic Preservation Act (1966, as amended
- Clean Water Act (1977)
- Endangered Species Act (1973, as amended)
- Migratory Bird Treaty Act (1918, as amended)
- Federal Noxious Weed Act (1974 as amended)

Executive Orders

- Executive Order 11990 Protection of Wetlands (24 May 1977) (42 FR 26961)
- Executive Order 13112 Invasive Species (2 February 1999 as amended) (64 FR 6183)

National Park Service Management Policies and Plans

- *National Park Service Management Policies 2006* (NPS 2006)
- Director's Order 77-1 Wetland Protection (2002)
- Director's Order 28 Cultural Resources (1998)
- *NPS-77 Natural Resources Management Guidelines* (NPS 1991)
- *NPS-28 Cultural Resources Management Guidelines* (NPS 1998)
- Hono-kō-hau Study Advisory Commission Report: *The Spirit of Ka-loko Hono-kō-hau* (1974)
- *Kaloko-Honokōhau National Historical Park General Management Plan/Environmental Impact Statement* (NPS 1994)
- *Vegetation Management Plan* (Pratt 1998)

Public Participation

During the summer of 2012, the NPS engaged the public in a scoping effort to identify potential issues and concerns and guide development of the Proposed Action.

Simultaneously, consultation under Section 106 of the National Historic Preservation Act was initiated in August 2012 with native Hawaiian organizations and community members, and in March 2013 with the Advisory Council on Historic Preservation and the State of Hawai‘i Historic Preservation Division. Information responsive to scoping and consultation comments were included the appropriate sections of this document. Public scoping and consultation responses supported the following components of restoration and management actions at ‘Aimakapā Fishpond: the restoration of native plant populations, protecting and improving habitat for endangered waterbirds and indigenous wildlife, increased community involvement, increased cultural use of the pond, and the removal of invasive plant and animal species including Mozambique tilapia. Removal of invasive fish was identified at public scoping as an important and desirable element of fishpond and wetlands restoration and is included herein as a component of the Management Plan. However, a separate environmental review and analysis of specific methods to control invasive fishes will tier from this Management Plan/Environmental Assessment at a future time. Several proposed components were considered but dismissed from further analysis. The NPS conducted both internal scoping and consultation with Park staff, and external scoping and consultation with the public and relevant agencies, and with interested and affected groups and agencies, which helped in identifying historic properties and in formulating the Proposed Action.

Impact Topics Retained for Further Analysis

Based on the information obtained from public scoping, the impact topics retained for further analysis in this EA are listed below. Detailed analyses of these topics, including the regulatory context and the existing baseline conditions (affected environment) for each of these topics are provided in the Environmental Consequences section of this document.

- Geology, Soils, and Topography
- Water Resources and Wetlands
- Special Status Species
- Wildlife
- Vegetation
- Cultural Resources
- Visitor Experience and Safety
- Climate Change

Impact Topics Dismissed from Further Analysis

Soundscape

Sound preservation and noise management is an important component of the NPS mission. Natural soundscapes, also referred to as “natural ambient sounds” or “natural quiet,” associated with national park units is preserved to the extent possible. The sounds generated by use of powered mechanical equipment (line cutters, chain saws, mini-

excavator, helicopter) during restoration of ‘Aimakapā wetlands will be intermittent, localized, and temporary and negligible. Long-term management and nonnative plant control/maintenance will primarily consist of hand tools, and small gas-powered tools (line cutters, chain saws) and noise from these will be intermittent, localized, and temporary. Specific impacts of temporary noise are addressed in *Special Status Species*, *Wildlife*, and *Visitor Experience and Safety* sections. Therefore this topic has been dismissed from further analysis as a separate topic.

Indian Trust Resources

There are no Indian trust resources at Kaloko-Honokōhau National Historical Park; therefore, this topic has been dismissed from further analysis.

Environmental Justice

The nature and location of the Proposed Action does not have the potential to have disproportionate health or environmental effects on minorities or low-income populations or communities as defined the Council on Environmental Quality (1997) environmental justice guidance; therefore this topic was dismissed from further analysis.

Air Quality

Kaloko-Honokōhau National Historical Park is classified as a Class II airshed under the Clean Air Act. The use of gas-powered mechanical equipment (line cutters, chain saws, mini-excavator, helicopter) by Park staff in the restoration of ‘Aimakapā wetland generates negligible localized hydrocarbon emissions; therefore this topic has been dismissed from further analysis.

Historic Structures

An “historic structure” (including prehistoric) is “*a constructed work …consciously created to serve some human activity*” (NPS 1998). Because all historic structures within the area of potential effect are also considered archeological resources by definition (NPS 1998), and are all components of larger historic/prehistoric complexes, these resources will be analyzed as archeological resources in this document and historic structure as a topic has been dismissed from further analysis.

Floodplains

It is NPS policy to restore and preserve natural floodplain values and to minimize potentially hazardous conditions associated with flooding. The restoration and management of ‘Aimakapā Fishpond wetland restores and preserves the natural floodplain, and no structures or facilities will be constructed in the wetlands, therefore this topic has been dismissed from further analysis.

Chapter 2: Alternatives

The NPS proposes to adopt and implement a 15-year plan to guide the restoration and management of the ʻAimakapā Fishpond and wetland. This chapter presents alternatives for the proposed action under this programmatic EA. Several actions are common to both alternatives. The NPS uses integrated pest management (IPM) to control nonnative plant and animal pests with the goal of mitigating pest damage while protecting human and environmental health and economic efficiency (NPS 2006). The IPM approach entails identifying and monitoring target pests, setting thresholds for action, and utilizing a combination of methods to take advantage of the range of appropriate pest management options for prevention and control. Integrated Pest Management would continue to be applied at ʻAimakapā under either of the alternatives. Under each alternative, actions to restore and manage the fishpond and wetlands will be implemented as funding becomes available. Under each alternative, the NPS will continue to actively engage in interagency coordination and consultations to protect cultural and natural resources and prevent jeopardizing any species listed under the endangered species act. For the purpose of this Management Plan/EA the term "nonnative" is used throughout and is defined as species that are "*nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health*" (Executive Order 13112). Nonnative plant species that are historically important or relatively benign, such as certain Polynesian-introductions, are not included as "harmful" under this definition.

Alternative 1 (No Action). Continue Existing Management and Programs

The National Environmental Policy Act (NEPA) requires the NPS to analyze a "No Action" Alternative (40 CFR 1502.14) and to compare potential environmental (natural and human) consequences associated with "no action" (continuation of current management) to other alternatives. If the NPS selects the No Action alternative, existing management, operations, programs, and conditions at ʻAimakapā Fishpond would continue. This alternative is essentially the management structure that has been in place since the park *General Management Plan/EIS* (GMP) was approved in 1994. The NPS would continue to use an integrated pest management (IPM) approach to treat site-specific infestations of target nonnative plant and animal species. Rather than following a strategic management plan with identified priorities and course of action towards ultimate restoration, target nonnative plant species would be removed on an *ad hoc* basis based primarily on the severity and immediacy of threat to individual historic properties and/or to threatened or endangered species within ʻAimakapā, and on the availability of resources and funding.

Under Alternative 1, these projects would continue to be small-scale, periodic, and limited in scope to areas that are primarily accessible by existing trails and access points. Actions to control nonnative vegetation would continue to be labor and time-intensive and would continue to use manual techniques for removal (hand tools such as shovels,

hoes, and sod cutters; small gas-powered tools such as line or blade cutters, small chainsaws, pruners, saws; and propane torches for "sweating" vegetation) rather than include strategic use of machinery. Chemical control of nonnative plants would continue to be an option for use under the Park's IPM program in accordance with the registered labels, state and federal regulations and permits, and NPS policy and Best Management Practices (BMP). By law, only herbicides registered by EPA specifically for application in wetlands would be used. A State of Hawai'i National Pollution Discharge Elimination System (NPDES) herbicide permit is required for herbicide application in wetlands and would be obtained. Plant material would continue to be loaded by hand and hauled out by all-terrain utility vehicles (UTV). Access to the wetlands project areas would continue to be primarily on existing park trails; if used, temporary access routes would be removed and replanted or seeded with native plants.

Mammalian predators in Kaloko-Honokōhau consist mainly of mongoose, *Herpestes javanicus*; feral cats, *Felis catus*; and rats, *Rattus* sp. In general, it is not feasible to completely eliminate nonnative predators in the Park; instead, the goal is to control their numbers so that native species can achieve population levels that reestablish their ecological function in the wetland system. Because breeding waterbirds nest on the ground, they are extremely vulnerable to terrestrial predators. Under Alternative 1, the Park's existing small-mammal predator control program would continue and nonnative predators (mongoose and feral cats) would continue to be live-trapped during the waterbird nesting/fledging season.

Under Alternative 1, the NPS would continue to respond to avian disease outbreaks such as avian botulism as they occur. Risk reduction and outbreak actions for avian botulism are to (1) prevent excessive buildup of decaying vegetable matter, (2) immediate collection of dead birds, fish, or other animals (decaying protein matter) from the pond and wetlands, and (3) immediate notification of the U.S. Geological Survey Wildlife Disease Unit in Honolulu, HI whenever dead birds are found.

Under Alternative 1, hazardous materials used to fuel (gas and diesel), lubricate, and maintain small engines, chemicals used to control invasive species, and propane fuel for sweating new plant growth will continue to be properly stored away from the wetlands at the Park's maintenance facility, and the Park staff will continue to follow best management practices (BMP) for storing, using, and transporting these materials. Small equipment will continue to be cleaned and maintained at the maintenance facility, and fueled offsite outside of the wetlands over secondary containment. UTV vehicles will continue to be fueled and maintained offsite at the maintenance facility and cleaned at the Park's wash rack where hydrocarbons are separated from the wash water and the water is recycled for use.

Under Alternative 1, actions to treat and re-treat nonnative plants in the wetlands would continue to be completed opportunistically when resources and funding allow and would not be part of a larger strategic plan for restoration and management of the wetlands as a whole. Treatment success would continue to be recorded for individual treatment events, however, an operationally efficient and systematic approach; including a standardized

monitoring protocol to describe treatment effectiveness, identify optimal re-treatment timing, and assess resource condition following treatment; would not be used. Restoration of native plant species following removal of nonnatives at a specific site would not include active out-planting, but would rely solely on passive restoration from the existing native seed sources that naturally re-establish themselves in the treated site. To protect endangered waterbirds from harassment, the fishpond environs would continue to be closed to general public access including cultural uses of the fishpond. Actions to treat and re-treat nonnative plants in the wetlands would continue to be scheduled to avoid disturbing Special Status species. Work would continue to be sited 100 ft away from waterbirds. To avoid disturbing breeding *ae*‘*o* (Hawaiian stilt) work would continue to be limited to occur primarily outside the peak stilt breeding season, mid-February to August. Avoidance of breeding coots would continue on a case by case basis because they have been known to nest in nearly all months of the year at ‘Aimakapā Fishpond. The NPS would continue to consult with the USFWS on activities at ‘Aimakapā. ‘Aimakapā would not significantly contribute to the resiliency and recovery of endangered waterbird populations on Hawai‘i Island because suitable habitat would remain limited.

Under Alternative 1, there would be no programmatic framework for taking a range of restoration management actions at ‘Aimakapā, for which formal analysis of potential impacts under NEPA, National Historic Preservation Act (NHPA) and other applicable laws would have been completed, thereby increasing operational efficiency. Under Alternative 1, the NPS would continue to analyze potential environmental impacts on a project by project basis for each action that is proposed at ‘Aimakapā and would continue to determine the appropriate pathway to document the analysis as described in *Director’s Order 12*. Individual project actions at ‘Aimakapā would continue to either qualify as a categorical exclusion or would require a project-specific environmental assessment of effects. The NPS would continue to ensure compliance with Section 106 of the NHPA, and consultation under section 7 of the Endangered Species Act (ESA), and other applicable laws for each individual project.

Interpretation of the fishpond, the endangered *ae*‘*o* (Hawaiian stilt) and ‘*alae ke*‘*oke*‘*o* (Hawaiian coot), and the native and culturally-important native plants found at ‘Aimakapā would continue through distribution of site brochures. Commercial bird-watching tours and individual wildlife-oriented recreation activities consisting of observation of waterbirds, migratory waterfowl and vagrant birds (a bird far outside of its expected range) with binoculars and spotting scopes from the beach berm outside the wetland areas of the Park would continue. Volunteer corps would not be formed to partner in the stewardship and restoration of ‘Aimakapā.

Alternative 2 (NPS Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.

Under the Proposed Action, as in Alternative 1, the NPS would continue to employ IPM strategies to manually control nonnative plants and animals in the ʻAimakapā ecosystem. The Proposed Action, however, would employ a 15-year planning framework and management toolbox for these actions, and provide long-term guidance for park managers. Under this alternative, a planning framework would establish priorities that set a course of action for wetland restoration, enhance protection and preservation of native wildlife populations (Appendix C) and cultural resources, and improve the quality of visitor and cultural practitioner experience. Under this framework the appropriate treatment/re-treatment methods and timing of treatments would be more rigorous, occurring on an optimal schedule based on monitored rates of regrowth or re-establishment of the nonnative plant species. Monitoring would follow a standardized, long-term monitoring protocol (e.g., Elzinga et al. 2001) to assess and document nonnative plant growth and recruitment, waterbird habitat use, predator populations, selected water quality parameters, and native plant growth and recruitment. Monitoring data collected on effectiveness of treatment actions, rates of regrowth of nonnatives, rates of return of native species, and overall condition of resources would allow the NPS to adaptively adjust methods and maintenance actions to achieve long-term restoration objectives. As park managers implement site-specific restoration actions under this Management Plan/EA, they would be able to select an approach presented in this chapter. Because these approaches would have already undergone the formal scrutiny required by NEPA and NHPA, the time and effort needed to prepare for implementation would be minimized. Unless the wetland site conditions vary from those described in this Management Plan/EA, or a new method is being employed that is not the same or similar to the methods described in this Management Plan/EA, implementing an action under Alternative 2 may involve little additional analysis beyond consultation with the U.S. Fish and Wildlife Service (USFWS) and the Hawaiʻi State Historic Preservation Division (SHPD).

Proposed Action Area & Action Priorities

The 40-acre (16- ha) Proposed Action area includes the ʻAimakapā delineated wetlands (water: ~12 acres, 4.8 ha; wetlands: ~18 acres, 7.3 ha), and upland areas along the southern wetlands boundary to be used for equipment and pedestrian access, and staging of removed vegetation before transport by UTV and helicopter, and a 1-acre (0.4-ha) site (Staging Area 2) for receiving, disposing of, and composting vegetative material located near the eastern boundary of the Park (Figure 2). On the west side of the fishpond, the project area includes a majority of the natural sand berm to facilitate pedestrian and UTV access. To the north and east, the Project Area extends outside of the wetland to include

an access trail along the wetland boundary. Existing Park trails will be used for primary access, and temporary routes will be established between project areas and trails. Under the Proposed Action, vegetation clearing will progress systematically within prioritized (1 to 4) Management Areas (Figure 2) as funding is obtained. The priority of actions may adaptively change based on lessons learned during implementation and monitoring.

Management Area 1 (6 acres; 2.4 ha) comprises the southern shore of ʻAimakapā from the barrier beach to the southeast corner. The vegetation is dominated by nonnative seashore paspalum (*Paspalum vaginatum*) and several large stands of pickleweed (*Batis maritima*) with seedlings and short milo (*Thespesia populnea*) trees are scattered throughout. Several cultural sites and small stands of native plants are in this area.

Management Area 2 (2 acres; 0.8 ha) is along the *mauka* (inland) shore of ʻAimakapā. This narrow area between the pond edge and lava flow is comprised of *milo (Thespesia populnea),* tree heliotrope *(Tournefortia argentea),* and *naupaka* (*Scaevola taccada*) with some *kiawe* (*Prosopis pallida*) and Christmas berry (*Schinus terebinthifolius*). This management area also includes the pond's internal rock walls, which are covered mainly by dense *Paspalum* grass. Because a lava flow rises abruptly above the shoreline of Management Area 2 (see *Chapter 3, Geology*; Figure 3), and because the upland access trail to this area is narrow and rocky, excavated *Paspalum* and cut woody material will be removed to the southern shore Staging Area 1 by water transport and/or helicopter to Staging Area 2.

Management Area 3 (10 acres; 4 ha) comprises the north shore of ʻAimakapā and includes a marshy meadow in the northwest corner discussed by Canfield (1990) and Pratt and Abbott (1996), and numerous anchialine pools located primarily in the northeast corner. Access to the western portion of Management Area 3 is by the coastal trail and water from the south shore. Removed vegetative material from this area may be held for a short time on elevated platforms in temporary staging areas prior to removal to the southern shore Staging Area 1 by water, and/or helicopter, and then to Staging Area 2.

Management Area 4 (0.3 acres; 0.1 ha) consists of the fishpond side of ʻAimakapā's barrier beach shoreline and the vegetation strand of native and nonnative plants. Management Areas are established based on their location, habitat type(s), nonnative species composition, seasonal and access considerations, control methods anticipated, equipment and personnel needed, and park planning needs.

The prioritization of management actions is based on immediacy of benefit to native species, cultural sites, and traditional activities. At all Management Areas, the priority vegetation removal and control species will be pickleweed (*Batis maritima*) and seashore paspalum (*Paspalum vaginatum*) because these species are aggressively dominate over ʻAimakapā's open water and mudflat habitats, and reproduction is primarily vegetative through underground rhizomes.

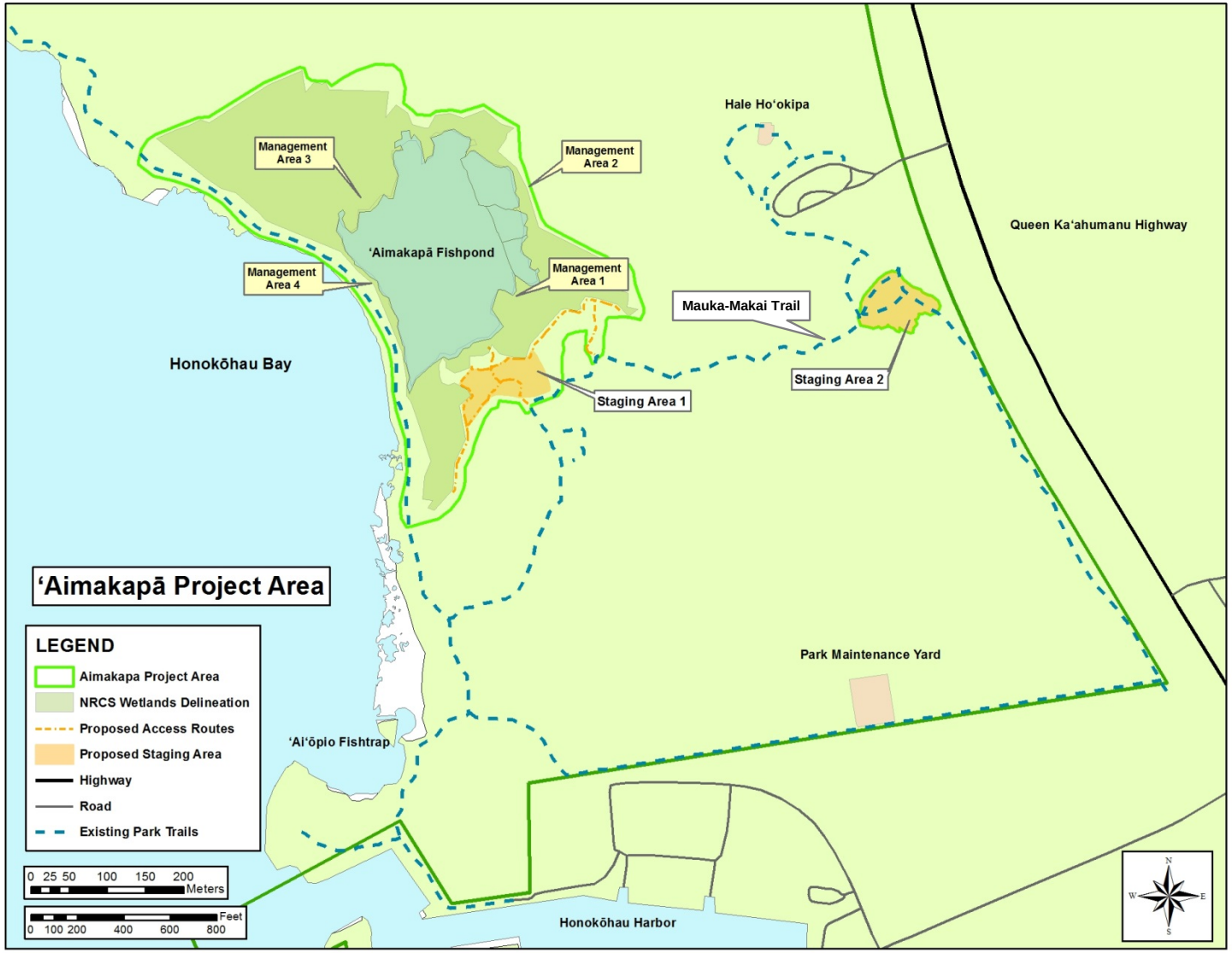


Figure 2. **ʻ**Aimakapā Fishpond and Wetlands Restoration Project Area, priority management areas, and primary staging areas**.**

Vegetation Control & Management

Under the Proposed Action, a larger "toolbox" of methods (manual, mechanical, chemical) will be selectively utilized to restore and maintain the wetland vegetation. Control methods that are economical, that minimize environmental damage and contamination, and that can be sustained over the long-term will be favored. As under Alternative 1, for all methods, archeological and endangered species monitoring would occur while work is underway. The Proposed Action does not include shaping or altering soil substrate (e.g., no cut, fill, or grading) and is confined to removal of plant root material. Organic soils and peat deposits will be removed only to the degree necessary to remove live belowground root biomass. Removal methods by dominant species are described below.

Manual control methods physically destroy, disrupt growth, or interfere with the reproduction of nonnative plants and include: hand tools such as shovels, hoes, and sod cutters to remove seashore paspalum grass (*Paspalum vaginatum*); small gas-powered tools such as line and blade cutters, small chainsaws, pruners, and saws to remove woody species; and hand-pulling, covering/smothering growth with tarpaulin, and use of torches for propane flaming or "sweating" the aboveground biomass of pickleweed (*Batis maritima*). Manual methods are highly-selective and best suited for hard-to-access or tight areas where machinery can't easily access, and are the most benign methods for removing nonnative plants from areas containing cultural features, anchialine pools, or stands of native plants. However, because these methods require a great deal of labor, the manual approach is not the most practical, efficient, or cost-effective method. Under Alternative 2, manual control would continue to be used throughout the wetland as necessary for treatment and re-treatment, and would continue to be required in and immediately around historic properties, anchialine pools, and areas with native plant stands.

Mechanical control methods are physical controls that include use of larger powered machinery such as the Park's mini-excavator, mini-tractor, or a remote access (RAV) amphibious utility vehicle with a backhoe attachment and amphibious trailer. Machinery would potentially be used for first removal of large expanses of nonnative vegetation, especially the floating masses of root-matter of paspalum grass, from areas where archeological clearance has been given and manual methods have proven infeasible. Because large areas of paspalum grass have grown into the pond over time, large areas of the root matter are not supported by soil substrate. A floating platform or barge constructed on site may be needed to support non-amphibious machinery weight in these areas, a platform would not be necessary if an amphibious utility vehicle were used. Alternatively, large mats may be used to distribute the weight of an excavator working in saturated soils (e.g., Ohiapilo Fishpond restoration on Moloka'i (Engilis 2013, pers. comm.)). Machinery and UTV would also be used on a constructed (geo-textile material covered with three to six inches of wood chips), temporary trail along the edge of pahoehoe and other stable edges of the pond for reaching out into paspalum and for using grappling equipment to haul or winch paspalum ashore.

Chemical control methods. As in Alternative 1, chemical methods may be selectively used in the wetland to control woody species, pickleweed, or other species. Chemical control of nonnative species would be implemented if an IPM action threshold is met and if other methods (physical, cultural, and biological methods or combinations thereof) prove ineffective or inefficient. If chemical control is needed, per NPS policy, the most specific (selective) chemical application available for the target species would be used unless considerations of persistence or other environmental and/or biotic hazards would preclude it. As in Alternative 1, herbicide use would be implemented in accordance with the registered labels, state and federal regulations and permits, NPS policy, and Best Management Practices (BMP). By law, only herbicides registered by EPA specifically for application in wetlands would be used. A State of Hawai‘i National Pollution Discharge Elimination System (NPDES) herbicide permit is required for herbicide application in wetlands and would be obtained. Herbicides registered by EPA specifically for use in aquatic settings have very low toxicity and mortality rate for fish and aquatic organisms, and short half-life in water (e.g., see Pless 2005). No applications would be made directly to water. Application methods appropriate to treating the target species while protecting adjacent desired species would be used. Targeted herbicide application methods such as hack and squirt, frill and girdle, injection, and cut-stump treatments are commonly used in Hawai‘i as cut-surface means to apply chemicals to woody nonnative plants such as *kiawe* (*Prosopis pallida*), *haole koa* (*Leucaena leucocephala*), and Polynesian-introduced *milo* (*Thespesia populnea*). These methods minimize drips and overspray drift, and are a prudent approach in sensitive species habitats. In addition, direct foliar (leaf) wick treatments and/or spot-spray treatments can be applied to individual plants or can be applied over areas of low growing plants such as pickleweed (Ansari and Thair 2012, Ellis 2013). Treated plant material would be removed following application from areas regularly utilized by waterbirds and migratory waterfowl.

Paspalum grass: Hand-removal of paspalum grass (*Paspalum* sp.) involves line-cutting the majority of plant material followed by cutting the sod with a sharp shovel or other cutting tool, then removing it with a claw hoe or other implement. In many areas the grass has infilled open water and is essentially a floating mass. Grass blocks would be placed on a vessel (non-motorized or powered with electric troll-motor) for transport to staging/drying access areas. Mechanical means of removal via machinery would include “surgical” removal of invasive paspalum in specific locations adjacent substrate stable enough to support machinery and away from cultural resources. For both methods, blocks would be stacked temporarily on constructed, elevated platforms covered by helicopter slings (constructed of wire fencing lined with shade cloth).

Pickleweed: Because its root system infiltrates lava-rock crevasses, pickleweed (*Batis maratima*) is difficult to fully remove. Methods have included combinations of cutting, propane flaming, systemic herbicide application, and hand weeding followed by outplanting native species with follow up maintenance as needed (Ansari and Thair 2012, Schuster 1996). In rocky areas, pickleweed will first be cut as close to the substrate as possible with a line-cutter. Cut material will be gathered, transported, and compiled in staging areas for later hauling. When regrowth is no more than 2-4 inches, the plants will

be flamed or "sweated" with a high-intensity propane torch. Regrowth is expected to occur from these roots and will require periodic retreatment at two week intervals for at least two months to deplete root-stored resources and kill new seedlings (Schuster 1996). In less rocky areas, direct hand removal of the root systems by shovel, weed wrench, or hand pliers, is followed by propane sweating of regrowth and seedlings. Shading with black plastic was found to be impractical as a permanent control method but can be used to "hold" regrowth until retreatment by propane torch (Pratt 1998, Truan and Metzler 2015). The cutting of pickleweed will be timed to the extent possible to avoid periods when the plant is producing seeds, and care will be taken during cutting and removal of plant waste to prevent propagules and fragments from being carried to new habitat by water, clothing, and machinery. Drift fences will be deployed around pickleweed stands during work to minimize fruits and propagules moving to new areas at high tides.

Milo**:** *Milo* (*Thespesia populnea*) saplings form sporadic, bushy outgrowths on walls and rocky substrate at ʻAimakapā. Where possible, these will be hand-cut below the waterline, effectively killing them. Away from open water, on the upland shorelines of the pond, level-cut surfaces of stumps will be carefully painted ("cut-stump" method) with an EPA-approved herbicide that is formulated specifically for use in aquatic areas and is permitted by an NPDES permit. Woody material will be collected at staging areas for later hauling.

Best Management Practices. As described in Alternative 1, the Park's best management practices (BMP) will continue to be followed for storing, using, and transporting all hazardous materials that are used for fueling and maintenance (e.g., gas, diesel, lubricants), for sweating vegetation (propane fuel), and controlling vegetation (herbicides). Under Alternative 2 during clearing operations, ground machinery (such as a mini excavator, tractor, or a RAV) would be stored, fueled, and maintained within the project area in an upland site away from open water. Fuel and lubricants would be transported to and from the site using the proper standard storage and transportation safety procedures for such fluids. On site, BMPs (e.g., drip pans, absorbent mats, biodegradable lubricants where possible, and daily maintenance checks of machinery) would be used to protect the wetlands environment from leaks and spills. A spill prevention plan would outline measures to reduce potential for spills and isolate accidental spills should they occur. Although it is not anticipated, should any previously undetected hazardous materials or wastes be encountered in the wetland, or generated during vegetation removal, the following steps would be taken: 1) The Park's hazardous waste emergency response plan will be followed; 2) local environmental regulatory and emergency response agencies will be immediately informed; and 3) all fill and debris associated with hazardous materials or wastes encountered on-site will be characterized and disposed of according to federal, state, and local regulations.

As in Alternative 1, to prevent loosed organic material from invading the pond during removal actions, silt fences will be installed along work area margins and will be relocated to active areas as work progresses. Additionally, in areas where large stands of seashore paspalum grow along the waters' edge, a border of plants would be left intact as a natural sediment barrier while shore-to-border areas are cleared, and then removed once

completed. Measures will be taken to prevent accidental introduction or transfer of non-native plant fragments or propagules between wetland areas and other sites. Barrier methods will be used to restrict propagules and broken pieces of plants, particularly pickleweed, from being carried to new habitat by water. Equipment used in other areas of the Park will be thoroughly cleaned before relocation to wetlands work areas. Equipment and clothing will be regularly checked to prevent moving seeds and propagules between work areas in the Park.

Hauling and Removal

All excavated plant materials will be transported (by hand, boat, or machine depending on removal location and method) along pre-defined access paths to an upland drying area located on an adjacent upland lava flat (Staging Area 1; Figure 2). A helicopter would be used periodically to remove large amounts vegetation material or move equipment at scheduled times when sufficient waste material is staged. Helicopter operations would avoid archeological resources and special species habitat, and would not land in the Project Area. Helicopter flights would hover above staging areas to sling-load material from Staging Area 1 to Staging Area 2 (Figure 2), or from temporary staging areas in Management Areas 2 and 3 to Staging Area 2 as necessary. The area of helicopter operations would be closed to park visitors while operations are underway. Foot, UTV, and machine access paths will be sited to protect cultural and biological resources, including stands of native plant species. If deemed necessary, paths will be covered to reduce compaction of wetland soils. Protective mats and/or constructed protective surfaces will be used to protect ground-surface historic properties on lava flats in work areas. At Staging Area 1, excavated plant materials will be stockpiled on constructed, raised platforms covered by helicopter slings (constructed of wire fencing lined with shade cloth). Once sufficient material is staged, the material may be hauled by water to Staging Area 1 and then by UTV along existing Park trails and/or by helicopter sling-load to a green waste collection point at Staging Area 2. Material may be dried and disposed of in at cost by weight in roll-off containers, and/or dried and pulsed through a chipper with dust-control baffling (box built around output chute) for incorporation into Park compost.

Vegetation Restoration

Under Alternative 2 (NPS Proposed Action), passive restoration from the existing seed bank, maintenance of native-plant stands via the Bradley Method (see Bradley 2002 in Rieger et al. 2014:195), wild-transplants, and outplanted nursery-propagated plugs would be incorporated into vegetation restoration actions (Appendix D). Under this alternative, a planting plan for each Management Area will be prepared to include source(s) for plant materials, type(s) of propagule for each species of plant, timing of rescue and transplanting of wild native-plant stands, timing of outplanting, consideration of mulch and soil amendments, and maintenance and weeding specifics (species id, methods, timing).

Propagation and outplanting of propagules from appropriate strains of native plants within in the Park would be incorporated where donor stands could tolerate harvesting. If the stand is large enough to withstand transplanting, no more than 1 ft^2 (0.09 m^2) of plant material would be moved from a 4 ft^2 (0.4 m^2) area (Hoag 2000). Natives may be propagated both on-site and at off-site partner nurseries for subsequent outplanting, or immediately wild-transplanted (Hoag 2000). Outplants may also be obtained through contract from certified sources (e.g., Amy Greenwell Ethnobotanical Garden, Future Forests Nursery, or other sources).

Under Alternative 2, active restoration actions would be accomplished using both Park staff and community volunteers Large stands of native vegetation would be flagged and protected in place, after which selective weeding would be performed by the volunteers following the Bradley Method (see Bradley 2002 in Rieger et al. 2014:195). A pilot project conducted at ʻAimakapā Fishpond in 2013-2014 showed good success with this approach (Truan and Metzler 2015). Once the wetland surface has been cleared and prepared for revegetation, volunteers will outplant rescued and newly-propagated plants into the wetland.

Vegetation Monitoring

Native and nonnative plant regrowth and seedbank germination will be monitored using standardized photo-documentation and quadrat sampling techniques at selected permanent sampling plots (Elzinga et al. 2001). Active control areas will be visually monitored monthly. Photo-documentation and quadrat data sampling at permanent plots will be conducted semi-annually.

Wetlands Access

In this alternative, as in Alternative 1, access to the wetland for equipment, materials, and laborers would continue to be via the Park's existing inland and coastal trails. Potential temporary routes have been identified during archeological survey (Figure 2; Paikuli-Campbell and Lizama 2015) and would be established and utilized for ingress and egress between existing trails and less-accessible parts of the wetlands, primarily the *mauka* (inland) areas. Prior to use, potential temporary access routes would be resurveyed for presence of native plants and locations of historic properties, and sited to avoid potential adverse effects to these resources. Where necessary, to protect temporary access routes from wear and to protect nearby ground-surface historic properties (e.g., petroglyphs, *papamu* (game boards), pavements, etc.) where they occur, protective mats and/or constructed protective surfaces will be placed over the ground-surface. Constructed temporary surfaces will consist of geotextile material covered with 3-6 inches of wood chips. The woodchips will be contained onto the geotextile material. Upon completion of major restoration actions in a particular area to the level that subsequent access for maintenance actions is sufficient by foot or boat (e.g., kayak or canoe); temporary access routes would be removed and replanted or seeded with native plants. For work in the north and south *makai* (ocean side) areas of the wetland, access will include the barrier beach portion of the Ala Kahakai coastal trail.

Predator Control

In this alternative, as in Alternative 1, IPM methods for nonnative animal pests are applied and the Park's small-mammal predator control program would continue. However, under Alternative 2, additional protocols will be established and implemented to improve trapping efficiency, effort, timing, and siting of traps, and to monitor success. As in Alternative 1, feral cats would continue to be live-trapped. Under the Proposed Action, in addition to live-traps, baited toxicants or toxin-free humane instant-kill traps may also be used to control populations of mongoose and rats. Toxin-free humane instant-kill traps have performed well in multiple study trials in Hawai‘i, and provide humane, efficient, and effective control for mongooses and rats (Bogardus 2015, Peters et al. 2011, Pias et al. 2015, Raine et al. 2015, VanderWerf 2015). Examples of traps that have been evaluated for humaneness and would be considered for use under this alternative are the New Zealand Department of Conservation DOC-250 kill-trap and the A24 Goodnature® multispecies (rat and stoats) repeating/self-setting kill trap (Jansen 2011, Peters et al. 2011, Poutu and Warburton 2005). Humane trapping and control of harmful terrestrial predators is an active area of research; other methods may be used in the future as technology evolves. Trapping efficiency will also be improved by directing trapping efforts towards known spatial and temporal peaks of the animal's activity and reproductive patterns. Predator presence will be monitored with species-appropriate methods to guide optimal deployment of species-specific traps (e.g., Gillies and Williams 2013).

Under this alternative, the NPS would potentially haze and control nonnative cattle egrets (*Bubulcus ibis*), which prey on adult or young ‘*alae ke*‘*oke*‘*o* (Hawaiian coot) and *ae*‘*o* (Hawaiian stilt) (Mitchell et al. 2005, USFWS 2011b, 2013). The NPS may apply for a depredation permit to control or haze cattle egrets, however, the USFWS is currently considering authorizing the control of cattle egrets, their nests, and eggs by certain authorized agencies without permits in Hawai‘i for the protection of native threatened and endangered species (78 Federal Register 69593, November 4, 2013; USFWS 2013). The USFWS-proposed order includes egg oiling, egg and nest destruction, firearms, and trapping and euthanasia as potential control methods.

Special Status Species Protection

It is inevitable that endangered waterbirds will reoccupy restoration work areas as work progresses, particularly in areas identified as high priority habitat areas for birds. To protect nesting birds, work areas will continue to be surveyed prior to the start of each day's work and locations of nests noted on a map. Under Alternative 2 (Proposed Action), the NPS will consult with the USFWS to obtain a permit for incidental "take" of endangered waterbirds under the Endangered Species Act (ESA) to enable work to continue for the long-term benefit of these species. Under the Proposed Action, "take" under the ESA would include harassment of endangered waterbirds while actions associated with restoration and management of ‘Aimakapā Fishpond and wetlands are underway. Simultaneously, the NPS will consult with the USFWS, and the NOAA Fisheries as appropriate, under Section 7 of the ESA on potential affects to all Special

Status species within the project area (see *Special Status Species* Section). Green turtles or monk seals hauled-out and basking on the ocean side of the barrier beach fronting ʻAimakapā Fishpond during restoration operations on the *mauka* (inland) side of the berm will be avoided. Briefings to project crews will include presence and location(s) of special status species, if any, identified within the day's work area. If monitoring shows that certain types of work in certain areas is disturbing or has the potential to disturb marine turtles, or monk seals, that work will be halted immediately until the animal clears the area on its own.

Disease Monitoring & Response

As under Alternative 1, the NPS would continue to respond to avian disease outbreaks as they occur. Of the diseases that affect endangered waterbirds (avian botulism, avian cholera, avian malaria, pox, avian influenza, and West Nile virus) avian botulism is the highest disease concern, and disease monitoring is an essential part of ʻAimakapā wetland area management under Alternative 2. Disease monitoring and response actions are presented in Appendix E. Removed vegetation and root material will continue to be managed as described above to avoid conditions that may contribute to an outbreak of avian botulism.

Waterbird monitoring

Under Alternative 2 (Proposed Action), monthly visual monitoring surveys will be conducted in addition to currently ongoing monthly surveys (Kona Coast Waterbird and Shorebird Surveys; Waddington 2002 to date) in order to evaluate the success of vegetation management strategies, and to inform adaptive management actions in ʻAimakapā wetlands. Survey protocols consist of area searches and direct counts of species abundance, diversity, behavior, and breeding activity (i.e., location of nests, clutch size, number of hatchlings, number of fledglings) for *aeʻo* and *ʻalae keʻokeʻo*. Sightings of banded birds and incidental observations for other resident, migratory, and accidental avian species are also recorded. Data will be compared to previous years to detect trends and significant changes. Trained park staff will survey the work area(s) for waterbirds and other special status species prior to the day's start.

Cultural Resource Protection

In the restoration and management of ʻAimakapā Fishpond and wetlands, the area of potential effects (the footprint of all project activities and surrounding viewshed) to prehistoric and historic archeological resources, ethnographic resources, historic structures, and cultural landscapes includes the entirety of Kaloko-Honokōhau NHP and the Honokōhau Settlement NHL (Figure 1). However, there is a higher likelihood of potential effects in the defined Project Area (Figure 2). Archival, GIS research, and project area surveys identified 461 archeological sites within the APE and 25 within the Project Area (Paikuli-Campbell and Lizama 2015).

Under the Proposed Action, any future project actions that are not the same or similar to the methods described in this Management Plan/EA, or actions that involve new areas

appended to the Project Area will be reviewed for potential affects to historic properties and determination of whether additional Section 106 consultation actions under the National Historic Preservation Act should be initiated. For all activities under this proposed Management Plan, the following strategies will be used to protect cultural resources:

Impact Avoidance, Minimization, and Mitigation Strategies

- Ingress and egress routes will be sited to protect cultural resources.
- Protective mats and/or constructed protective surfaces will be placed over ground-surface historic properties (e.g., petroglyphs, *papamu*, pavements, etc.) where they occur on lava flats in staging areas and other work areas, and along temporary access routes within the project area. Constructed protective surfaces will consist of geotextile material covered with 3-6 inches of wood chips. The wood chips will be contained onto the geotextile material. When the temporary access route is no longer required, the mats and constructed surfaces will be removed.
- An archeologist will monitor project actions as required to ensure no impacts to known archaeological sites, and will monitor in areas where ground-disturbing activities (vegetation removal from soils) have potential to impact unknown buried archaeological deposits. Outplanting areas will be approved by the archeologist.
- Vegetation removal will be by manual methods when in close proximity to historic properties (e.g., stacked walls, terraces, platforms, pavings, petroglyphs, etc.). Mechanical methods, a small machine, and/or UTV, may be used to remove and/or haul material from within the ʻAimakapā wetland boundary and the project area and ground-protection measures will be used as described above.
- Should unidentified archeological resources be discovered during restoration and maintenance actions, work in that location would be halted, the Park Cultural Resources Program Manager would be contacted, and the site secured. Any archeological site identified would be properly recorded by an archeologist and evaluated under the eligibility criteria of the National Register of Historic Places.
- If the newly identified resource is determined eligible, appropriate measures would be implemented either to avoid, or prevent further resource impact (if such has occurred), or to mitigate their loss or disturbance (e.g., by protective measures as described above or other means) in consultation with the Hawaiʻi State Historic Preservation Division and the Advisory Commission on Historic Properties as required according to 36 CFR 800.11.
- In compliance with the Native American Graves Protection and Repatriation Act, the NPS would notify and consult Park lineal descendants and Native Hawaiian Organizations for the proper treatment of human remains, funerary and sacred objects, should these be discovered during the course of the Proposed Action.
- Daily briefings to project crews will include location(s) and description(s) of sites identified prior to restoration actions within the project area, and specifically within the day's work area. Guidance will be given to project crew to avoid specific sites

where necessary and/or to ensure that protective mats or constructed protective surfaces are in place.

Hydrologic Conditions

Under Alternative 2 (Proposed Action), the NPS would continue to maintain existing fishpond hydrologic conditions. Reshaping of the basin topography would not occur beyond removal of root matter necessary to eradicate nonnative plants. The beach sand berm would remain intact and natural water inflow would continue solely from groundwater seeps and from seawater percolation through the berm.

Under this alternative, the NPS would initiate long-range climate change planning to extend beyond the 15-yr lifespan of this Management Plan. Due to the increased threat of inundation under future climate change scenarios, park personnel will initiate simple monitoring techniques to monitor ‘Aimakapā’s barrier sand berm. Georeferenced aerial photographs and GIS will be archived to measure shoreline movement (erosion and accretion) along the barrier beach long term (see Hapke et al. 2005). Periodic visual monitoring of overtopping of waves along the berm will be used to establish frequency of overtopping and correlate with storm event intensity. Monitoring will begin at the start of the next high-wave season (winter) and last 25-50 years or longer. Monitoring will especially target high-tide events (full and new moon phases) when large swell is expected. Ideally, monitoring will start a few days before the high-tide and high-wave events to capture before-and-after states. Photographic records of wave wash and any damage associated with it, beach profiles of the beach shape (if a beach exists), and differential GPS on archeological sites will provide a catalog of data to identify emerging and progressive threats.

Coastal threats can appear quickly and without ample warning period. Under this Alternative, the NPS would formulate an advance plan of action with the Army Corps of Engineers specifically for a potential storm surge or tsunami breach of the beach fronting ‘Aimakapā Fishpond within the next 15 years so that actions can be taken quickly if a breach occurs. In these cases, if feasible, the beach would be replenished to close the breach.

Water Quality and Hydrology Monitoring

Hydrology is at the core of wetland functions and measuring hydrology provides insight into the most dynamic part of a wetland system. An In Situ Inc. Aqua Troll 200 CTD transducer measuring conductivity, temperature, and depth (pressure; psi) is installed in the fishpond and monitors data at 10 min intervals. A staff gauge is also installed in the wetland on the south shore. Rainfall is monitored hourly through the Park’s remote automated weather station. Under this Alternative, dissolved oxygen, pH, turbidity, temperature, conductivity, and oxidation/reduction potential would be monitored quarterly at selected historic monitoring locations (Bienfang 2007) and nutrients would be measured semiannually at minimum.

Visitor Interpretation and Community Stewardship

Under Alternative 2, fishpond environs would continue to be closed to individual access by the general visiting public to protect endangered waterbirds from harassment and regenerating native plants from trampling. However, perpetuation of traditional cultural management of the fishpond and environs are goal of the Proposed Action and may occur under this alternative where these practices are feasible, are compatible with the mission of the Park, and do not have adverse effects on natural and cultural resources and visitor experience. Vegetation and waterbird management presents enhanced opportunities for visitors and school groups to become involved in new interpretive programs. Under this alternative, interpretation programs would be expanded to include specific education and outreach about the restoration process and ʻAimakapāʼs natural and cultural history. Under Alternative 2, signage and site bulletins informing visitors about ongoing work and the need for revitalizing the native ecosystem and traditional management would be used and would include information and regulations about introduction of nonnative species, the detrimental effects of predators such as feral cats, tilapia, unleashed dogs, unauthorized access, and other resource management issues would be included.

Volunteer stewardship opportunities would be created to engage the community in the restoration of ʻAimakapā ideally resulting in a core of individuals with a wide range of knowledge and interests who may desire to demonstrate, teach, and learn Hawaiian cultural pursuits and natural area preservation. Such interests may include (but are not limited to) wildlife watching and preservation, native plant propagation and restoration, participating in traditional management of the pond, and cultural uses of native wetland plants. Stewardship volunteer groups will contribute to the success of the restoration process. Manual removal and control of invasive vegetation, rescue, and wild transplanting of native plants, and maintenance weeding tasks would be aided by volunteer groups organized under park and community stewardship groups. The hands-on volunteer opportunities would be used to provide educational focus on a variety of topics including Hawaiʻiʼs native species, reasons for preserving them and threats to them, threats to native ecosystems from invasive species, Hawaiian fishponds and their management, the historic cultural importance of the ʻAimakapā Fishpond in the context of the Honokōhau Settlement, and the ways in which ancient Hawaiians lived with and related to the forces of nature. This volunteer and education program would integrate with and build upon the Park's Na Leo Kahiko Cultural Center (NPS 2013a) programs and activities.

Aquatic Invasive Species

Under Alternative 2, nonnative fish would ultimately be controlled as part of the restoration and management of ʻAimakapā Fishpond and wetland. The US Geological Survey is analyzing options for removal and control of invasive fishes, primarily Mozambique tilapia (*Oreochromis mossambicus*), at ʻAimakapā Fishpond. A separate environmental review and analysis of specific methods to control invasive fishes will tier from this EA. If the recommended control methods are approved following environmental review, they would be employed in pond management under this

Alternative. Removal and control of tilapia is critical for the health of the ʻAimakapā Fishpond and its adjacent ecosystems. Mozambique tilapia was first recorded in ʻAimakapā during 2008-09 (MacKenzie and Bruland 2012) and is now abundant and widespread throughout ʻAimakapā. Listed as one of the 100 "World's Worst Invasive Alien Species" (Lowe et al. 2004), tilapia are likely having direct and indirect adverse effects on ʻAimakapā natural and cultural resources through predation on native fish, direct competition with native fish and endangered waterbirds for prey, competition with native fish for breeding space, and potential for disease and parasite transfer to fish and waterbirds, and indirect ecosystem alteration by burrowing into pond sediments and cultural deposits.

Alternative Action Components Considered but Dismissed from Further Analysis

Internal and public scoping, and pilot study work in the wetlands identified several components for inclusion in the Management Plan/EA that were considered but dismissed from further analysis. Management of ʻAimakapā Fishpond is complicated by conflicting legislative mandates that foreclose the maximum possible use for any one single management aspect of the pond, be it the management for the maximum benefit of native wildlife and plants, traditional fish production, historic preservation, or public recreational use of the pond. The Management Plan over the next 15 years seeks a mix of these objectives in a manner that best fulfills each of the management objectives without irreversible long-term effects. Dismissal from consideration in this current analysis does not foreclose consideration and environmental analysis of a component action in the future.

Exclusive Use of Manual Removal of Non-Native Vegetation

A management action component to use only manual methods of removal of non-native invasive vegetation was dismissed due to the large area involved (approximately18 acres) and the difficulty in removing by hand large amounts of alien invasive biomass from the wetland surface quickly enough to keep ahead of its rampant growth. To be effective, manual control efforts must be persistent and several treatments are generally needed to reduce or eliminate target populations. If infestations are too pervasive, manual control becomes overly labor intensive and thus not economically feasible (Wisconsin Dept. of Natural Resources 2012). Pilot projects undertaken in fall of 2012 and 2013 tested manual methods of removal and determined that inordinate amounts of backbreaking labor by very large labor crews would be needed to clear and keep the wetland surface free of non-native invasive vegetation, and that invasive vegetation would generally grow back faster than hand crews could clear it. Moreover, pickleweed—because of its vast root system that permeates soils and lava interstices—proved impossible to remove manually. For these reasons, we determined that an integrated approach consisting of a variety of appropriate control methods would be most effective.

Install Predator-Proof Perimeter Fence Around Wetland

Because the endangered ground-nesting waterbirds found at ‘Aimakapā Fishpond are extremely vulnerable to mammalian predators, the construction of predator-proof fencing around the fishpond was considered as a potential management action. The control of these predators is essential to attain the goal of restoring and maintaining ‘Aimakapā’s native wildlife communities. Predator-proof fencing has been used in a variety of locations, including in Hawai’i, to exclude mammalian predators from areas containing native species (Young et al. 2012). Predator-proof fencing combined with active monitoring and trapping (since predators do still find their way into fenced areas, particularly near the ocean) is the best way to prevent predation on ground-nesting birds (Young et al. 2012). Fencing the ‘Aimakapā wetland would also limit unauthorized access by hikers and visitors with leashed or unleashed dogs, preventing disturbance to wildlife and native plant restoration, and to historic properties. However, construction of such a fence was dismissed from further consideration at this time because of the potential to adversely affect historic properties and the visual cultural landscape. In the future it may be advantageous to consider fencing the *mauka* (inland) back and sides of the fishpond where the majority of waterbird nesting takes place and the majority of predators appear to gain access to the wetland.

Open ‘Aimakapā Fishpond to the Sea through Excavation and Opening of Historic ‘Auwai (channel) or Excavation of New ‘Auwai.

Because historic Hawaiian fishpond practices maintained at least one confirmed and one probable ‘*auwa*i (channel opening to the sea) through ‘Aimakapā’s sand berm (Duarte and Kauahikaua 1999, Junqueira 2001), and because ‘Aimakapā Fishpond suffers from water quality issues, some of which could be improved by increasing tidal flushing, opening a channel to the sea was considered as an alternative action component. Reopening the fishpond’s known, historic ‘*auwai* or excavating a new ‘*auwai* and restoring a functioning *makaha* (sluice gate) was identified as a possible action during 2012 public scoping and also during park management discussions following the 1994 avian botulism outbreak at ‘Aimakapā (see Morin 1996a). Installation of a solid rather than fenced *makaha* within an ‘*auwai* to allow periodic (but not continuous) flushing of silt and water during high outgoing tides without allowing saltwater inflow has also been mentioned as a potential action (Morin 1994).

The known, historic ‘*auwai* sluice channel site at the northern end of the wetland is nonfunctional and the pond area behind it has been silted in and vegetated for decades. Restoration of the historic ‘*auwai* would require a considerable amount of excavation and channelization (several hundred feet) in order to allow water flow at its location (Morin 1996a). Using magnetic survey methods, other potential sites for historic ‘*auwai* have been identified along the berm and further magnetic surveys are recommended before excavation or restoration in these areas (Duarte and Kauahikaua 1999). Alternatively, one or more new ‘*auwai* could be sited and constructed away from potential historic sites following appropriate circulation modeling studies and detailed assessment of effects to the historic fabric of the fishpond.

The benefits of opening a connection for exchange of water with the sea include: improving some aspects of the pond's water quality and nutrient dynamics, reducing potential for botulism disease outbreaks and fish kills, flushing out of silty sediments, and flocculent organic matter, potential influx of coarse marine sediments and native fish species, and revitalization of traditional fishpond production and practices specific to ʻAimakapā.

However, there are also numerous, potential, major long-term adverse effects of this alternative action component. Avian disease management in inland freshwater wetlands includes draining the wetland to prevent or halt a botulism outbreak or maintaining a single water level to prevent an outbreak. Although *ʻauwai* would increase the ability to prevent or halt an outbreak, this strategy does not transfer well to intertidal, brackish water habitats supporting endangered species where maintaining an intact native ecosystem is a priority (Morin 1996a). *ʻAlae keʻokeʻo* (Hawaiian coots) generally prefer freshwater; though they will use brackish water bodies (USFWS 2011b). A permanent increase in salinity caused by direct influx of seawater to the pond might make the habitat unacceptable to coots (Morin 1998, USFWS 2011b) and migratory waterfowl (Morin 1998). Because of the scarcity of wetlands on Hawaiʻi Island, ʻAimakapā Fishpond is an important site for migratory waterfowl as well as endemic birds. Loss of available fresh/brackish water habitat is likely to also affect these migrants (Morin 1996b). Increasing the pond salinity would potentially affect food availability for the waterbirds by altering the existing salt tolerant (but not salt loving) vegetation and invertebrate prey species (Morin 1998, USFWS 2011b). If the influx and salinity change were abrupt, a resulting invertebrate or fish die-off could potentially trigger a botulism outbreak (Morin 1996a, 1998). Salinity fluctuations are less likely to have an effect on *aeʻo* (stilts; USFWS 2011b) and migratory shorebirds using the pond (Morin 1998). However, Morin (Morin 1996b, 1998) expressed concern that flushing out of all accumulated sediments may reduce available mudflat foraging areas for stilts. An open connection with the sea would allow the entry of predatory marine fishes that might prey on endangered waterbird young and even adults. Predatory marine fish would also likely prey beneficially on nonnative fish (tilapia, guppies, mosquitofish) but would not likely eradicate their populations (Nico et al. 2014 *in litt*).

An *ʻauwai* would increase the likelihood for some nonnative Mozambique tilapia to escape to the sea and potentially disperse along the coastal marine environment to Kaloko Fishpond and other habitats within and outside of the National Park. Mozambique tilapia are highly adaptive to a wide range of salinities, able to invade, thrive and in some cases dominate in fresh, brackish, and coastal marine habitats(Eldredge 1994, Nico et al. 2014 in litt). The species is known to compete aggressively in marine waters with *ʻamaʻama* in Hawaiʻi, and at Fanning Atoll, fishermen reported fewer mullet, bonefish, and milkfish after tilapia were introduced (see review by Eldredge 1994). Salinity tolerance experiments conducted with Mozambique tilapia captured from ʻAimakapā showed that the fish easily tolerated direct transfer from brackish salinities to pure seawater (Nico et al. 2014 *in litt*). Because of the potential impacts to cultural and other fish resources, eradication of tilapia would be a necessary step prior to construction and operation of *ʻauwai* and *mākāhā*.

Export of sizable sediment and nutrient loads from the pond to the near-shore reef and coastal environment through one or more ‘*auwai* has the potential to affect corals and nearshore marine habitats. Finer particles of flocculent sediment and organic material potentially may be entrained in the surface layer and carried farther off shore ultimately depositing in very deep water. Larger particles may be regularly re-suspended in the relatively high energy waves on the extensive shallow (5- to 20-ft depth) basalt pavement habitat immediately off shore of the pond and potentially on the ~30- to 90-ft deep reef slope at its seaward edge.

Based on these potential environmental consequences, we determined that additional studies and evaluations are necessary to analyze this alternative action component. Appropriate measures to avoid, lessen, or mitigate the degree or extent of potential impacts would also need to be developed based on the results of these studies. Needed studies include: 1) further review of historic records, maps, photos, oral history accounts and onsite surface and subsurface magnetic surveys with modeling to better identify historic ‘*auwai* locations, potential “new” locations, and to assess potential affects to the historic property by opening one or more historic or “new” ‘*auwai*; and 2) circulation, mixing, and water quality modeling studies to characterize the fate and potential effects of discharge from the fishpond to the sea and the potential effects of direct seawater flow to the pond on endangered birds and other organisms. The combination of 1) the need for additional scientific studies, 2) the potential threat of spreading tilapia to uninvaded habitats, 3) the recommendation of the *Spirit Report* for ‘Aimakapā to be “*restored to the extent at which it will not have an adverse effect on the wildlife that presently inhabits the pond*” (Hono-kō-hau Study Advisory Commission 1974:30), and 4) the plan to initiate traditional fishpond management of Kaloko Fishpond as a focus of Na Leo Kahiko Cultural Center programs and activities (NPS 2013a) led us to dismiss this action component from further consideration under this Management Plan/EA. However, our dismissal here does not preclude future consideration of this action in a separate environmental review that would tier from this EA/Management Plan.

Chapter 3: Affected Environment

This chapter describes existing environmental conditions in the area potentially affected by the alternatives. The affected environment is described for each of the impact topics retained for analysis, as identified in Chapter 1. Although this EA separates resources into discrete categories for the purposes of impact analysis, in Hawaiian cultural tradition cultural and natural resources are viewed as inseparable, one and the same, within the traditional cultural landscape. Cultural resources stem from nature’s provision; therefore natural resources are culturally important.

Park Setting

Kaloko-Honokōhau National Historical Park is an approximately 1200-acre (485 ha) coastal and marine national park unit situated within the coastal portion of four *ahupua‘a*

(mountain-to-sea land divisions) Kohanaiki, Kaloko, Honokōhau, Honokōhau Iki, and Kealakehe on the western (leeward) coast of the Big Island of Hawai‘i (Figure 1). ‘Aimakapā Fishpond is within the Honokōhau *ahupa‘a*. Located on the coastal flank of Hualalai Volcano, the parklands consist of semiarid, rugged basalt lava flows, Hawaiian fishponds, anchialine pools, carbonate sand beaches, rocky intertidal areas, and approximately 600 ac (242 ha) of marine waters. The Park receives an average annual rainfall of about 20 inches (51 cm) with monthly rainfall averages fairly constant throughout the year. Upslope of the Park, annual rainfall increases to up to 78 inches (198 cm) at 1,500-2,900 feet on the slopes of Hualalai volcano (Giambelluca et al. 2013). The largest modern population center in the vicinity of the Park is Kailua-Kona, about three miles south-southeast. Since the Park’s authorization in 1978, the majority of open space around the Park has been zoned urban for future growth. Kona International Airport is about three miles to the north, a new luxury-residential and golf development, The Shores at Kohanaiki, is situated along the northern park boundary, the Honokohau Small Boat Harbor adjoins the Park's southern boundary, rock quarries and several large light-industrial and business parks are immediately upslope across the Queen Ka‘ahumanu Highway on the eastern boundary. The Kealakehe wastewater treatment plant is situated 0.5 miles (0.8 kilometers) south of the Park boundary and discharges its treated effluent at a pond on the east side of the highway. A county green waste facility, and closed metal yard and landfill are also located upslope 0.8 mi (1.3 km) south of the Park.

Geology

Hawai‘i Island is approximately 0.5 million years old, the youngest and largest of the Main Hawaiian Islands. The Park lies within the landform region known as the Kona Lava Plain, formed by the gently sloping western flank of Hualālai Volcano. Three distinct basalt lava flows consisting of highly permeable, flat to undulating *pāhoehoe* and jagged a‘a form the parklands (Figure 3). Age ranges for these Holocene-era flows are approximately 1,500 to 3,000 years old, 3,000 to 5,000 years old, and 5,000 to 10,000 years old (Moore and Clague 1991, Wolfe and Morris 1996). The ages of the submerged flows is unknown (Gibbs et al. 2007). The majority of shoreline is rocky, consisting of a low-lying basalt platform or bench overlain in areas by carbonate and basalt sand and gravel beaches. Two types of beach are present: intertidal accumulations of beach sediment subjected regularly to wave action (e.g., Honokōhau Beach), and storm beach deposits—perched beaches that are typically affected only during large-wave events (Richmond et al. 2008).

Two lava flows boarder ‘Aimakapā and a barrier white-sand berm, Honokōhau Beach, isolates ‘Aimakapā from the ocean on the *makai* (seaward) side (Figure 3). The Park’s oldest lava flow (5,000 and 10,000 years ago) forms the underlying permeable pāhoehoe substrate and shorelines for ‘Aimakapā Fishpond. A narrow finger of younger a‘a lava (2200 to 2300 years old) overlooks the *mauka* (landward, eastern) edge of ‘Aimakapā Fishpond (Moore and Clague 1991). Honokōhau Beach forms a natural barrier between ‘Aimakapā Fishpond and the ocean and is the Park’s largest sandy beach, with a width of

about 105 ft (32 m) and a maximum height of 10 ft (3 m) above Mean Lower Low Water. Extending north about 300 yds (274 m) beyond the open pond water and about 85 yds (78 m) south of the pond, the barrier beach is moderately stable, eroding at average rates of 0.25-0.5 ft (0.08-0.15 m) per year (Vitousek et al. 2010).

Another geological process, the steady tectonic subsidence of Hawai‘i Island has shaped the Park and ‘Aimakapā Fishpond in particular. Island subsidence has ranged from 0.07 in/yr (1.8 mm/yr) to more than 0.1 in/yr (3 mm/yr), increasing over the last 0.3 million years, although it is unknown whether the steady subsidence was punctuated by rapid drops over this time (Athens and Ward 2006, Moore and Clague 1991, Walker 1990). At a steady rate, about 8.8 ft (2.7 m) of subsidence would have occurred during the past 1300-1400 years (Athens and Ward 2006). Within the Park, the ongoing process of subsidence means that the land surface, and therefore likely the fishpond basins, were above sea level when the various lava flows covered the land. A paleo-environmental study by Athens and Ward (2006) provides the following information about ‘Aimakapā’s development. A radiocarbon assay of ‘Aimakapā sediment cores indicates that the base sediment (peat) formed in pre-human times about 1334-1408 years ago (542-616 AD), probably within a lava depression with a freshwater seep but still well above sea level. Wetlands formed during the prehistoric Hawaiian period, and pollen-core samples show that the wetland was probably too crowded with sedge and too shallow for open water at that time. As subsidence proceeded, the sand berm likely continued to build and seawater percolated into the pond basin making the water too deep for the sedges to persist by the middle to late 19th century. The resulting open water ultimately enabled the use of the pond as a fishpond in historic times. The sedimentary record shows no evidence that fish farming was possible in prehistoric times and no evidence that the pond was directly open to the ocean in prehistoric times. Continuing coastal subsidence likely enabled human access to the freshwater table and a change in vegetation of the area (Carson and Rieth 2008).

Topography& Bathymetry

The topography of the terrestrial portion of the Park is relatively flat, rising in elevation from sea level to over 80 ft (24 m) along the eastern portion. The underlying lava flows are gently seaward-sloping, about 5-10% and less than 1% near the shoreline (Thornberry-Ehrlich 2011). The Park’s 3.5-mile shoreline extends along a double bay; the Kaloko interior embayment was converted into a fishpond during the late pre-contact Hawaiian period (Athens and Ward 2006). The larger of the Park’s two fishponds, the ~30-acre ‘Aimakapā Fishpond lies within the Honokōhau embayment, fronted by a shallow, fairly low-relief, broad bench extending seaward about ¼ mile at its widest point and fringing reef (Figure 3). There are no surface drainages into either fishpond. The offshore bathymetry is characterized by flat to gently sloping basalt lava benches, cliffs, and steep shelf escarpments that in some locations is irregular and mounded into ridges, pinnacles, and arches (Gibbs et al. 2007).

‘Aimakapā is shallow, 2-6 ft (0.6-1.8 m) deep and about 5 ft (1.5 m) deep in most areas. Evidence suggests that ‘Aimakapā Fishpond was formed through the combined action of

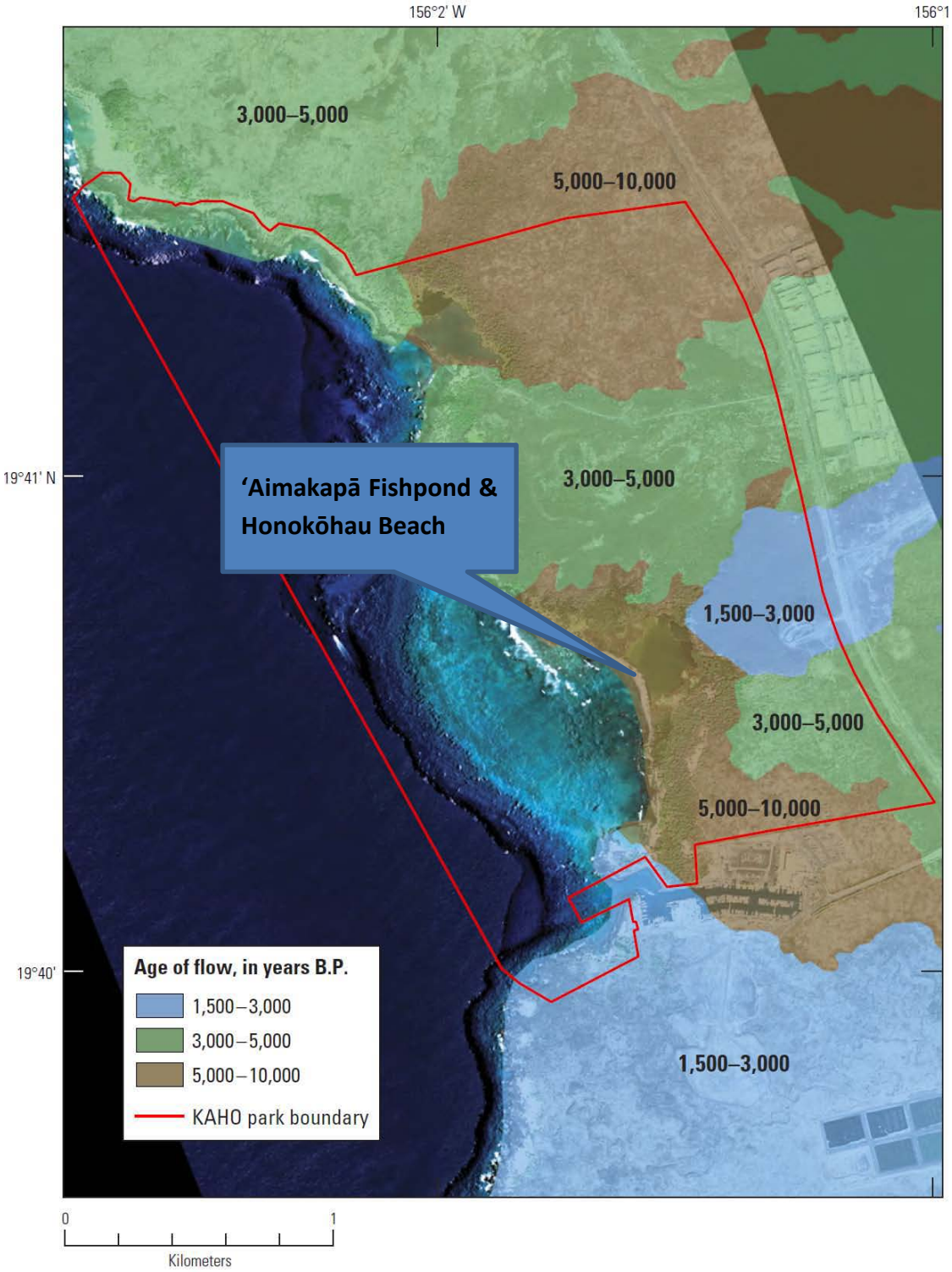


Figure 3. Map of Kaloko-Honokōhau National Historical Park (KAHO) showing three distinct flows from Hualālai Volcano of ages between approximately 1,500 and 10,000 years Before Present (BP) overlain on an aerial photo. Modified U.S. Geological Survey graphic from Gibbs et al. (2007).

land subsidence and shoreline depositional processes that formed a barrier spit across the mouth of the fishpond (Athens and Ward 2006, Maciolek and Brock 1974). Although it is also possible that a constructed sea wall exists beneath the barrier beach, data from a magnetic study of the berm indicate that the barrier beach is natural and there is no manmade wall beneath it (Duarte and Kauahikaua 1999). No excavations of the berm have been conducted.

Soil

Because of the relatively young age of the lava flows and the low rainfall soil development within the park is minimal, limited to pockets in the pāhoehoe lava, where eolian deposits of silt, volcanic ash and dust, and shoreline vegetation-derived organic humus accumulate (Thornberry-Ehrlich 2011). Terrestrial sediments generally are not present along the Park's shoreline (Oki et al. 1999). The Park falls within the "Lava Flows Association" on the General Soil Map of Hawai‘i Island, which consists of excessively-drained and well-drained nearly barren lava flows (USDA Soil Conservation Service 1973).

A 2010 custom soil map of the Park (USDA/NRCS 2010) provides the following information. The majority soil classification by acreage (32%) in the park is rLV (a‘a lava flow) followed by rLW (pāhoehoe lava flow; 27%), which are described as "excessively drained". These soil types comprise the larger area around ‘Aimakapā and Kaloko ponds. The shoreline soil around both fishponds is classified as BH (Beaches; 8% of parklands), which is described as 0-10 elevation 1-5% slope and excessively drained. However, *mauka* shorelines of both ponds are pāhoehoe.

‘Aimakapā Fishpond's sediments are comprised of silty, flocculent anaerobic mud. Sediment accumulation ranges from 0 to 59 inches (0 to1.4 m) with the deepest accumulations in the far northeastern side of the pond and several locations have thicknesses in the 31 to 39 inch (0.78 to .99 m) range (Athens and Ward 2006). The sediments consist of wood and peat at the deepest layers topped by gelatinous soil sediment, presumably formed from detrital algal and plant material; small amounts of windblown calcareous sand are also present (Athens and Ward 2006). A thin layer of mixed calcareous and basalt sand grains in a core at the back portion of the pond suggest a large storm-surge event or possibly a tsunami in the prehistoric period (Athens and Ward 2006).

Reductions in pond water-area in recent times have resulted primarily from infilling by locally-generated sediments and overgrowth by nonnative vegetation. In 2010, Mike Kolman, Soil Scientist for the Natural Resources Conservation Service, field sampled the newly-formed soils within the 18-acre, nonnative, paspalum grass plant community. Kolman (2010) described a new soil series that was recently (within the previous 10 years) created by the filtering action of the fibrous above-and-below-ground biomass of the paspalum grass structure. The fibrous roots and stems effectively filter and trap suspended solids, during each hydraulic exchange, which built a soil profile on what was originally mud flat area or shallow water, extending the grass as a floating mass over

water. As of 2010, a one-inch layer (A horizon) of mucky peat, and beneath that, a layer (B horizon) of peat extended from below the A horizon down to 9.5 inches (24 cm) depth at the water's edge to 21 inches (53 cm) depth 30 ft (9 m) inland from the water's edge down to the lava bedrock, depending on the topography of the underlying lava flow surface (Figure 4). Buried archeological deposits were not identified in any paspalum sample, nor were any archeological deposits identified during a 2012-2013 pilot study.

Figure 4. A photo of a plug of paspalum roots (dense, fibrous belowground biomass) that extends down to the surface of the bedrock. This sample has a one-inch A-horizon of mucky peat (10YR 2.1), the B-horizon is peat that extends from one inch down to the bedrock at 9.4 inches.

Geologic Hazards

Hualālai Volcano is considered "active" and volcanism remains a possibility that may affect the parklands. The Park shoreline and coastal areas are susceptible to inundation during tsunamis, hurricanes, and storm-surge. Coastal erosion and sea level rise, combined with ongoing subsidence also may affect beaches, anchialine pools, reefs, and coastal cultural resources. Earthquakes occur frequently on Hawai'i Island. Large earthquakes can cause damage to cultural sites and park facilities, and cause localized uplift, subsidence, or ground rupture. The 2006 Kona earthquakes registered 6.7and 6.0 and caused significant damage to several cultural sites.

Water Resources

Fresh and Brackish Water Resources

Groundwater

Kaloko-Honokōhau NHP is located at the coastal foot of the local watershed and within the state's Keauhou Aquifer System Area management unit. No surface water streams or intermittent streams exist within the Park or in the immediately surrounding area; local surface runoff occurs only under intense rainfall conditions. Groundwater is a critical park resource, supplying fresh water to a variety of ponds and pools. Groundwater inputs to park resources alter the salinity and temperature of receiving waters (ponds, pools, marine waters), and add nutrients and other dissolved constituents, including pollutants, derived from upland portions of the watershed (Hoover and Gold 2005). Varying pond sizes and their degree of hydraulic connectivity with ocean waters affects their groundwater residence time and therefore their individual ecosystem response to changes in water quality and quantity (Hoover and Gold 2005). Groundwater occurs a few feet above sea level within the Park and is composed of brackish water overlying saltwater in a highly permeable volcanic-rock aquifer (Oki et al. 1999). The brackish water is formed by seaward-flowing fresh groundwater mixing with underlying saltwater from the ocean. Recharge to groundwater is from places of higher rainfall on the slopes of Hualalai and local rainfall (Engott 2011). Groundwater levels in the Park are affected strongly by ocean tides and ocean level (Oki et al. 1999). Ultimately, groundwater discharges to the coastal Hawaiian fishponds and anchialine pools in the Park, and to the ocean, delivering nutrients and establishing estuarine-like conditions in the coastal nearshore waters (Johnson et al. 2008, Juvik and Juvik 1998, Knee et al. 2008). All water resources in the Park are vulnerable to contamination from human activities and saltwater intrusion.

Fishponds

The Park's unique water resources include a fishtrap, and two large ancient Hawaiian fishponds and their associated wetlands: ʻAimakapā Fishpond (approximately 30.5 ac; 12.3 ha), and Kaloko Fishpond (approximately 17.4 ac; 7 ha). These fishponds are also described further in the Special Status Species, Vegetation, Wildlife, and Cultural Resources sections of this chapter. ʻAimakapā Fishpond is brackish, with no direct connection to the sea and exchanges of water through the barrier beach are very low (Hoover and Gold 2005, Knee et al. 2008). Locations of groundwater influx into the pond are visibly evident along the eastern *mauka* edge and at seeps on the shoreline. An ʻ*auwai* (channel) at the north end of the barrier beach is now filled with sand, but likely the pond had greater exchange with the ocean water when it was in use as a fishpond in historic times (Athens and Ward 2006). Within the fishpond, secondary walls form separated areas where fingerlings were raised and/or where different species of fish were kept.

ʻAimakapā Fishpond's salinity currently averages around 12 parts per thousand (ppt), corresponding to ~65% volume percent freshwater (Bienfang 2007, Knee et al. 2008,

MacKenzie and Bruland 2012). Brock and Kam (1997) reported similar salinities ranging from 11.4 –12.1 ppt. However, older studies suggest that salinities in ʻAimakapā Fishpond were once much lower. Sparks (1963) reported average salinity at 9 ppt, Kikuchi and Belshe (1971) measured salinity at 7.9 ppt, and Maciolek and Brock (1974) reported average salinity at 7-7.5 ppt. The mechanisms for this increase in salinity include decreases in freshwater discharge (e.g., drought, production wells), increases in marine inputs (e.g., sea-level rise), and sampling artifacts (Hoover and Gold 2005).

Kaloko Fishpond occupies a natural embayment separated from the sea by a large man-made *kuapā* (seawall), the largest, and widest in the state. The *kuapā* has been recently rehabilitated by park staff using traditional techniques and materials. Secondary walls within the pond form separated areas where fingerlings were raised and/or where different species of fish were kept. Kaloko Fishpond is also supplied by groundwater but has an open connection to the sea through two *ʻauwai* (channels) in the *kuapā* and has higher salinities, around 22 ppt (~40% volume percent freshwater) as a result of its direct connection to the ocean.

ʻAiʻōpio Fishtrap is a small, 1.7-ac (0.69 ha) marine fishtrap at the southern end of Honokōhau Bay. Groundwater discharges at the shoreline and marine substrate of ʻAiʻōpio. Its stone walls are constructed from the shoreline across a small bay forming an artificial enclosure around the naturally curving shoreline. The fishtrap wall has a large opening to the sea and its walls are submerged at high tide. ʻAiʻōpio is the park area most utilized by visitors and cultural practitioners.

Wetlands

The Park's wetlands comprise about 4% of the parklands (not including submerged lands) (Cogan et al. 2011). The major wetlands areas are associated with Kaloko and ʻAimakapā Fishponds and a small area inland of ʻAiʻōpio Fishtrap; smaller wetlands areas are associated with a few anchialine pools (Canfield 1990, Cogan et al. 2011, Hoover and Gold 2005, Kikuchi and Belshé 1971, Pratt 1998). Using the Cowardin classification system (Cowardin et al. 1979), the Park's wetlands are considered "Estuarine." The Estuarine System consists of "deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land" (Cowardin et al. 1979).

ʻAimakapā, Kaloko, and ʻAiʻōpio wetland habitats have been altered by natural and artificial processes, including the invasion of nonnative vegetation that dominates some areas today. Large-scale tree removal of nonnative red mangrove (*Rizophora mangle*) and *kiawe* (mesquite; *Prosopis pallida*) was completed around the fishponds in the 1990's (Pratt 1998). Vegetation (Canfield 1990, Pratt and Abbott 1996, Pratt 1998) and waterbird habitat studies (Morin 1996b, 1998) have examined the Park's wetland habitat. In 1998 it was observed that although Park wetlands were invaded by nonnative vegetation, some areas of native marsh remained, which supported native species and comprised some of the best wetlands remaining in the state at that time (Pratt 1998).

Kaloko Fishpond, ‘Aimakapā Fishpond, and their adjoining wetlands have, up until the late 1990’s provided important waterbird habitat. Because of the history of bird census data showing use of wetlands by abundant numbers of listed bird species, the USFWS (USFWS 2011b) identified ‘Aimakapā as a “core wetland” in its recovery plan for the endangered *ae‘o* (Hawaiian coot) and the endangered *‘alae ke‘oke‘o* (Hawaiian stilt). Core wetlands are areas that provide habitat essential for the larger populations of Hawaiian waterbirds that comprise the bulk of the numbers prescribed for recovery. It is crucial for wetlands at these sites to be secure from conversion to non-wetland condition and to have sufficient enduring management to recover Hawai‘i’s waterbirds. ‘Aimakapā Fishpond and Honokōhau Reef, when exposed at low tide, are important resources for Kona Coast endemic and migratory waterbirds, whereas Kaloko Fishpond, because of its higher salinity, is not used by coots and migratory waterfowl (Morin 1996b, USFWS 2011b, Waddington 2002-2015).

A review of historical photographs of ‘Aimakapā reveals a gradual and extensive reduction in open water and mud flat area through encroachment of emergent vegetation, with a steady increase in upland and invasive plant species in the marsh flats (Figure 5). In 1977, the ratio of open water to emergent vegetation was reported at 20:10 acres (Shallenberger 1977). In 1995, the ratio of open water to emergent vegetation was 15:15 acres (Morin 1998). In 2014, approximately 20 of the 30 acres of estuarine habitat (previously comprised of a mix of native emergent vegetation, mud flat, and open water) have been populated or displaced by the two dominant nonnative emergent plant colonies. Other contributing factors may be recent drought conditions (Giambelluca et al. (2013) show a long-term declining trend in rainfall across Hawaii), increased organic input to the aquatic system from the decay of the robust nonnative plant species biomass, increased turbidity due to non-native bottom-dwelling fish behavior, or other changes in quality and quantity of freshwater inflow to the marsh associated with upslope land-development and land-use activities.

According to Levin et al. (2006), tidal flat and brackish estuarine wetlands, which provide critical trophic and habitat support for fish, shellfish, and migratory birds, are particularly susceptible to change through non-native flora and fauna invasion. The vascular plants that invaded the ‘Aimakapā mud-flat areas dramatically altered the abundance, community composition, and diversity of sediment microbe and animal communities, and therefore changed the flow of organic matter, energy, and nutrients. Essentially, the invasion of vascular plants has shifted the algae-based food web to a detritus-based food web. This is a trophic-level shift that has resulted in the loss of basic support for the native fish and shorebirds by reducing the type and amount of species that were consumed by the higher trophic-level species.

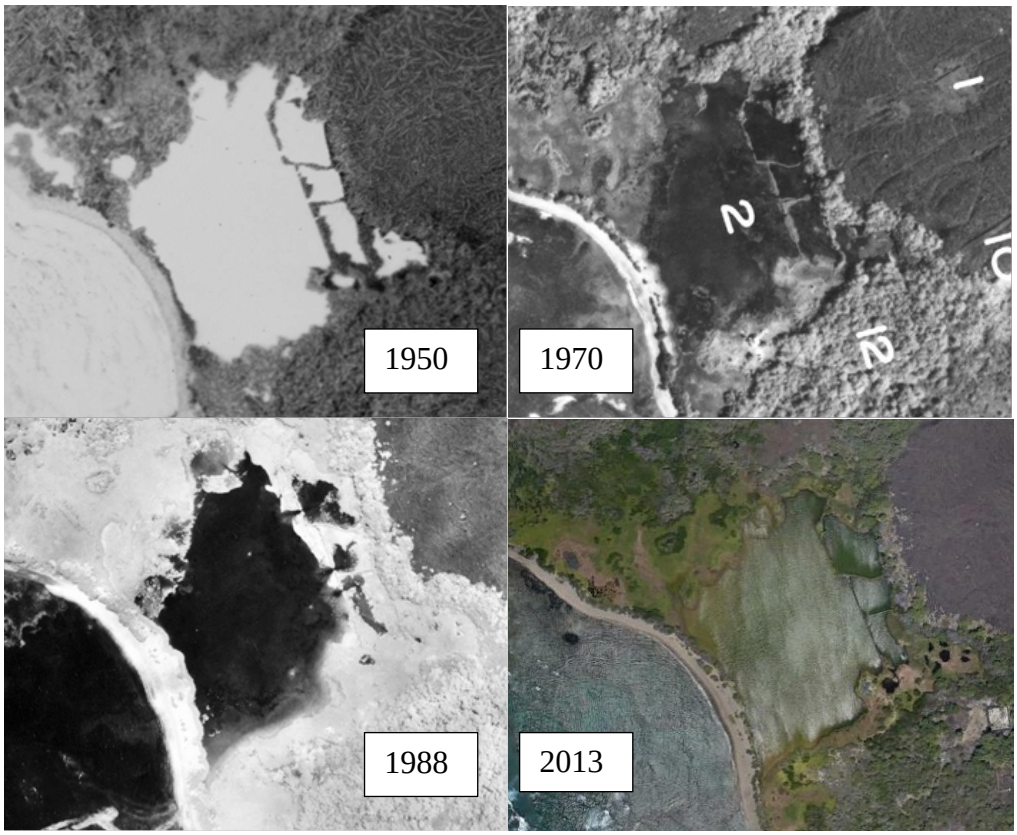


Figure 5. Historical aerial photographs of ʻAimakapā Fishpond showing gradual reduction of open water and mudflat habitats and encroachment by exotic invasive vegetation.

Anchialine Pools

In addition to the two fishponds, more than 180 anchialine pools have been identified within the Park, representing approximately 25% of pools estimated to occur in the state (Mitchell et al. 2005). Anchialine pools are small brackish coastal pools that lack a surface connection to the ocean but are hydrologically connected to groundwater and the ocean through a permeable aquifer (Holthuis 1973). These anchialine pools are significant biological and cultural resources within the Park, and are home to unique, endemic flora and fauna including three invertebrates, which are candidates for listing as endangered or threatened by the US Fish and Wildlife Service. Anchialine pools occur in the ʻAimakapā wetlands and on the margins. Anchialine pools adjacent to ʻAimakapā Fishpond occur on very flat pahoehoe and are unusual in their shallowness and strong tidally-driven surface area and salinity fluctuations (Maciolek and Brock 1973, 1974).

Anchialine pools are threatened statewide by the direct and indirect effects of coastal development, including nonpoint source pollution, interference with groundwater flows, introduction of invasive species (alien fish, prawns, insects, and vegetation) and possibly nighttime light pollution (Hoover and Gold 2005, USGS 2005). Climate change will

certainly cause pools to be lost and new pools to form inland (Marrack and O'Grady 2014). In the Park, bathing or swimming in anchialine pools, and Kaloko and ʻAimakapā Fishponds, is prohibited through the *Superintendent's Compendium* (NPS 2014).

Water Quality

The Park's inland waters are designated Class 1.a. under the State of Hawaiʻi water quality standards (Hawaiʻi Administrative Rules §11-54-3). They are subject to narrative (rather than quantitative) criteria with the objective to maintain their natural wilderness character with an absolute minimum of pollution from human caused sources, and to specify their protection for "*scientific and educational purposes, protection of native breeding stock, baseline references from which human-caused changes can be measured, compatible recreation, aesthetic enjoyment, and other nondegrading uses which are compatible with the protection of the ecosystems associated with waters of this class*" (HAR §11-54-4 (A)).

Park inland waters are in relatively good condition (Hoover and Gold 2005). However, they are at risk of degradation from nonpoint source pollution (e.g., Grossman et al. 2010, Knee et al. 2008, Oki et al. 1999, Parsons et al. 2008) and groundwater development (e.g., Duarte and Kauahikaua 1999, Grossman et al. 2010, Oki et al. 1999) associated with urban development and human activities upslope of, and adjacent to, the Park. Groundwater withdrawals from the aquifer system have doubled since 1986 while rainfall has been steadily declining and sea level has been rising over the past century in Hawaiʻi (Giambelluca et al. 2013, NOAA 2014). ʻAimakapā Fishpond is extremely vulnerable to changes in water quality and quantity because of lack of direct exchange with the marine environment and much longer residence time for groundwater inputs.

Groundwater pollutants include nutrients (e.g., nitrogen and phosphorus) that have the potential to enhance primary production (i.e., the growth of phytoplankton, micro- and macroalgae, and aquatic plants), and toxic pollutants that may interfere with biological activity (Hoover and Gold 2005). Within coastal ecosystems, increases in nitrogen and phosphorus often result in the expansion of aggressive nonnative wetland plants (Mitsch and Gosselink 2000, Vitousek et al. 1997) such as pickleweed (*Batis maritima*) and *Paspalum* grass, and increased algal biomass such as the nonnative alga *Acanthophora spicifera* in Kaloko. Nitrogen-related bursts of primary productivity often lead to episodes of oxygen depletion and eutrophication, which in turn can set up conditions for a disease outbreak. ʻAimakapā Fishpond was the site of an avian botulism outbreak in 1994 (Morin 1996a) and a fish kill in 2003, both of which may have been related (directly or indirectly) to low oxygen levels. Even if increased nitrogen inputs don't significantly increase rates of primary productivity, other effects might result from the changing nutrient subsidy, such as changes in the types and relative abundances of phytoplankton, macroalgae and aquatic plants, with attendant impacts on the pond ecosystem.

Groundwater withdrawals are also a water quality concern for Park water resources. The U.S. Geological Survey, using a numerical groundwater-flow model, predicted a 47%

reduction in freshwater coastal discharges and a subsequent 0.6 ft (0.18 m) decline in groundwater levels relative to 1978 values within the Park if all permitted wells as of 1998 were to operate at full capacity (Oki et al. 1999). Although salinity changes were not modelled, salinity is expected to increase as withdrawals increase (Oki et al. 1999).

Human activities influence water quality in a variety of ways: wastewater discharges increase nutrient concentrations; construction activities increase suspended sediment loads; agricultural operations deliver pesticides and harmful nutrients; and urban stormwater runoff contains pesticides, harmful nutrients, metals (lead, cadmium, copper, zinc, and others), oil, grease, and polycyclic aromatic hydrocarbons. Within the Park, pollutants from paved-parking lot runoff at the Visitor Contact station are captured in a drainage filtration device. Other parking areas within (Kaloko Fishpond) or adjacent to (Honokōhau Harbor) the Park are unpaved and oils and other fluids may drip from vehicles and adhere to the gravel. Gas-powered chainsaws used within the Park use biodegradable bar lubricant. Additionally, wash water for vehicles in the Park is recycled and hydrocarbons separated from the water. The NPS Inventory and Monitoring Program monitors water quality in the Park's anchialine pools, marine waters, and groundwater levels in wells on a quarterly basis.

Marine/Ocean Resources

The 600 ac (243 ha) of marine waters within the legislative boundary of Kaloko-Honokōhau NHP are under the jurisdiction of the United States (36 CFR 1.2(3)). The submerged lands within in the legislated boundary are owned by the State of Hawai‘i and are under the jurisdiction of the State Department of Land and Natural Resources. The Park marine waters are classified by the state as Class AA, which are "*waters to remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions.*" (HAR §11-54-3(c)(1)). Hawai‘i Administrative Rules also require that "*where high quality waters constitute an outstanding national resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected*." (HAR Section11-54-1.1(c)) Pursuant to section 303 (d) of the Clean Water Act, states are required to compile a list of waters that do not meet state water-quality standards. Waters off Honokōhau Beach do not meet State of Hawai‘i water quality standards for total nitrogen, total phosphorous, turbidity, nitrate-nitrite, ammonium, and phosphate. Waters from Pine Trees Beach in Kohanaiki *ahupua‘a* to Honokōhau also do not meet these standards. In 2008, the state listed the water quality of Park marine waters (Honokōhau Beach and Pine Trees – Honokōhau) as 303(d) "impaired" based on consistently elevated nutrient concentrations above state standards and these waters remain listed (Hawai`i DOH-CWB 2014). These increases in nutrient concentrations have been documented along with evidence of increased algal cover and coral decline (Parsons et al. 2008).

Special Status Species

Federally Listed Species

The Endangered Species Act (ESA) of 1973 was enacted to conserve species that have been identified as threatened or endangered as well as those ecosystems upon which the species depend. Endangered species are species that are in immediate danger of becoming extinct and need protection to survive; threatened species are those that are declining in numbers and may become endangered in the foreseeable future if conservation efforts are not immediately taken. NPS Management Policies (NPS 2006) require that these species will be managed in parks for their natural distribution and abundance. Thirteen species in the Park are listed as "threatened" or "endangered" under the ESA and three are considered "candidates" for listing (Table 1). The endangered *koloa*, (Hawaiian duck, *Anas wyvilliana*), has never been confirmed as sighted within the Park's wetlands (Morin 1998). Sightings reported in the early 1990s at ʻAimakapā were identified as a feral mallard (Morin 1996b). Listed species that could be affected by projects occurring at ʻAimakapā Fishpond and its immediate vicinity include Hawaiian coot (*Fulica alai*) and Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian hoary bat (*Lasiurus cinereus semotus*), Hawaiian monk seal (*Neomonachus schauinslandi*), and Hawaiian green sea turtle (*Chelonia mydas*).

Waterbirds

The endangered ʻ*alae keʻokeʻo* (Hawaiian coot, *Fulica alai*) is endemic to the Hawaiian Islands and was listed under the Endangered Species Act (ESA) in 1970. ʻ*Alae keʻokeʻo* were on the Hawaiʻi game bird list until 1939 (USFWS 2011b). Historically, this waterbird was likely common in large natural marshes and ponds, and in wetlands of constructed taro fields and fishponds. Hawaiians collected eggs from nests (USFWS 2011b). Hawaiʻi Island has few wetlands that support coots, ʻAimakapā and ʻŌpae`ula Ponds on the Kona Coast, and Waiākea and Loko Waka Ponds in Hilo. ʻAimakapā and Loko Waka are considered core wetlands for the recovery of the ʻ*alae keʻokeʻo* population (USFWS 2011b). The island supports a small breeding population of less than 100 birds (USFWS 2011b). Hawaiian coots breed year-round with peak breeding activity at ʻAimakapā April through July (Morin 1998, Waddington 2015b, pers. comm.). Coot nesting and reproductive success at ʻAimakapā have declined since the early 1990s (Morin 1998), with no nests recorded during monthly surveys in 2006 and 2010-2011 and no fledging chicks recorded between 2003 and 2012 (Waddington 2002-2015, Waddington 2015b pers. comm.; Appendix F). Possible reasons for this decline include: nests and fledging chicks may have been missed during surveys, inconsistency of predator control effort, and declining suitable breeding habitat at ʻAimakapā while the development of the Kealakehe wastewater treatment plant provided new, non-natural nesting habitat (Waddington 2015b, pers. comm.). Water salinity appears to be important in coot habitat selection. ʻ*Alae keʻokeʻo* prefer freshwater areas over brackish for nesting and are rarely found in saline habitats; likely because coots may be limited to freshwater by an inability to excrete excess salt at an efficient rate (USFWS 2011b). Additionally, salinity fluctuations may affect food availability for adults and chicks (USFWS 2011b).

Coots prefer open water, interspersed with emergent plants, that is less than 1 ft (30 cm) deep for foraging, but they can dive in water up to 4 ft (120 cm) deep. Coots obtain food near the water's surface and dive for aquatic plants (seeds and leaves) and invertebrates (including snails, crustaceans, and insects) and small fish (USFWS 2011b). Threats to the *'alae ke'oke'o* include loss of wetland habitat, introduced predator species, altered hydrology, habitat alteration by nonnative plants, disease (especially avian botulism), and environmental contaminants. In the Park, *'Alae ke'oke'o* may be preyed on by introduced predators, including cats, mongooses, rats, native and nonnative large fish, and cattle egrets (*Bubulcus ibis*), and predator control has a positive effect on reproductive success of both waterbird species at 'Aimakapā (Morin 1998). The indigenous black-crowned night heron, *auku'u* (*Nycticorax nycticorax*) may also be a predator of chicks (Pratt and Brisbin 2002). The USFWS (2011b) considers *'alae ke'oke'o* as having high potential for recovery. The North American Waterbird Conservation Plan considers the *'alae ke'oke'o* a species of high concern. The State population averages approximately 2,000 birds with a long-term slightly increasing population trend overall (USFWS 2011b). Criterion #1 for downlisting the *'alae ke'oke'o* is, "*All core wetlands* [including 'Aimakapā] *are protected and managed in accordance with the management practices outlined in* [the] *recovery plan*" (USFWS 2011b).

The endangered *ae'o* (Hawaiian Stilt, *Himantopus mexicanus knudseni*) is an endemic subspecies of the black-necked stilt and was listed under the ESA in 1970. Although populations have been stable for several decades, they remain at very low levels. *Ae'o* were scarce by 1900, likely due to loss of natural wetlands and aquatic agriculture lands (USFWS 2011b). A popular game bird, hunting contributed to local population declines until waterbird hunting was prohibited in 1939. Hawaiians traditionally hunted *ae'o*, though the flesh was apparently of little value for food (Henshaw 1902 cited in USFWS 2011b). The Kona Coast supports the largest number of *ae'o* on Hawai'i Island, and 'Aimakapā is considered a core wetland for the *ae'o* population recovery (USFWS 2011b). Stilts breed at 'Aimakapā February through September with a peak from March through July (Morin 1998, Waddington 2015b, pers. comm.). Nesting and successful reproduction at 'Aimakapā has declined since the early 1990s (Morin 1998), with no nesting recorded in 2006 and in 2009 to 2011, and no fledging chicks recorded between 2003 and 2013 (Waddington 2009, 2010, 2015b pers. comm.; Appendix F). Possible reasons for the decline include: nests and fledging chicks may have been missed during surveys, inconsistency of predator control effort, and declining suitable breeding habitat at 'Aimakapā while the development of new areas (e.g., Cyanotech Corp. and the Kealakehe wastewater treatment plant) provided non-natural nesting habitat (Waddington 2015b, pers. comm.). Adult stilts use habitats with a range of salinities (Robinson et al. 1999) but they nest more often and more successfully in freshwater (Nadig 2015, pers. comm.) and salinization of wetlands is a threat to stilt populations (Rubega and Robinson 1996). *Ae'o* generally nest in areas of low cover with low-growing vegetation combined with freshly exposed mudflats and, in 'Aimakapā, on islands or rock walls. Stilts are wading birds, feeding in shallow water up to about breast height. Chicks will swim from nest islands to foraging areas (Robinson et al. 1999). *Ae'o* opportunistically feed on a

wide variety of aquatic invertebrates (including water boatmen, beetles, brine fly larvae, polychaete worms, crabs) and small fish, which are an important part of their diet (Robinson et al. 1999, USFWS 2011b). Threats to the *ae‘o* include loss of wetland habitat, introduced predator species, altered hydrology, habitat alteration by nonnative plants, disease (especially avian botulism), and environmental contaminants (Robinson et al. 1999, USFWS 2011b). In the Park, *Ae‘o* may be preyed on by introduced cats, mongooses, rats, cattle egrets, native and nonnative large fish, and native *auku‘u*, (Robinson et al. 1999, USFWS 2011b). Predator control has a positive effect on reproductive success of both waterbird species at ‘Aimakapā (Morin 1998). The USFWS (2011b) considers *ae‘o* as having high potential for recovery. Statewide population estimates fluctuate between approximately 1,100 and 2,100 birds (USFWS 2011b). Criterion #1 for downlisting the *ae‘o* is, "*All core wetlands* [including ‘Aimakapā] *are protected and managed in accordance with the management practices outlined in* [the] *recovery plan*" (USFWS 2011b).

Hawaiian Hoary Bat

The endangered ‘*ōpe‘ape‘a* (Hawaiian hoary bat, *Lasiurus cinereus semotus*) is the only existing native terrestrial mammal known from Hawai‘i. Federally listed as endangered in 1970, threats to this species include habitat loss, roost disturbance, pesticide use on prey populations (direct and indirect), barbed-wire fences, wind farms, and potentially climate change; it is unknown if disease or predation are a significant threat (USFWS 2011a). Bats are solitary, roosting during the day, mainly in densely-leafed native and nonnative vegetation higher than 15 ft (5 m) (Bonaccorso 2011, pers. comm., USFWS 2011a). Hoary bats are rarely observed roosting in lava tubes, cracks in rocks, or man-made structures. They begin foraging either just before or just after sunset, primarily along watercourses, coastlines, and forest/pasture boundaries. Acoustic surveys were made in the Park on 15 nights between April and July in 2005 (Fraser et al. 2007) and 42 nights during bimonthly surveys between October 2011and September 2012 (Pinzari et al. 2014). In the Park, bats were active one to two hours after sunset with peak activity between six and eight PM. In both surveys combined, bats were detected in January, April, May, September, and October; none were detected in March or July. The breeding season for the hoary bat is generally April through August. In 2005, acoustic detections of bats in the Park consisted of foraging activity in a variety of habitats: over native and non-native shrub-land, roads and trails, and coastal water bodies (including ocean and brackish water pools) (Fraser et al. 2007). However in 2011-2012 all detected foraging was over the fishponds. Bat foraging calls were detected (14 call events) at the north shore ‘Aimakapā Fishpond recording station (no recording at south shore) in 2011-2012, and at Kaloko-Fishpond south shore (38 call events, Pinzari et al. 2014). In 2005, some calls were detected south of ‘Aimakapā near ‘Ai‘opio Fishtrap and Honokōhau Harbor (Fraser et al. 2007). The lower than expected number of detections in the Park throughout the breeding season suggests that the fishpond areas may not offer consistent levels of food and/or that bats may not be roosting in the Park because of lack of suitably large, densely-foliated trees (Pinzari et al. 2014). A year-round acoustic study by the USGS to collect baseline information on activity levels and annual variation in bat presence and insect prey in the Park recently concluded field work. Activities associated

with restoration and management of ‘Aimakapā wetlands are not likely to affect the bat because the timing of bat usage of the area (after sunset) does not coincide with daytime work hours, and suitable bat-roosting trees are not present in the wetlands area.

Hawaiian Monk Seal

The endangered Hawaiian monk seal, *‘Īlio-holo-i-ka-uaua* (*Neomonachus schauinslandi*) hauls-out onto beaches for resting, molting, giving birth or nursing (Antonelis et al. 2006, NMFS 2007). Although the monk seal is much less abundant in the main Hawaiian Islands compared to the Northwestern Hawaiian Islands (Antonelis et al. 2006, NMFS 2007), they do enter National Park waters and occasionally haul out on the shoreline to rest; potentially using ‘Aimakapā’s barrier beach for basking. Monk seals are solitary, and are threatened by human disturbance, especially mothers with pups. Pupping and nursing activity by monk seals has not been recorded within the Park. As main island populations increase, conflicts, and interactions with a variety of ocean and beach users are becoming more frequent and significant (Mitchell et al. 2005). Information on the use of Park waters and shoreline by the monk seal is through opportunistic sightings rather than systematic surveys. Seventy one opportunistic sightings have been recorded in the Park since 2003, (NPS unpub. data; Mercer 2015, *in litt*). The NPS coordinates with and reports monk seal sightings to the NOAA Fisheries. The NMFS has revised Hawaiian monk seal critical habitat (80 Federal Register 50925; August 21, 2015) to include areas in the Main Hawaiian Islands. The Park’s shoreline falls within the criteria essential to monk seal conservation and is included as critical habitat under the new revision. During restoration and management actions, all-terrain UTVs or other equipment may traverse the beach berm to access the *makai*, southern portion of the wetlands. Occurrence of seals in the park is rare; however, if a resting monk seal is encountered by crews on foot, by UTV, or other equipment when accessing the wetlands via the barrier beach berm, avoidance and minimization actions will be employed. The UTVs will not enter the area occupied by the seal and an alternate access route (from the main trail) will be used until the seal has returned to the ocean. Signs and barriers will be placed to keep visitors at distance away from a resting seal. Noise generated by the project will not affect resting seals because project noise levels will be primarily low and will generally be drowned-out by wave-action noise on the ocean side of the berm.

Marine Turtles

The Hawaiian green sea turtle, *honu* (*Chelonia mydas*), was listed as threatened under the ESA in 1978. Although the Northwestern Hawaiian Islands, primarily French Frigate Shoals, continue to be the main breeding area for the Hawaiian green turtle, nesting has occurred on some beaches in the main Hawaiian Islands (Maison et al. 2010); however, no green turtle nesting or attempted nesting has been recorded in the Park. The *honu* forages on marine algae around the main Hawaiian Islands (Arthur and Balazs 2008, Hirth 1997). At Kaloko-Honokōhau NHP, resident juveniles are regularly observed foraging in nearshore waters and basking on park beaches; however, mature adults have not been observed (NPS unpubl. data, NMFS unpubl. data). Disease (fibropaplloma tumors), direct take, fisheries incidental take, boat collisions, and nest predation are

primary threats to the Hawaiian green sea turtle (NMFS and USFWS 1998). The Park is one of the few areas in Hawai‘i where green sea turtles do not have fibropapilloma tumors. The turtles can be found throughout the Park’s waters, however the main areas of use by *honu* for foraging, resting, and basking on the shore are ‘Aimakapā’s barrier beach and the ‘Ai‘ōpio Fishtrap area in Honokōhau Bay. Park beachgoers are requested to keep a distance of at least 20 feet from turtles in the water and onshore. However, many basking green turtles appear habituated to passing human foot traffic and UTV traffic. Basking green turtles encountered by crews on foot, by UTV or other equipment when accessing the wetlands via the barrier beach berm will be avoided until the individual clears the area on their own.

The *honu ‘ea*, hawksbill sea turtle (*Eretmochelys imbricata*) lives around the main Hawaiian Islands but is rare. The hawksbill turtle was listed as endangered under the ESA in 1970. Beach development, predation, and harvesting for shells and eggs are responsible for its population decline (NMFS and USFWS 2013). Hawksbill turtles have been observed sporadically and opportunistically in Park waters by NPS and recreational divers, including repeat sightings of identified individuals. Although *honu ‘ea* occur in the Park’s offshore waters, they are not known to bask on Park beaches or elsewhere in Hawai‘i as do green turtles. No historic records have been found describing past nesting by *honu ‘ea* in the Park. The proposed action will not affect the hawksbill sea turtle because the species does not haul-out or nest in the project area.

Blackburn’s Sphinx Moth

The endangered Blackburn’s sphinx moth (*Manduca blackburni*) is known to occur near the Park (USFWS 2005); however, its status within the Park is unknown. The species is found in the dry to mesic habitats between the elevations of sea level and 5,000 ft (USFWS 2005). Threats to the moth include habitat loss, fragmentation, and degradation from urban and agricultural development, invasion by non-native plant species, non-native parasitoids and insect predators, over-collection (trade and personal collections), and increased wildfire frequency (Black 2005, USFWS 2005). Likely food sources for the adult moth are nectar from native plants including species in the genus *Ipomoea* (e.g., *koali ‘awa*), *ile‘e* (*Plumbago zeylanica*), *maiapilo* (*Capparis sandwichiana*); the larvae feed upon non-native tree tobacco (*Nicotiana glauca*) and the native *Nothocestrum breviflorum* (Black 2005, USFWS 2005). Several of these plant species occur within the Park; however, the larval host plants have not been reported in the Park (Canfield 1990, Cogan et al. 2011, Pratt and Abbott 1996), and none of the nectar-plant species have been found in ‘Aimakapā wetlands (Canfield 1990, Cogan et al. 2011, Pratt and Abbott 1996). Therefore, the proposed action will not affect the Blackburn’s sphinx moth larvae or adults.

Plants

Several species of endangered plants have been out-planted in the Park (Table 1). NPS Management Policies (NPS 2006) requires the NPS to manage out-planted species for their natural distribution and abundance. None of the out-planted endangered plant

species also currently occur naturally in the Park, although *loulu* (*P. affinis*) was found in the Park's pollen record (Athens and Ward 2006, Douglas and Hotchkiss 1998, Pratt 1998). The endangered *ko'oko'olau* (beggartick, *Bidens micrantha* ssp. *ctenophylla* ; listed under the ESA in 2013) was recorded by Pratt and Abbot (1996) and probably by Canfield (1990) as *B. hawaiensis* (Pratt and Abbott 1996). *Sesbania tomentosa* is planted as landscaping at the visitor contact station. Critical habitat was proposed for the *Bidens* and two other species on October 17, 2012 (77 Federal Register 63927), which would include parklands at elevation of 20 feet and above if established. The project area and access routes are below 20 ft elevation. Vegetation waste will be transported on existing park trails or via helicopter to an existing disturbed area where plant compost, chips, and green waste are staged above 20 ft elevation. No endangered plant species naturally exist or have been outplanted in the 'Aimakapā project area.

—This Section Intentionally Blank—

Table 1. Threatened, endangered, and candidate species at Kaloko-Honokōhau NHP.

English Common Name	*Hawaiian Name*	*Scientific Name*	*Listing Category*	*Status in Park / In Project Area*	*Taxa*
Anchialine pool shrimp	*ʻōpaeʻula*	*Metabetaeus lohena*	Candidate	Current / Yes	Crustaceans
Anchialine pool shrimp	ʻōpaeʻula	Palaemonella burnsi	Candidate	Current / Unknown, possible	Crustaceans
Green sea turtle	honu	Chelonia mydas	Threatened	Current / Hauls out on berm	Reptiles
Hawaiian coot	*ʻalae kea*	*Fulica americana alai*	Endangered	Current / Yes	Birds
Hawaiian hoary bat	*ʻōpeʻapeʻa*	*Lasiurus cinereus semotus*	Endangered	Current / Yes	Mammals
Hawaiian monk seal	*ʻĪlio-holo-i-ka-uaua*	*Neomonachus schauinslandi*	Endangered	Current / Possible haul out on berm	Mammals
Hawaiian stilt	*aeʻo*	*Himantopus mexicanus*	Endangered	Current / Yes	Birds
Hawksbill sea turtle	*honu* ʻea	*Eretmochelys imbricata*	Endangered	Current / No	Reptiles
Humpback whale	*kohola*	*Megaptera novaeangliae*	Endangered	Current / No	Mammals
Insular false killer whale		*Pseudorca crassidens*	Endangered	Current / No	Mammals
Hawaiian fan palm	*loulu*	*Pritchardia affinis*	Endangered	Outplant / No	Flowering Plants
Hawaiian orangeblack damselfly	*Pinao ʻula*	*Megalagrion xanthomelas*	Candidate (proposed for listing 9/3/2015)	Current / Yes	Insects
none	*Hala pepe*	*Pleomele hawaiiensis*	Endangered	Outplant / No	Flowering Plants
Beggartick	*koʻokoʻolau*	*Bidens micrantha ctenophylla*	Endangered	Outplant / No	Flowering Plants
none	*ohai*	*Sesbania tomentosa*	Endangered	Landscape Outplant / No	Flowering Plants
none	*uhiuhi*	*Mesoneuron kavaiensis*	Endangered	Outplant / No	Flowering Plants

Other Federally Protected Species and Species of Concern

Birds

The ‘*auku‘u*, (black-crowned night heron, *Nycticorax nycticorax hoactli*), and the *kolea* (Pacific golden plover, *Pluvialis fulva*,) as well as three other common migratory shorebirds (sanderling, ruddy turnstone, wandering tattler) are frequently seen in the Park (Table 2) and are protected under the Migratory Bird Treaty Act (MBTA). Threats to the ‘*auku‘u*, the *kolea*, and shorebirds include habitat loss or degradation, introduced predators, non-native invasive plants, avian diseases (most importantly avian botulism), and environmental contaminants (Engilis and Naughton 2004, Mitchell et al. 2005).

Table 2. Birds protected under MBTA, state recognized as indigenous, and commonly observed at Kaloko-Honokōhau NHP.

Common Name	Hawaiian Name	Scientific Name
Pacific Golden Plover	*Kolea*	*Pluvialis fulva*
Ruddy Turnstone	‘*Akekeke*	*Arenaria interpres*
Northern Pintail	*Koloa mapu*	*Anas acuta*
Northern Shoveler	*Koloa moha*	*Anas clypeata*
Sanderling	*Huna kai*	*Calidris alba*
Wandering Tattler	‘*Ulili*	*Heteroscelus incanus*
American Wigeon	none	*Anas americana*
Black-Crowned Night-Heron	‘*Auku‘u*	*Nycticorax nycticorax hoactli*

The ‘*auku‘u* is indigenous in Hawai‘i and uses shallow wetlands for foraging and captures insects, fish, frogs, mice, and the young of other native waterbirds (Mitchell et al. 2005). Unlike continental night-herons, the species is diurnal in Hawai‘i (Mitchell et al. 2005). According to Mitchell et al. (2005), information on breeding in Hawai‘i is limited, but in North America breeding occurs from December to August. Eggs are laid in a bulky stick nest usually placed low in vegetation (Mitchell et al. 2005). Morin (1996b) reported a single family-group in the Park in 1992 and 1993. On Hawai’i Island, where wetland habitats are sparser than on the other older islands, the maximum number of ‘*auku‘u* counted number 57 from August 2006 (Pyle and Pyle 2009). Threats to

‘*auku‘u* include habitat loss, introduced predators, nonnative invasive plants, disease, and environmental contaminants.

The migratory Pacific golden plover (*kolea; Pluvialis fulva*) is indigenous to Hawai‘i and is listed in the U.S. Shorebird Conservation Plan as “high concern” (Engilis and Naughton 2004). The species is also listed as “least concern” on the International Union for Conservation of Nature’s (IUCN) Red List of Threatened Species (IUCN 2015). The *kolea* breeds in Siberia and westernmost Alaska, and occupies Hawai‘i from late summer to late spring, foraging in natural areas such as crop fields, pastures, coastal salt marshes, mudflats, beaches, grassy areas in urban locations and woody areas (Mitchell et al. 2005). The ruddy turnstone (*A. interpres*) and the wandering tattler (*H. incanus*) have also been identified as “high concern” and “moderate concern,” species respectively by the U.S. Shorebird Conservation Plan. These bird populations in Hawai‘i are important because they are hemispherically significant or relatively large (Engilis and Naughton 2004). The black-crowned night heron, the Hawaiian stilt, and the migratory shorebirds (e.g., wandering tattler, Pacific golden plover, ruddy turnstone, and sanderling) use the Park’s shoreline habitat at Kaloko Fishpond, Honokōhau Bay, and the rocky intertidal beach areas of the Park for feeding including Honokōhau Reef (Morin 1996b, Waddington 2002-2015). The plover and ruddy turnstone are occasionally seen inland of the ‘Aimakapā wetland foraging in the duff along the Ala Hele Ike Hawai‘i Trail. Modern threats to shorebirds in the Pacific Islands include: urban, industrial, military, agricultural, and recreational development (loss of habitat); introduction of invasive, non-native plants (degradation of habitat) and non-native animals (predation, disease, competition); human disturbance; and contaminants (sewage discharge, oil spills, radioactive wastes, pesticides). Conservation and restoration of shorebird habitats in the U.S. Pacific Islands is a growing effort and essential for the protection of endangered and declining shorebird populations. Wetlands, beach strand, coastal forests, and mangrove habitats are particularly vulnerable on Pacific islands due to increasing development pressures and already limited acreage. Modified habitats, such as pastures, urban grass parks, and golf courses provide habitat for wintering shorebird species across the Pacific Islands.

Several other species of migratory waterfowl, which are protected under the MBTA, have been known to winter at ‘Aimakapā Fishpond (see Morin 1996b, and Waddington 2002-2015). These include *koloa māpu* (northern pintail; *Anas acuta*), *koloa moha* (northern shoveler; *Anas clypeata*), pied-billed grebe (*Podilymbus podiceps*) American wigeon (*Anas americana*), lesser scaup (*Aythya affinis*), green-winged teal (*Anas carolinensis*), semipalmated plover (*Charadrius semipalmatus*), and blue-winged teal (*Anas discors*). Blue-winged teal produced young at ‘Aimakapā in 1982 and 1983, the first breeding records of migratory waterfowl in the Hawaiian Islands (Paton et al. 1986). The Ruff (*Philomachus pugnax*) ring-necked duck (*Aythya collaris*), and tufted duck (*Aythea fuligula*) have been observed in the Park. A variety of other uncommon, rare and “accidental” sightings of bird species have been recorded over the years and can be found in the Park publication, *Check List of the Birds of Kaloko-Honokōhau NHP*, and Morin (1996b). Oral histories recount that area residents ate the “foreign kind” ducks, not *koloa* (*Anas wyvilliana*), that utilized the fishponds (Maly and Maly 2002). They would see

hundreds of them coming in from the ocean side in November to mingle with the coots. *"Now they don't even come."* … *"Sometimes you would find nene here. . . . It's too bad the ducks stopped coming and the nene. Now just ʻalae keʻokeʻo.*" (Maly and Maly 2002:327).

Wedge-tailed shearwaters, *ʻuaʻu kani* (*Puffinus pacificus*) have been recorded in the Park in the past, and nesting activity may have occurred. Several unattended burrows were discovered near the coastal trail and Huehue Trail intersection prior to the breeding season in 2003, but these were washed away by a storm-surge and high-wave event in January 2003. Since 2003, no new burrows have been recorded in the Park.

Invertebrates

Several anchialine pools are in or adjacent the ʻAimakapā wetlands. Three invertebrate species listed as candidate for protection under the ESA within the Park are associated with anchialine pool habitat: the *pinao ʻula*, (orangeblack Hawaiian damselfly, *Megalagrion xanthomelas*), and two caridean shrimp *ʻōpaeʻula* (*Metabetaeus lohena*, and *Palaemonella burnsi*). *Pinao ʻula*, and *M. lohena*, are also associated with the ʻAimakapā wetlands and pools (Foote 2015 pers. comm., Maciolek and Brock 1974). All *Megalagrion* sp. damselflies are endemic to Hawaiʻi (Polhemus and Asquith 1996) *Pinao ʻula* were once the most abundant species of damselfly (Polhemus 1993, 1995). Due primarily to habitat loss, *pinao ʻula* distribution and abundance have substantially declined from most low elevation areas in the state (Englund 1999). Known populations of the orangeblack Hawaiian damselfly (*M. xanthomelas*) occur along the Kona Coast, including within Kaloko-Honokōhau (Polhemus 1995).

The anchialine pool shrimp occupy both hypogeal (subterranean) and epigeal (surface) waters. Additional threats to these candidate invertebrate species include loss of pool habitat from coastal development, degradation of habitat from invasive species (nonnative fish, prawns, insects, and vegetation), nonpoint source pollution, and possibly nighttime light pollution (Hoover and Gold 2005, Tango et al. 2012, USGS 2005).

Plants

The *maiapilo* (Hawaiian native caper, *Capparis sandwichiana*) is an endemic shrub that grows in dry, coastal habitats within the Park. *Maiapilo* distribution is widespread throughout the Park (Canfield 1990, Pratt and Abbott 1996), and it is abundant in the Park relative to adjacent areas outside the Park boundary. *Maiapilo* is listed on the IUCN Red List as "vulnerable, (IUCN 2015) and is considered a species of concern by the USFWS because of habitat loss; however it is not presently a candidate for listing. It has been considered "vulnerable" since 1999 (Wagner et al. 1999). *Maiapilo* are not located within the ʻAimakapā wetland, small numbers of *maiapilo* may be scattered at the western edge of the project area and can be expected to increase and spread further following nonnative plant control.

Wildlife

The only remaining native, resident birds in Kaloko-Honokōhau are the waterbirds, the endemic *ae‘o* (Hawaiian stilt, *H. mexicanus knudseni*) and the *‘alae ke‘oke‘o* (Hawaiian coot; *F. alai*), and the indigenous *‘auku‘u* (black-crowned night heron; *N. nycticorax hoactli*) (Morin 1996b). These species along with protected migratory waterbirds, Hawaiian hoary bat, marine turtles, candidate anchialine-pool invertebrates, and marine mammals are described and analyzed in the *Special Status Species* section.

Birds

The native *pueo* (Hawaiian short-eared owl; *Asio flammeus sandwichensis*) and nonnative barn owl (*Tyto alba*) are uncommon in the Park. Common non-native terrestrial bird species at Kaloko-Honokōhau include the Japanese white-eye (*Zosterops japonicas*), house finch (*Carpodacus mexicanus*), nutmeg mannikin (*Lonchura punctulata*), common myna (*Acridotheres tristis*), yellow-billed cardinal (*Paroaria capitata*), northern cardinal (*Cardinalis cardinalis*), zebra dove (*Geopelia striata*), spotted dove (*Streptopelia chinensis*), yellow-fronted canary (*Serinus mozambicus*), saffron finch (*Sicalis flaveola*), red-masked parakeet (*Aratinga erythrogenys*) and francolins (*Francolinus pondicerianus* and *Francolinus francolinus*).

The nonnative cattle egret (*Bubulcus ibis)* is regularly seen perched in *milo* trees and foraging in the *Paspalum* meadows in the Park and at ‘Aimakapā (Morin 1998, Waddington 2002-2012) and its numbers are increasing. Introduced to Hawai‘i in 1959 to control insect pests associated with cattle, the cattle egret’s adaptability, and strong dispersal ability (Arendt 1988) has enabled its spread throughout the islands. Unlike most herons, it is typically found in fields and dry grassy habitats, exploiting agricultural areas, and urban areas including lawns and golf courses (Telfair 2006). They nest in colonies, which are not always found around bodies of water, and have recently been recorded nesting in the Park at ‘Aimakapā and ‘Ai‘ōpio. Cattle egrets are considered active, voracious feeders (Telfair 2006) and may compete with endangered waterbirds at ‘Aimakapā for native invertebrate food resources. Readily adaptable to what food is locally available, they feed particularly on insects, but also spiders, frogs, earthworms, crustaceans, fish, and birds (including eggs and nestlings) (Telfair 2006). In Hawai‘i, cattle egrets are known to prey on and young stilt chicks (Silbernagle 2010, pers. comm.). They have been linked as a vector in the spread of parasites and disease organisms to livestock, wild birds, domestic fowl, and people (Telfair 2006). The cattle egret is listed as a species of “Least Concern”, by IUCN; its global population is an estimated 3.8–6.7 million and is increasing (IUCN 2015). The USFWS is currently considering authorizing the control of cattle egrets by certain authorized agencies without permits in Hawai‘i for the protection of native threatened and endangered species (78 Federal Register 69593, November 4, 2013).

Reptiles and Amphibians

Marine turtles are discussed in the *Special Species* section. There are no native terrestrial amphibians or reptiles on the Hawaiian Islands. A 2007 herpetological inventory of the Park (Bazzano 2007) identified seven species of herpetofauna from three different families. No amphibians or reptiles were found on transects skirting the west, south and east sides of the ʻAimakapā wetland, and no transects within the wetlands were surveyed. The coqui frog (*Eleutherodactylus coqui*) has been reported in nearby areas but is not known to exist in the Park. Jackson's chameleon (*Chamaeleo jacksonii xantholophus*) and brown anole (*Anolis sagrei*), which are nonnatives of concern known from the west side of Hawaiʻi Island, were not found during the survey.

Invertebrates

The Park's fishponds and anchialine pools support a distinctive assemblage of aquatic invertebrates. Native ʻ*opaeʻula*, (red shrimp; *Halocaridina rubra* and *Metabetaeus lohena*), grapsid crabs, amphipods, snails (*Theodoxus* spp.) and undescribed invertebrate species inhabit the anchialine pools. Over-collection of ʻ*ōpaeʻula* for the aquarium trade is an emerging issue that may be a threat to these shrimp in the future. Maciolek and Brock (1974) identified a limited aquatic invertebrate community in ʻAimakapā Fishpond, including one species of oligochaete (worm), two mollusks (snail), one amphipod (crustacean), two decapods (crustacean), and two insect species. Nico et al. (2014 *in litt*) recorded a total of 32 aquatic macroinvertebrate taxa were collected in 2012 within the ʻAimakapā complex, including 27 different taxa of insects, three crustaceans, and two mollusks. Of these 32 macroinvertebrates, 13 (41%) are considered native species (including some Hawaiian endemics), 17 (53%) are non-native species, and 2 (6%) of undetermined biogeographic origin. Various terrestrial invertebrate species also occur at ʻAimakapā, including many arthropods (bees, wasps, beetles, and ants). The native ʻ*opae huna* (feeble shrimp, *Palaemon debilis*) has been consistently reported in good numbers in Kaloko and ʻAimakapā Fishponds (MacKenzie and Bruland 2012).

Fishes

The primary fish cultured in Hawaiian fishponds—ʻ*amaʻama* (striped mullet, *Mugil cephalis*), *awa* (milkfish, *Chanos chanos)*, and *āhole* (Hawaiian flagtail, *Kuhlia sandvicensis)* —are catadromous, spawning in the ocean, then seeking out brackish estuaries in which to mature. Culturally important native fish are found in both ʻAimakapā and Kaloko Fishponds. In Kaloko are ʻ*amaʻama*, *awa*, *āholehole*, and ʻ*oʻopu akupa* (*Eleotris sandwicensis*) among others. Kaloko is open to the sea through two ʻ*auwai* (sluice gates). An assemblage of common nearshore reef fish as well as the predatory barracuda (*kaku, Sphyraena barracuda*) enters the pond through these openings. ʻAimakapā also contains ʻ*awa* and ʻ*amaʻama* but today has no opening to the sea. Morin (1996a) reports *palani* (eyestripe surgeonfish, *Acanthurus dussumieri*) and "balloon fish" (possibly *Diodon holocanthus*) were found dead on the shores at ʻAimakapā in 1994 and 1995. A recent fish survey by USGS *(*Nico et al. 2014, *in litt*) also found an *omilu* (bluefin trevally, *Caranx melampygus*) in the pond, which may have

been introduced by a shoreline fisherman. Little appears to be known about ‘Aimakapā’s historic fish production. Oral histories recount that ‘Aimakapā keepers kept and harvested ‘*ama‘ama*, *awa*, *moi*, and ‘*ō‘io* (Maly and Maly 2002:325). In fishpond aquaculture, fry were released into or allowed to enter fishponds to feed on the productive food web of the pond (Kelly 1971). Entering a pond along with the desirable fry species through *māk*ā*hā*, were the fry of predators like the *awa awa* (Hawaiian ladyfish, *Elops hawaiensis*), *kaku* (*S. barracuda*), ‘*o‘io* (bonefish, *Albula vulpes*), and others, which fed on small fish, eels, and crustaceans. These carnivores also fed on the young of ‘*ama‘ama* and *awa* and so were actively controlled (Hiatt 1947 in Kelly 1971).

Nonnative Fishes

The numbers of highly invasive nonnative fish species in Hawaiian wetlands are increasing and nonnatives are fast becoming the dominant group (MacKenzie and Bruland 2012). Nonnative species in the Park fishponds include mosquito fish (*Gambusia affinis*) and guppies (*Poecilia reticulata*) in ‘Aimakapā and mosquitofish in Kaloko. Non-native fishes prey on native fishes, compete with them for food and habitat resources, carry introduced parasites that affect viability and reproduction in native fishes, and degrade habitat and water quality, potentially excreting 15 times more total dissolved nitrogen than native fishes (MacKenzie and Bruland 2012). Guppies and tilapia can spawn year-round in Hawai‘i and are omnivorous feeders, giving them an advantage over native fish when invading a new area (MacKenzie and Bruland 2012).

In 2007, MacKenzie and Bruland (2012) found that of 38 wetlands sampled across the main Hawaiian Islands, ‘Aimakapā and Kaloko Fishponds were two of only eight wetlands dominated by native species; specifically ‘*opae huna* (feeble shrimp; *Palaemon debilis*). Within two years, however, nonnative guppies had become the dominant species at ‘Aimakapā. Prior to 2008, ‘Aimakapā Fishpond was free of nonnative Mozambique tilapia (*Oreochromis mossambicus*); however it was subsequently introduced to the pond by unknown persons and first recorded by MacKenzie and Bruland (2012). Whether the introduction was deliberate or accidental is unknown.

Mozambique tilapia is one of eight fish species on the IUCN list, *100 of the World’s Worst Invasive Alien Species* (Lowe et al. 2004). Tilapia is very salt-tolerant; able to spawn and grow in water from 0-49 ppt salinity (full-strength seawater is 35 ppt) and survive up to 120 ppt (Nico and Neilson 2015). They reach sexual maturity in just two to three months, after which they can breed every 3-6 weeks under warm-water conditions, quickly out-competing native fish for food and breeding space. Various species and hybrids of tilapia now dominate estuarine regions in Hawai‘i, and are directly associated with the decline of native ‘*ama* ‘*ama* and *awa* by preying on their young, competing for food, disturbing their bottom habitat, and displacing them from preferred habitats (Eldredge 1994, Jenkins A. P. et al. 2009, Nelson and Eldredge 1991, Spennemann 2002). Harmful effects on waterbirds also have been reported following invasion by Mozambique tilapia (Diamond 1984, Eldredge 2000, Lever 1996, Stinson et al. 1991). In California’s Salton Sea, high numbers of dead and sick Mozambique Tilapia harboring type-C of the bacterium *Clostridium botulinum* were considered a main culprit in a 1996

avian botulism outbreak that killed over 15,000 pelicans and other fish-eating birds, including numerous Black-necked Stilts *Himantopus mexicanus* (Nol et al. 2004, Rocke et al. 2004). At least one major avian botulism outbreak occurred at ʻAimakapā prior to introduction of Mozambique Tilapia (Morin 1996a). The current presence and abundance of Mozambique tilapia in ʻAimakapā likely increases the risk and severity of avian botulism outbreaks (see Rocke and Friend 1999). At ʻAimakapā Fishpond, Mozambique tilapia are competitors with waterbirds and native fish for food including native aquatic invertebrates, and plants (e.g., *Ruppia maritima*).

Mammals

Hawaiʻi's two native mammals, the Hawaiian hoary bat, and the Hawaiian monk seal are discussed in the *Special Status Species* section. The most noticeable nonnative, terrestrial mammal in the Park is the small Indian mongoose (*Herpestes javanicus*; Synonym: *Herpestes auropunctatus*) a disastrous introduction to the islands in the 1800s that has played a part in upsetting the fragile terrestrial ecosystem of Hawaiʻi. In addition to the mongoose, feral cats (*Felis catus*) are in the Park. Mongoose and feral cats are significant and devastating predators of the Park's native wildlife; preying on the eggs and young of waterbirds. Feral cats also impact native wildlife by transmitting disease (Duffy and Capece 2012). Mice (*mus musculus*) and rats (*Rattus* spp.) are in the Park, and rats may prey on waterbird eggs or chicks. Pet dogs, and occasionally, feral dogs (*Canis lupus familiaris*), have been known to harass the endangered waterbirds and basking green sea turtles within the Park. Feral goats and pigs, which cause major problems throughout the Hawaiian Islands by disrupting ecological processes, are currently uncommon in the Park. On rare occasions single feral pigs (*Sus scrofa*) and feral goats (*Capra hircus*) have been discovered in the Park and immediately removed. Most recently, in 2010, a pig was discovered rooting in ʻAimakapā wetlands and the Honokōhau restoration areas and was removed from the Park. The small Indian mongoose, feral cat, feral goat, and black rat are each on the on the IUCN list, *100 of the World's Worst Invasive Alien Species*, because of their serious impact on biological diversity and/or human activities (Lowe et al. 2004).

Mongoose and feral cats are live-trapped in the Park on an on-going basis and effort is increased during waterbird breeding season. Trapping of small-mammal predators is successful at removing animals in the short term. Live-trapping programs are expensive and labor-intensive because traps need to be checked daily, and programs need to operate almost constantly as mongooses and feral cats re-colonize trapped areas very quickly (Duffy and Capece 2012, Hays and Conant 2007). Toxin-free humane instant-kill traps deployed within wetlands must also be checked daily to guard against avian botulism.

Vegetation

Vegetation is a biological resource that includes both terrestrial and aquatic plant species, which can also create or destroy unique or important wildlife habitat. Management Policies (NPS 2006) require maintenance of native communities of plants, including their natural abundance, diversity, and ecological integrity. Restoration and management of

the ‘Aimakapā wetland requires the eradication and control of nonnative plant species, and the protection of rare and culturally-important plant species. Proposed actions will affect vegetation and vegetative communities, which, in turn, will affect and improve habitat quality for native wildlife.

The vascular plants of Kaloko-Honokōhau National Historical Park have been well documented. Surveys were completed in 1987 (Canfield 1990) and in 1992-1993 (Pratt and Abbott 1996). ‘Aimakapā’s wetland habitats were partially covered by these surveys. Plant lists resulting from these surveys were summarized and revised in the Park’s vegetation management plan (Pratt 1998). Cogan et al. (2011) recently prepared a GIS-based vegetation inventory and map (2008 data) for the Park. In total, 130 plant species have been recorded through surveys and incidental encounters within Kaloko-Honokōhau NHP since 1987, though not all species are currently present. Cogan et al. (2011) classified and mapped 14 vegetation types (plant communities) but did not complete detailed surveys as part of that effort.

A study of pollen collected from cores of sediment in ‘Aimakapā Fishpond suggests that pre-human vegetation assemblage in the area of the Park was an open forest with shrubby understory (Athens and Ward 2006). The dominant trees were *loulu* palms (*Pritchardia sp*.) and a type of *Euphorbia* (possibly *E. haeleeleana*) with an understory of *Chenopodium* (probably *āheahea Chenopodium oahuense*), ‘*akoko* (*Chamaesyce sp.*) and *ilima* (*Sida sp*.) shrubs, some grass and other taxa (Athens and Ward 2006). According to the pollen record in the sample cores, the *loulu* forest rapidly declined in the years following human (Polynesian) settlement on Hawai'i Island and the landscape became much more open (Athens and Ward 2006). By the middle to late 19th century, historically introduced (since 1778) plants, begin to dominate the pollen assemblage including *kiawe* (*Prosopis pallida)*, ironwood (*Casuarina equisetifolia*; though none are found in parklands), and pickleweed (*Batis maritima*; Athens and Ward 2006).

Vegetation within the Park is now dominated by nonnative species several of which pose a significant threat to archeological sites: *kiawe* (*Prosopis pallida*), Christmas berry (*Schinus terebinthifolius*), *koa haole* (*Leucaena leucocephala*), sour bush (*Pluchea indica*), *klu* (*Acacia farnesiana*), pickleweed (*Batis maritima*) and seashore paspalum (*paspalum sp.*). In the 1980s and 1990s, the nonnative red mangrove (*Rhizophora mangle*) invaded and damaged park wetlands and adjacent archeological remains. The NPS performed aggressive eradication measures on the red mangrove, removing it from approximately 5 ac (2 ha) in both the Kaloko and northern ‘Aimakapā wetlands (Fronda et al. 2008, Pratt 1998). Monitoring and removal of seedling mangrove in both wetlands is ongoing. Large-scale tree removal of nonnative *kiawe* (mesquite; *Prosopis pallida*) was completed from the southeastern margin of ‘Aimakapā in the 1990’s (Pratt 1998).

Situated on the coast with shoreline *kiawe* and *milo* forest to the north and south, ‘Aimakapā’s wetland marsh habitats are currently dominated by nonnative seashore paspalum (*Paspalum vaginatum*) and pickleweed (*B. maritima*) with scattered Polynesian-introduced *milo* (*Thespesia populnea*) invading walls and *pahoehoe*. However, a number of native species persist in the wetland including ‘*ākulikuli*

(*Sesuvium portulacastrum*), *ōhelo kai* (*Lycium sandwicense*), the sedges *makaloa* (*Cyperus laevigatus*) and *kaluhā* or *makai* (bulrush, *Bolboschoenus maritimus*), *'ae'ae* (water hyssop *Bacopa monnieri*), and the aquatic grass (*Ruppia maritima*). Pratt and Abbot (1996) reported extremely low numbers of the sedges *Cyperus polystachyos* (previously *Pycreus*) and *mau'u 'aki'aki* (*Fimbristylis cymosa*) immediately south of 'Aimakapā. 'Aimakapā's terrestrial communities include a forest of *hau* (*Hibiscus tiliaceus*) and *milo* with Christmas berry shrubs and very little ground cover, a *milo* forest with a ground cover of native seashore paspalum (*Paspalum vaginatum*) and nonnative pickleweed (*Batis maritima*), and an open marsh of *Paspalum* with scattered *milo*, *hau*, and patches of pickleweed (Pratt and Abbott 1996). Several other marsh subtypes or associations were observed nearby by Pratt and Abbot (1996), but were not surveyed. Canfield (1990) also described a meadow community characterized by native *'ae'ae* (water hyssop, *Bacopa monnieri*) and *makaloa* sedge (*Cyperus laevigatus*) north of 'Aimakapā Fishpond that was not intersected by Pratt's transects.

Milo, and less so *hau*, *kou* (*Cordia subcordata*), and *naupaka* (*Scaevola sericea*), are the dominant vegetation along the interior edge of the 'Aimakapā barrier beach. *Pōhuehue* (beach morning glory, *Ipomoea pes-caprae*) and the beach vine *pā'ū o Hi'iaka* (*Jacquemontia ovalifolia sandwicensis*) are also on the beach strand and northern perimeter of the pond. Coconut palms (*Cocos nucifera*), a Polynesian introduction, are very sparse in the vicinity of 'Aimakapā Fishpond and are only present on the barrier beach; those that are present are young trees. Fountain grass (*P. setaceum*) is common at the top edge of the lava flow above 'Aimakapā Fishpond, and a patch also occurs just inland at the south side of the pond.

Cultural Resources

Area of Potential Effects for Cultural Resources

Kaloko-Honokōhau National Historical Park is also a designated National Historic Landmark (NHL), the Honokōhau Settlement NHL (NPS 1962). Both the NHL and the Park are included on the National Register of Historic Places (1966 and 1978 respectively) under Criterion D (Information Potential). The NHL nomination for the Honokōhau Settlement NHL is in the process of being updated to include an updated, detailed, and accurate description of the significance, context, integrity and description of the resources within the Honokōhau Settlement NHL. Thus, all archeological sites within the boundaries of the Park and NHL are eligible for the National Register as contributing elements, and have the potential to be affected by the plan for restoration and management of 'Aimakapā wetlands. The NPS initiated consultation with the Advisory Commission on Historic Properties (ACHP) and the Hawai'i State Historic Preservation Division (SHPD) in March 2013 (NPS 2013b), and also notified them of the development of this Management Plan/EA. In November, 2015, the NPS submitted a determination of No Adverse Effect to Historic Properties (NPS 2015a) to the SHPD for review and concurrence .

Within the boundaries of Kaloko-Honokōhau National Historical Park, evidence of the traditional Hawaiian culture that once thrived here is abundant. The cultural landscape, archeological sites, and ethnographic resources within the Park represent a wide range of the diverse aspects of Hawaiian culture, including societal organization and leadership, agriculture, aquaculture, religion, recreation, housing, and burial practices. These sites represent not only pre-contact Hawaiian culture, but also the changes that took place in that culture over time during post-contact. The following definitions are used to discuss cultural resources.

Archeological Resources- Archeological resources are the physical evidences of past human activity, and its effects on the environment. Archeological resources are significant based on their identity, age, location, and context in conjunction with their capacity to reveal information. They represent both traditional and historic periods and are found above and below ground, and underwater. Examples of traditional archeological resources in the Park include *heiau* (temples), petroglyphs, fishpond walls, platforms, trails, and midden deposits. Examples of historic archeological resources in the Park include fishpond walls, remnants of historic fishing villages, historic trash dumps, a historic church site, ranch walls, trails, and house sites.

Ethnographic Resources- Ethnographic resources may be any "*site, structure, object, landscape or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it*" (NPS 1998). Ethnographic resources are important to a people's sense of purpose or way of life and are understood from the viewpoint of peoples or groups for which they have a special importance different from that enjoyed by the public. ʻAimakapā Fishpond is an example of an ethnographic resource within Kaloko-Honokōhau.

Cultural Landscapes- A cultural landscape is "*a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values*" (NPS 1998). ʻAimakapā Fishpond is a significant component of the larger cultural landscape encompassed by the Park and NHL. A Cultural Landscape Inventory for the Park is planned for 2017.

Previous archeological surveys documented the historic properties within the area of potential effect (APE) at length (Ching and Rosendahl 1968a, 1968b, Cluff 1971, Cordy et al. 1991, Durst and Glidden 1999, Emory and Soehren 1971, Nelson and Gmirkin 2001, O'Hare and Goodfellow 1992, Reinecke 1930, Renger 1970, 1974, Stasack and Stasack 2001, Stasack et al. 2003, Stasack and Stasack 2004a, 2004b, 2005a, 2005b, 2007, in prep.-a, in prep.-b, in prep.-c, Tomonari-Tuggle and Tuggle 2006a, 2006b, Walsh and Hammatt 1995). To date, 461 archeological sites have been recorded in the APE (entire Park). Undoubtedly, many more terrestrial and submerged sites remain unrecorded and will be documented as the overgrowth of nonnative vegetation is removed. These sites substantiate significant traditional and historic Hawaiian occupation of this area. The area was used by *makaʻāinana* (common people), and *aliʻi*

(chiefs, nobles) until the late nineteenth century (Tomonari-Tuggle and Tuggle 2006a, 2006b).

The traditional Hawaiian economy was based on agriculture, aquaculture, and fishing (Greene 1993). This land use was tied to a system of land divisions, *ahupuaʻa*, that ran from the forested uplands, across agricultural lands, and down to the coast and sea. The coastal and seaward portions of the *ahupuaʻa* of Kaloko and Honokōhau are within the boundaries of the Park, as are parts of the lower portions of the *ahupuaʻa* of Kealakehe and Kohanaiki. The *ahupuaʻa* concept is an important component of Hawaiian land use, subsistence practices, and societal organization from prehistoric through modern times.

Among the significant and unique ethnographic and archeological sites in the Kaloko-Honokōhau cultural landscape are the three aquaculture ponds: Kaloko and ʻAimakapā Fishponds, and the ʻAiʻōpio Fishtrap. These fishponds "*still represent the finest example of the ancient Hawaiian ability to adapt to their physical environment*" (Hono-kō-hau Study Advisory Commission 1974). They were a significant asset for people living on the arid Kona coast, providing a dependable source of food for royalty and commoners alike, and their size and location encouraged settlement and development in the area (Greene 1993). The fishponds played important roles in the culture of the original inhabitants and "*great care was taken to keep them intact and clean and clear of overgrowth*" (Hono-kō-hau Study Advisory Commission 1974).

The *ahupuaʻa* of Kaloko and Honokōhau with their large fishponds are intertwined with the history of the Hawaiian Kingdom (Emory and Soehren 1971, Tomonari-Tuggle and Tuggle 2006a, 2006b, Wyban 1996). Their importance was reflected in the Great Mahele (1948) when Kaloko, with its fishpond, was set aside for Kamehameha V, the grandson of Kamehameha the Great. Honokōhau Nui (large), with ʻAimakapā Fishpond, was set aside for Kekauʻonohi, a cousin of Kamehameha V and a granddaughter of Kamehameha the Great. Honokōhau Iki (small), and its fishtrap, ʻAiʻōpio, was set aside for Leleiohoku, the husband of Princess Ruth Keʻelikolani, great granddaughter to Kamehameha the Great (Emory and Soehren 1971, Tomonari-Tuggle and Tuggle 2006b).

Kaloko Fishpond (12 ac; 4.8) is a *loko kuapā*-type pond, a natural embayment separated from the sea by a massive, 800-ft long constructed seawall (*kuapā*). The *kuapā* is an excellent example of the engineering skill of the ancient Hawaiians. Many archeological sites surrounding Kaloko Fishpond indicate significant human occupation and include habitation sites, burial grounds, and petroglyph fields. The Kaloko Fishpond was managed as a functioning aquaculture fishpond until the late 1950s but by 1961, it was in disrepair (Bond and Gmirkin 2003). Oral histories and ethnographic studies indicate Kaloko Fishpond and the surrounding area contain ethnographic resources including the fishpond, anchialine pools, fishing *koʻa*, offshore and nearshore fisheries, shoreline gathering areas, and trails (Maly and Maly 2002). Important historic leaders, ʻUmi, Kahekili, Kamehameha I, Hoapili, and Kamehameha V are associated with the Kaloko area (Tomonari-Tuggle and Tuggle 2006a, 2006b). A large platform in the Kaloko *ahupuaʻa* is interpreted as a *heiau* that may be associated with the Kaloko Fishpond (Cordy et al. 1991).

ʻAiʻōpio Fishtrap, is a small, 1.7-ac (0.7-ha) marine fishtrap that consists of a stone and coral wall forming an artificial enclosure along a naturally curving shoreline and contains four rectangular walled enclosures that may have been used as holding pens for netted fish (Kikuchi and Belshé 1971). ʻAiʻōpio is a *loko kuapā*-type fishtrap, meaning the builders created a wall as an artificial means for trapping fish as opposed to using natural shoreline features or an inland pond (Apple and Kukuchi 1975). The only fishtrap on Hawaiʻi Island; it had a variety of uses well into recent history.

At the south side of the ʻAiʻōpio Fishtrap is the Puʻuoina Heiau, probably the finest example of a platform type in Kona. To the south at Alaʻula Cove (Alula Bay) is a *heiau* known as Makaʻopio. The striking feature of this *heiau* is two great upright stone slabs. Several other *heiau* are present in the Honokōhau and Kealakehe *ahupuaʻa*.

The Park also contains numerous Hawaiian burial sites. These sites are important to Native Hawaiians, and most especially to descendants of the area. In Hawaiian culture, burial sites are considered especially sacred grounds with *mana* (supernatural or divine power).

The Ala Kahakai National Historic Trail traverses Kaloko-Honokōhau National Historical Park and includes prehistoric *ala loa* (main trails), and other trails on or parallel to the seacoast as well as *mauka-makai* trails. A system of *mauka-makai* trails (trails extending from mountain to sea) within the Park was used by Hawaiians to travel and communicate within the *ahupuaʻa*. These trails were important to the livelihoods of the ancient Hawaiians. These trails were commonly used by Hawaiians living *makai* (near the sea) to take ocean products, fish, salt, *limu* (seaweed), and other items to people living *mauka* (upland). In return, they were given agricultural food products such as *kalo* (taro) and other items unavailable closer to the sea. This form of exchange was the basis of the Hawaiian economy, and the system of trails provided the physical means to make it possible (Hono-kō-hau Study Advisory Commission 1974). Another trail with historical significance is the portion of the Mamalahoa Trail (also known as the King's Highway) that runs through Kaloko-Honokōhau. This trail extends around the Island of Hawaiʻi and was built between 1822 and 1855. Many parts of the trail outside the Park have been destroyed by urban development (NPS 1994).

More than 180 anchialine (brackish) pools have been identified throughout the Park, many of which were modified with rock walls, platforms and other features for access. The waters of anchialine pools have strong cultural significance. The only source of potable water along this area of the West Hawaiʻi shoreline, the pools were a significant factor in enabling Native Hawaiian settlement of the area, and continued to be important through historical times for a variety of uses including bathing, washing, and cooking (e.g., see Hono-kō-hau Study Advisory Commission 1974).

Numerous other sites of significance are located throughout the Park, including: *kahua hale* (house platforms), *koʻa* (fishing shrine), *ahu* (stone mounds), a concentration of more than 100 stone enclosures (believed to be agricultural planters), lava tube shelters; canoe landings, salt pans, and important concentrations of petroglyphs. These

concentrations include *papamu*, grids of pecked holes used for the Hawaiian game konane, and most likely other uses (Stasack 2010, pers. comm.), *poho piko* (pecked cups in the lava used for ceremonial placement of a baby's umbilical cords), anthropoid images, images of material culture, geometrics, words/letters, and battered processing areas. One of the petroglyph sites is the only known commemoration of the *Makahiki*, an annual event beginning with the *Lono* ceremony and ending with the *Ku* ceremony (Stasack 2010, pers. comm.).

Project Area

The project area consists of two separate areas; a 40-ac (16-ha) area that includes ʻAimakapā Fishpond, wetlands, and upland areas along the shoreline, and a 1-ac (0.4 ha) area of disturbed ground used currently under normal Park operations as a cut vegetation staging and processing area (Figure 2). Twenty archeological sites comprised of 48 individual features are identified within the Project Area (Paikuli-Campbell and Lizama 2015). As the thick overgrowth of nonnative vegetation is removed, more archeological sites are expected to be identified and documented.

ʻAimakapā Fishpond (state site number 50-10-27-3845) is the paramount historic property within the project area. ʻAimakapā Fishpond, a *loko puʻuone* (large pond formed behind a barrier beach), is the largest of the Park's fishponds. *Loko puʻuone* fishponds may have been the earliest type of fishponds (Kikuchi and Belshé 1971) and their brackish conditions were prized for the ability to produce fat, fast-growing fish (Wyban 1996). Modified for use by Hawaiians to hold and grow fish, the pond contains a variety of internal rock-wall partitions and was an active Hawaiian aquaculture pond until the 1950's. Athens and Ward (2006) suggest that construction and use of ʻAimakapā Fishpond began sometime in the 19th century, well after initial settlement of the area in the 17th and 18th centuries. Geomorphic analyses suggest that it was not until about 1800 that the land had subsided enough for there to be standing open water in the pond sufficient to support fish farming. (See *Geology Section* for detailed description of how the basin may have formed). At the same time, population pressures may have necessitated the construction of a new fishpond adjacent to the Honokōhau settlement. However, oral histories (Maly and Maly 2002) recall the presence of working fishponds in the Kaloko-Honokōhau vicinity dating back to at least the early 17th Century. More recently, none of the interviewees recall much fishing from ʻAimakapā, much more so from Kaloko.

Outside of the Project Area, partially-collapsed manmade seawalls remain on the ocean-reef platform offshore of ʻAimakapā suggesting that this reef area was perhaps once part of a larger-built larger fishpond or fishtrap complex for the efficient capture and raising of fish (Greene 1993, Junqueira 2001). Oral histories support this suggestion, recounting that ʻAimakapā Fishpond was very different 40 years ago (Maly and Maly 2002). Respondents imply that there were two ponds within one large complex, the current pond behind the barrier beach, and another pond *makai*, formed by seawalls constructed on the papa (reef) 50 ft (15 m) from shore.

‘Aimakapā Fishpond has internal walls forming at least eight internal compartments for separating fish. Many of these walls now have destructive vegetation (*milo, Paspalum,* and *Batis*) growing on and within them. Channel openings in these walls suggest that they were used for the raising of fingerlings (Kikuchi and Belshé 1971). The majority of the shoreline is formed naturally, with the geography determining the pond’s edge; however, portions of the *mauka* (inland) shoreline of ‘Aimakapā are modified, forming a terraced edge with a flat surface on top at the base of the eastern a‘a flow.

An oral history respondent recalls fishing for *awa* and *‘ama‘ama* from ‘Aimakapā Fishpond when he was young and describes that during his time, the compartments in the back were used as holding pens by individual families. The families would put their fish there and then share among the people. People would help each other manage their pens (Maly and Maly 2002). Near the northern end of ‘Aimakapā’s barrier berm, a partially buried, stone-lined, and cemented ‘*auwai* (channel) cuts into the sand barrier beach. This channel and metal *mākāhā* (sluice gate) are now filled-in with sand and marsh with no standing water on the inland side. This ‘*auwai* indicates that this area, and possibly other marsh areas, were formerly open water when the pond was actively maintained for aquaculture. Structural evidence and oral histories indicate that another ‘*auwai* existed further south (Duarte and Kauahikaua 1999, Junqueira 2001, Kikuchi and Belshé 1971). Based on an in-depth understanding of the movements of fish, fish habitat, and fish life cycles, the ancient Hawaiians developed the ‘*auwai* (channel) and *mākāhā* (grate) system as versatile technology to circulate water, remove silt, harvest fish, and introduce stocking materials to the pond (Wyban 1996). Traditional *mākāhā* consisted of a fixed wooden-pole grate with spaces large enough to allow small fish to enter the pond while preventing escape by larger fish, and to prevent entry by large predator fish. Harvest-sized fish were attracted to the ocean water entering the ‘*auwai*, especially during spawning months, and could be collected with nets (Wyban 1996). Modern materials (cement, metal for fixtures and screens) were used in historic times. Water circulation and sediments were managed through operation of two ‘*auwai* with *mākāhā*. *“On the flow of the tide, the water entered through one entrance and washed the silt to the other side of the pond were it would be carried out through that entrance at the ebbing of the tide*” (Wyban 1992).

Historic properties situated within the ‘Aimakapā wetland are a platform and two wall segments. A large platform (27 yd (25 m) N/S x 14 yd (13 m) E/W; ~1 yd (~1 m) height) is located in the northern wetland area. This platform has been interpreted as a heiau with association to the fishpond (Emory and Soehren 1971). Also located within the northern wetland is a short wall segment (15.3 yd (14 m) E/W; ~2.6 ft (~0.8) m height). This area is densely covered with nonnative pickleweed. In their 1961 survey, Emery and Soehren (1971) described this wall segment as dividing a brackish pool into two compartments. On the southeastern shore is a wall segment (23 yd (21 m) E/W; ~ 2.5 ft (0.76 m) height). Other walls and/or modifications may exist throughout and within ‘Aimakapā Fishpond and wetlands, but due to the heavy cover of invasive plants, they will not be identified and documented until after removal of the vegetation. Removal methods will be monitored and conducted in a manner so that there is no adverse effect to known or unknown historic properties.

Just as around Kaloko and ʻAiʻōpio, numerous archeological sites indicate intensive human activity in the area surrounding ʻAimakapā, particularly use by *aliʻi* for recreational and ceremonial purposes (NPS 1994). Surveys document many sites in the area surrounding ʻAimakapā Fishpond (Cluff 1971, Emory and Soehren 1971, Paikuli-Campbell and Lizama 2015), suggesting a permanent population immediately to the south and east of the pond. Historic properties in the Project Area are platforms (5), terraces (3), enclosures (3), walls (3), an alignment (1), a C-shaped wall (1), rock scatterings (2), remnants of historic cement structures (3), petroglyph complexes (13), isolated petroglyphs (2), *papamū* (5), modified anchialine pools (6), and ʻAimakapā Fishpond, a modified fishpond with internal walls and ʻ*auwai*. These historic properties are components of the overall settlement pattern common throughout the Park. Most of these historic properties are from the pre-contact time period although at least one of the historic properties was modified and used in historic and even modern times.

Visitor Experience & Safety

The enjoyment of national park resources and values by people is a fundamental purpose of all national park units (NPS 2006). Within the national parks, the NPS strives to maintain an atmosphere that is open, inviting, and accessible to all, and is appropriate to the exceptional natural and cultural resources found in national parks. Moreover, a major objective of resource management at the Park is to provide and maintain the resources needed for continuing education, enjoyment, and appreciation of traditional native Hawaiian activities and culture by local residents and visitors. In addition to ongoing school programs and events, interpretation programs include weekly hula classes and ukulele lessons. Walk-and-talk-programs include geology hikes and a Kaloko Fishpond Wall tour. Monthly workshops and cultural events further provide visitors and the community the opportunity to explore aspects of Hawaiian culture in depth. Workshops include instruction in traditional activities such as bamboo flute making, feather-work, *halau* building, and cordage lashing.

Although recreation is not the primary purpose of the Park, visitor recreation activities include picnicking at ʻAiʻōpio beach and the Kaloko picnic area, sunbathing, especially on the barrier beach fronting ʻAimakapā Fishpond, swimming, surfing, snorkeling, SCUBA diving, and fishing. The 9.5 miles (15.3 kilometers) of trails in the Park include the Ala Hele Poʻe Kahiko, Mamalahoa Trail, Ala Hele Huʻe Huʻe, Ala Kahakai, and the Mauka-Makai Trail, which are enjoyed by hiking groups and individuals. Leashed-dogs are allowed in the Park (NPS 2014) and dog walking is a common activity. Casual bird-watching takes place at Kaloko and ʻAimakapā fishponds and on trails throughout the Park. In addition to the attraction of viewing endemic endangered waterbirds, many bird-watchers come to see the numerous migrant waterfowl and the unusual, vagrant bird species from Asia and other parts of the Pacific (Morin 1998). Currently there are no formal bird watching programs offered by the NPS at the Park.

Park visitation is year-round with peaks at Christmas, spring break, and the summer months. Visitation has increased steadily since 2000 and has nearly doubled since 2005 (NPS 2015b) and has leveled off over the past four years. The 2014 annual visitation

count was 154,206 visitors (NPS 2015b). Primary visitation areas in the Park are the Visitor Contact Station (*Hale Hoʻokipa*) located off Queen Kaahumanu Highway, the Kaloko area (fishpond, picnic area, beach, trail access), and the ʻAiʻōpio and Honokōhau Bay areas, which includes ʻAimakapā Fishpond's adjacent barrier beach for sunbathing and hiking. The ʻAimakapā Fishpond and wetlands themselves are officially closed to visitors to protect cultural resources, migratory waterfowl, and the endangered waterbirds that use the area for breeding and loafing (NPS 2014). The nearby ʻAiʻōpio area is the Park area most utilized by visitors, local residents, and cultural practitioners. Viewing of archeological sites, sunbathing, swimming, picnicking, observing wildlife (sea turtles, shore and waterbirds, tide-pool life), and fishing and other cultural practices are common activities in this area. The Kaloko Fishpond area is also heavily used by local residents, cultural practitioners, and visitors.

Visitors to the to ʻAiʻopio, Honokōhau Bay, and ʻAimakapā Fishpond areas may walk in from the Visitor Contact Station along the Ala Hele Ike Hawaiʻi Trail, from the Honokōhau Small Boat Harbor parking lot berm gate trail, or from the Kaloko Fishpond Parking Area via the Ala Kahakai Coastal Trail. Boating visitors enter Park marine waters via the Honokōhau Harbor in motorized and non-motorized vessels (e.g., Hawaiian canoes, kayaks). Vessel launching is not allowed from the Park shoreline without a special use permit (36 CFR 3.8(2)).

The Park's coastline is susceptible to flooding caused by high waves generated by winter storms and hurricanes, generally up to the 10-ft contour line and by tsunami. The NPS has an Emergency Operations Plan that includes procedures, and warning and evacuation times for securing Park operations and for evacuation of the Park in the event of a tsunami, high surf event, hurricane, or other life-threatening emergency. Tsunami-warning sirens, activated by Hawaiʻi Civil Defense, are located to the south at Honokōhau Harbor and to the north at the Natural Energy Laboratory Hawaiʻi Authority, and can be heard from within the Park.

Climate Change

Climate change will impact the Park's resources through increasing air and sea temperatures, shifts in precipitation and wind patterns, and changes in storm and storm-wave intensity and frequency (Hoover and Gold 2005). On Hawaiʻi Island, the threat of sea-level rise is worsened by relatively rapid island subsidence (Apple and Macdonald 1966, Fletcher et al. 2002). Subsidence is the continuing process of the Hawaiian Islands slowly sinking below mean sea level by approximately 0.1 in/yr (2.5 mm/yr) because of volcanic and seismic activities (Walker 1990; See *Geology Section*). This combination of island subsidence with the effects of rising sea levels, particularly in the form of increasing frequency of seasonal wave damage and erosion, will affect coastal areas, including Honokōhau Beach and the ʻAimakapā sand berm. The following data and description of climate-related coastal hazards to Honokōhau Beach and the ʻAimakapā sand barrier are found in Vitousek et al. (2010).

It is estimated that sea level around Hawai‘i Island will reach approximately 0.5-1.3 ft (0.15-0.41 m) above present levels by 2050, and 1-5 ft (0.32-1.55 m) by 2100. In addition to ambient sea-level rise, climate change is likely to increase the frequency of swell events. During swell events, both tide height and wave runup contribute to the total water level on a beach and have a strong influence on extreme water levels and the occurrence of beach-overtopping by waves.

Presently, ‘Aimakapā’s sand berm is moderately stable, with a current average erosion rate of 0.25-0.5 ft (0.08-0.15 m) per year. It is partially, but not completely, overtopped by waves more than once a year. (Figure 6) The sandy beach situated north of the ‘Aimakapā Fishpond beach barrier has the largest risk of overtopping and deterioration from wave impacts because of its low elevation. The Honokōhau Beach sand berm and area from ‘Aimakapā Fishpond to ‘Ai‘ōpio Fishtrap is at higher elevation (> 6.6-ft; 2-m elevation) and should be relatively resilient to overtopping impacts until sea-levels rise to greater than +1.6 ft (0.5 m).

By the years 2050 to 2100, it is estimated that for sea-level scenarios of 0.8-1.6 ft (0.25-0.5 m), the overtopping of the berm will increase slightly in frequency; however, impacts should be fairly minimal initially, leading to slightly increased erosion. For higher sea-level scenarios, 1.6 to >3 ft (0.5 to >1 m), the entire berm will be fully overtopped by waves several times a year, causing erosion and potentially a breach of the sand barrier. The low elevation beach and wetland to the north of the sand berm would be constantly submerged.

Seawater intrusion to Aimakapā as a result of climate change and local water development is also a concern given the proximity of seawater to the surface. Natural events, such as tidal movements, seasonal variation, and long-term climate changes, all affect the degree of seawater intrusion. Human activities such as groundwater development also affect seawater intrusion. Groundwater heads in the park are small, with water levels about 1 –2 feet above mean sea level and therefore levels are affected strongly by sea level, ocean tides, storm events, and extraction (Oki et al. 1999).

Figure 6. Honokōhau Beach fronting ʻAimakapā Fishpond. Debris lines show partial overtopping of the berm (from Vitousek et al. 2010).

Chapter 4: Environmental Consequences

Methodology

Potential impacts associated with the proposed alternatives are described below in terms of type (beneficial or adverse), context (site specific, local, or regional), duration (short-term or long-term), and intensity (negligible, minor, moderate, or major). Both indirect and direct impacts are described; however, they may not be identified specifically as such. These terms are defined below. The impact analyses and conclusions were based on the review of existing literature and studies, information provided by on-site experts and other government agencies, professional judgments, and NPS staff insight. Impact topics were analyzed for each alternative based on published and unpublished reports, expertise, and judgment of the Interdisciplinary Team, and consultation with resource specialists. Topics analyzed in this chapter include Geology, Water Resources, Special Status Species, Wildlife, Vegetation, Visitor Experience and Safety, Cultural Resources, and Climate Change.

Type of Impact: A measure of whether the impact will improve or harm the resource and whether that harm occurs immediately or at some later point in time.

- **Beneficial**: A positive change in the condition or appearance of the resource, a change that reduces resource impact being discussed, or a change that moves the resource toward a desired condition.

- **Adverse**: A change that moves the resource away from a desired condition or detracts from its appearance or condition. Depletes resources.
- **Direct**: An effect that is caused by an action occurring in the same time and place as the action.
- **Indirect**: An effect that is caused by an action occurring later in time, or farther removed in distance, but is still reasonably foreseeable.

Context: The context is the setting within which impacts are analyzed – such as the project area or region, or for cultural resources – the project area or area of potential effects.

- **Site** Spe**c**ific: Impacts would be restricted to the project footprint and the use corridor around the project footprint.
- **Local**: In the general project area, defined as the Honokōhau *ahupua‘a* section of the Park.
- **Park Wide**: Includes the entire Park
- **Regional**: Includes the west coast of Hawai‘i Island, or Hawai‘i Island (Hawai‘i County), and/or neighbor islands.

Duration: describes the length of time an effect would occur, either short-term or long-term:

- **Short-term** impacts generally last only during restoration activities, and the resources resume their pre-restoration conditions following restoration.
- **Long-term** impacts last beyond the physical restoration activity period, and the resources may not resume their pre-restoration conditions for a longer period following restoration.

Intensity of Impact: describes the degree, level, or strength of an impact. Intensity definitions are presented below and are applied to each impact topic. Beneficial impacts are described but are not assigned a level of intensity.

- **Negligibl**e: Impacts would be at the lowest levels of detection and would have no perceptible effect on resources, values, or processes.
- **Minor**: Impacts would be perceptible but slight. If mitigation were needed to offset any adverse effects, it would be relatively simple to implement and would likely be successful.
- **Moderate**: Impacts would be readily apparent and measurable. The resource might deviate from normal levels but would remain viable. Mitigation measures would probably be necessary to offset adverse effects and would likely be successful.
- **Major**: Impacts would be readily apparent and widespread, and would result in a substantial alteration or loss of resources, values, or processes and would likely be permanent. Mitigation measures to offset adverse effects would be necessary, extensive, and their success could not be guaranteed.

Impact Mitigation: Impacts have been assessed under the assumption that proposed measures to minimize or mitigate the impact would be implemented. The following terms identify the way to change the intensity of impacts. Project actions can:

- **Avoid** conducting management activities in an area of the affected resource;
- **Minimize** the type, duration or intensity of the impact to an affected resource; and
- **Mitigate** the impact by:
    - **Repairing** localized damage to the affected resource immediately after an adverse impact;
    - **Rehabilitating** an affected resource with a combination of additional management activities; or
    - **Compensating** a major long-term adverse direct impact through additional strategies designed to improve an affected resource to the degree practicable.

Cumulative Impact Analysis

The CEQ regulations (40 CFR 1508.7) require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are the effects on the environment that would result from the incremental impacts of the action when added to other past, present and reasonably foreseeable future actions. Impacts are considered cumulative regardless of what agency or group (federal or non-federal) undertakes the action.

The cumulative projects addressed in this analysis include past and present actions, as well as any planning or development activity currently being implemented or planned for implementation in the reasonably near future at Kaloko-Honokōhau National Historical Park and in the surrounding region. Cumulative actions are evaluated in conjunction with the impacts of each Alternative to determine if they have any additive effects on a particular resource. Because most of the cumulative projects addressed in this analysis are in the early planning stages, the evaluation of cumulative impacts was based on a general description of the project. The following projects, together with ongoing Park operations, were included in the cumulative effects analysis presented in this chapter:

- Urban Development Projects: an estimated 16,000 new residences are planned for lands near the National Park (Gomes 2010). These residences are part of the Kula Nei, Palamanui, Kamakana Villages, Villages at Laʻiʻopua, Shores at Kohanaiki, and Kaloko Makai developments, some of which are proposed (Kaloko Makai) or recently approved (Kula Nei, Kamakana Villages) and some are underway in varying stages of development (Palamanui, Villages at Laʻiʻopua, Kaloko Heights, Shores at Kohanaiki). Other proposed projects in the vicinity include the Kona International Airport expansion, Air Force military training routes, a municipal-waste incinerator facility, and Honokōhau Harbor improvements. The approved C-17 Short Austere Air Field construction at Kona International Airport, and the construction of two new light industrial parks, West Hawaiʻi

Business Park, Kaloko Phases III and IV, are approved but are in various stages of development. The Queen Kaʻahumanu Highway Widening Phase 2 project will expand the highway from two to four lanes along the Park's eastern boundary.

- Kaloko Fishpond Management: As planned in the Park's GMP, Kaloko Fishpond would be restored to a functioning fishpond through the practice of traditional Hawaiian aquaculture. A fishpond hui (group) would be organized to work with the NPS to manage the pond. This activity would include removal of alien vegetation from the pond shoreline to improve water quality and fish harvest activities.
- Construction of the Kaloko-Honokōhau Curation Facility: The NPS has proposed the construction of a curation/museum facility adjacent to the Hale Hoʻokipa Visitor Contact Station (to be built in 2020-2025, if funding is provided).
- Construction and operation of the Kaloko-Honokōhau Cultural Center, Na Leo Kahiko, through formal partnership between the National Park Service and Makani Hou o Kaloko-Honokōhau. Na Leo Kahiko activities will take place throughout the Park providing opportunities for learning the values and traditions of the Hawaiian culture and for actively participating in in-depth cultural pursuits. The Na Leo Kahiko Cultural Center site is located in the Kaloko *ahupuaʻa* near Kaloko Fishpond (NPS 2013a).
- Ongoing Park Operations: resource management projects (removal of alien vegetation, archeological site rehabilitation, maintenance of Kaloko Fishpond wall), interpretation activities (school group tours, cultural activity workshops, annual children's cultural festival, ranger-led hikes, and special events), law enforcement activities, and facilities management and maintenance (trail maintenance, vegetation maintenance, beach and parking area maintenance, facilities repair).

Cumulative Impact Contribution Methodology

In defining the contribution of each alternative to cumulative impacts, the following terminology is used:

- **Imperceptible**: The incremental effect contributed by the alternative to the overall cumulative impact is such a small increment that it is impossible or extremely difficult to discern.
- **Noticeable:** The incremental effect contributed by the alternative, while evident and observable, is still relatively small in proportion to the overall cumulative impact.
- **Appreciable:** The incremental effect contributed by the alternative constitutes a large portion of the overall cumulative impact.

Cumulative impacts are described only for those projects where cumulative impacts of the proposed action contribute to an incremental effect.

Impact Analysis

This section analyzes the impacts to park resources associated with a programmatic plan for restoration and management actions at ʻAimakapā to improve wetland ecosystem integrity, recover endangered waterbird populations, protect cultural resources, and interpret the fishpond's ecology and Hawaiian cultural history. The analysis considered a 15-year period from the end of 2015 through 2030. Although resources are separated into individual categories for the purposes of impact analysis, in Hawaiian cultural tradition, cultural and natural resources are viewed as inseparable. Because cultural resources stem from nature's provision, it follows that natural resources are culturally important.

The impact analysis of the two alternatives is examined by each park resource topic and is described in Table 3, *Environmental Consequences*. Several actions are common to both continuing current management and the Proposed Action. Integrated Pest Management (IPM) would continue to be applied at ʻAimakapā under both alternatives. The IPM approach entails identifying and monitoring target pests, setting thresholds for action, and utilizing a combination of methods to take advantage of the range of appropriate pest management options for prevention and control. Under both alternatives, actions to restore and manage the fishpond and wetlands will be implemented as funding becomes available. Under both alternatives, the NPS will continue to actively engage in interagency coordination and consultations to protect cultural and natural resources and prevent jeopardizing any species listed under the Endangered Species Act.

Table 3. Environmental Consequences.

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Geology, Soils, Topography	Under both Alternatives, the existing fishpond hydrologic conditions would be maintained. Reshaping of the basin topography would not occur beyond removal of root matter of nonnative plants. The beach sand berm would remain intact and natural water inflow would continue from groundwater seeps and from seawater percolation through the berm. Disturbance to soil and lava surface–and wetland and pond-basin topography–from manual removal of rooted wetland plants will have **site-specific, short-term negligible adverse** impact on soil and lava resources. However these impacts would be repeated over the long-term as vegetation removal will be opportunistic when resources and funding allow (likely permitting regrowth), and would not be part of a larger strategic plan for restoration and management of the wetlands as a whole. There would be **local, short-term, negligible to minor, adverse** impacts from repeated surface disturbance on wetland soils (compaction) and pahoehoe lava flats from crews accessing restoration areas on foot and with equipment and UTVs during treatment and removal of materials from the site. Additionally, mobilization of crews and UTV equipment to the wetlands would have **localized, long-term, negligible, adverse** impact on soils and lava of existing park trails, and **site-specific, short-term, negligible, adverse** impacts on soils and lava at the location of temporary access routes created for access of equipment. Protective mats and surfaces would continue to be used to minimize impacts to substrate. If the use of wetlands-approved herbicide is deemed necessary under integrated pest management (IPM) protocols, the selective use of wetlands-approved herbicide to treat nonnative plant infestations would produce limited adverse impacts to soils. Due to brief half-life of these chemicals, especially in tropical climates, and their limited ability to move through the soil, the impacts of their use on park soils would be **site-specific, short-term, negligible to minor, and adverse**.	As in Alternative 1, soil and lava surface-disturbance from manual and mechanical removal of rooted wetland plants will have **site-specific, short-term negligible adverse** impact on soil resources, however these impacts would be lessen over time as better-planned treatment and maintenance actions, and increased monitoring would result in the incremental reduction of the total acreage of nonnative plant cover in the wetland. **Long-term benefits** to park soil and lava resources would result because less intensive methods would be required over time to maintain vegetation in cleared and treated sites, and as nonnative plants and excess organic matter responsible for imbalances in wetland accretion are removed, long-term site-specific beneficial impacts to topography and bathymetry would result.. If used, the effects of chemical methods would be the same as under Alt. 1. The use of larger equipment: e.g., mini-excavator, RAV, would produce **localized, short-term minor, adverse** impacts on wetland soils from compaction and surface disturbance. Mobilization of equipment to the wetlands would have **localized, short-term, minor, adverse** impact on soils and lava of existing park trails, and **site-specific, short term, minor adverse** impacts on soils and lava at the location of temporary access routes created for access of equipment. To minimize impacts, protective mats and/or other surfaces (geo-textile material covered with three to six inches of wood chips), would be used to protect substrates when transiting equipment, and temporary trail areas would be reseeded and restored. Over the long term, reduction in the total acreage of nonnative plant infestation and maintenance of native plants would produce **localized, major, beneficial** effects on soils as nutrient cycling and soil chemistry return to native system levels. Active restoration of native vegetation on previously infested sites would result in **site specific, long-term, major beneficial** effects to soils due to a more rapid return to natural hydrologic conditions in the wetlands, and enhanced nutrient cycling and soil chemistry towards desired conditions. Under Alternative 2, ultimately, nonnative fish would be controlled as part of the long-term restoration and management of ʻAimakapā Fishpond and wetland following a separate environmental review of specific control methods, which would have **site-specific, long-term major beneficial** effects on pond sediment.

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Geology, Soils, Topography (Continued)	**Cumulative impacts** to park substrates in combination with park operations would be **imperceptible.**	**Cumulative impacts** to park substrates in combination with park operations would **range from imperceptible to noticeable** depending on the extent of equipment use.
Water Resources	Under both alternatives, nonnative wetland-plant removal would improve ʻAimakapā wetlands, anchialine pools, and water quality by decreasing nutrient input resulting from the decay of nonnative plant biomass. Removal also increases open water and improves wetland hydrology towards a more naturally functioning system. However, **the intensity of these site-specific long-term minor beneficial effects is less in Alternative 1** because wetland-plant removal projects would continue to be periodic and limited in area. Ground disturbance and loosening of roots and sediment during plant removal could potentially contribute to water turbidity and have **site-specific, short-term, negligible adverse** effects on water quality in ʻAimakapā and wetland-associated anchialine pools. These effects are temporary in duration and would continue to be minimized by Best Management Practices (BMP), such as silt screens and vegetation buffers that prevent sediment release to water. If the use of wetlands-approved herbicide is deemed necessary under IPM protocols, negative impacts to water quality would be **site- specific, short-term, and negligible.** Due to their rapid degradation in water and sunlight via hydrolysis and photolysis, wetlands-approved herbicides are rapidly dissipated from water in several days (Pless 2005). High-accuracy, direct application methods would be used to minimize or prevent overspray. The use of BMPs and standard operating procedures (SOP) to prevent spills and overspray would reduce impacts to negligible. A State of Hawaiʻi National Pollution Discharge Elimination System (NPDES) permit is required for use of herbicide chemicals in wetlands and would be obtained. Risk of leaks from motorized equipment (UTVs and gas=powered tools) would continue to be minimized through regular maintenance and daily equipment checks. Potential impacts to water quality from a leak during a maintenance issue would be **localized, short-term, negligible to minor, and adverse.** To minimize leaks, equipment would continue to be well-maintained, and cleaned and fueled offsite.	The impacts of Alternative 2 on water resources would be similar to those discussed for Alternative 1. Removal and maintenance of nonnative plants under planned treatment and maintenance actions would result **site-specific long-term minor to moderate beneficial** effects to wetland hydrology. Under Alternative 2, regular water-level monitoring and periodic water quality monitoring would occur to monitor improvements to wetland hydraulic connectivity. Ground disturbance from mechanical plant removal with machinery has potential to cause **site-specific, short-term minor** effects on water turbidity. These effects would be minimized by use of Best Management Practices to prevent sediment release. Effects of chemical methods, if used, would be the same as described under Alternative 1. Because it would be fueled and maintained within the Project Area (upland, away from open water), the use of large, powered machinery increases potential for leaks and spills of hydrocarbons, which adversely affect water quality. Daily operations may also result in leaks. Potential impacts to water quality from a spill or leak during fueling or a significant maintenance issue would be **site-specific, short-term, minor to moderate, and adverse**. To minimize risk of leaks and spills, machinery would be cleaned and inspected prior to initially entering the site, and proper planning (a Spill Plan) and Best Management Practices (e.g., drip pans, absorbent mats, biodegradable lubricants where possible, daily maintenance checks, and proper standard storage and transportation safety procedures for such fluids) would be used. Active restoration of native vegetation on previously infested sites would facilitate a more rapid return to natural hydrologic conditions in the wetlands, resulting in **site-specific, long-term, minor beneficial** effects to water quality of the fishpond, wetlands, and pools. Native vegetation, particularly sedges, may help improve water quality by filtering and sequestering excess nutrient inputs. Under Alternative 2, ultimately, nonnative fish would be controlled as part of the long-term restoration and management of ʻAimakapā Fishpond and wetland following a separate environmental review of specific control methods. Removal

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Water Resources (Continued)	**Cumulative impacts** to water resources in combination with Na Leo Kahiko Cultural Center would improve ecological resiliency of the wetland system, would **imperceptibly and beneficially** offset adverse impacts from urbanization.	of Mozambique tilapia would improve water quality by reducing turbidity caused by burrowing behavior into pond sediments, and reducing nutrient input. Nonnative fish potentially excrete 15 times more total dissolved nitrogen than native fishes (MacKenzie and Bruland 2012). Control of nonnative fish would result in **site-specific, long-term moderate to major benefits** to water quality at ʻAimakapā. **Cumulative impacts** to water resources in combination with Na Leo Kahiko Cultural Center would be **beneficial and noticeable** as people, especially *keiki* (children), become increasingly involved in improving fishpond integrity, and would imperceptibly offset adverse impacts from urban development.
Special Status Species	Under Alternative 1, wetland areas of nonnative plant infestation would continue to be to be controlled periodically, as funding and staffing allow, and be limited in area. Under this Alternative, wetland habitats would be unlikely to be fully restored because removal is unlikely to keep ahead of vegetation regrowth. Benefits to special status species habitats would range depending on the scale and timing of the projects and **would not have the same intensity of benefit as in Alternative 2.** Cleared vegetation material will continue to be managed and disposed of to avoid habitat conditions that may contribute to an outbreak of avian botulism. Control of emergent alien vegetation and removal of excess organic material from anchialine pool habitats would improve hydrologic connectivity and result in site-specific, long-term, and minor to moderate beneficial impacts for invertebrates. If the use of wetlands-approved herbicide is deemed necessary under IPM protocols, negative impacts to special status species would be **site-specific, long-term, and negligible to minor.** Herbicides that are EPA-registered for application in aquatic settings pose very low risk to wildlife because a wide margin of safety exists between concentrations that cause mortality to laboratory test animals and the potential exposure to wildlife from use in their habitat. Potential impacts are minimized by the use of BMPs and SOPs to prevent spills and overspray, the accuracy of application, and the low impact and low level of toxicity on species and non-target vegetation in their habitat. A State of Hawaiʻi NPDES permit is required for use of herbicide chemicals in wetlands and would be obtained. Disturbance to shorebirds, migratory water fowl, and endangered	Under Alternative 2, wetland areas of nonnative plant infestation would be treated by a combination of methods, with an increased use of periodic helicopter operations to carry waste material via sling-load. Planned treatment/re-treatment timing would occur on an optimal schedule based on monitoring and rates of regrowth or re-establishment of the nonnative plant species. Removing nonnative species will restore the ecological integrity and biodiversity of special status species wetland and anchialine pool habitats. **Site-specific, long-term, moderate to major beneficial** impacts would result from nonnative plant removal in waterbird habitats due to the strong dependence of waterbirds and migratory birds on that habitat. Nonnative plant removal improves and expands available endangered waterbird breeding, foraging, and loafing, habitat, removes woody perches for avian predators (e.g., cattle egret, night heron) of waterbirds, and cover for ground predators (e.g., rats, mongoose, cats). As under Alternative 1, cleared vegetation material will continue to be managed and disposed of to avoid habitat conditions that may contribute to an outbreak of avian botulism. Control of emergent alien vegetation and removal of excess organic material from anchialine pool habitats would have the same beneficial impacts as Alternative 1. Effects of chemical methods, if deemed necessary, would be the same as described in Alternative 1. Disturbance to shorebirds, migratory water fowl, and endangered waterbirds from human activity, including volunteer work groups, UTVs, machinery, helicopter flight, and other noisy equipment used in the vicinity of birds and nesting birds would result in **short-term, site-specific, minor to moderate,**

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Special Status Species (Continued)	waterbirds from human activity, and noise from UTVs and gas-powered tools in the vicinity of birds would be **short-term, negligible, and site-specific**. Human activity and noise would continue to be isolated and temporary, occurring during weekday work hours. These effects would continue to be minimized by surveying the area for birds and nests prior to work, and by restricting highly-disturbing activities during the waterfowl migrant and waterbird breeding season. The curtailed season of work would continue to result in interruption of restoration and maintenance activities such that true restoration is not achieved in any given area. UTVs and gas-powered tools could potentially release fuels and oils that could affect habitat. Project-related equipment would continue to be cleaned of pollutants and invasive species propagules prior to entry to the wetlands and to use BMPs to prevent leaks and spills resulting in **site-specific, long-term negligible adverse** impacts. Nonnative, small-mammal predators would continue to be live-trapped and removed from the park resulting in **localized, short to long-term minor to moderate beneficial** impacts to special status bird species. The wetlands would continue to be closed to general public access, including cultural uses of the pond, limiting sources of disturbance of special status species to vegetation removal projects. Restoration of native plants would rely solely on regeneration from existing native seed sources, which may take years, provided regrowth of nonnatives does not overgrow native seedlings. Benefits to special status species habitats would be **site-specific, short to long-term, and negligible to minor beneficial** impacts. Monk seals or green turtles resting on the barrier beach may occassionally be encountered by crews, UTVs, or other equipment that may need to transport materials or to access different portions of access the wetland via the beach berm. Seals and turtles would continue to be avoided until the individual(s) clears the area on their own. Therefore there would be **no adverse** impacts to individuals of these special status species**.** Placing barricades or signage and establishing a buffer zone for monk seals would continue to be done in coordination with the National Marine Fisheries Service (NMFS), and visitors are requested to stay 20 ft from basking turtles. The NPS would continue to consult with the NMFS and USFWS under Sec. 7 of the Endangered Species Act for these species.	**adverse** impacts to individuals of special status species. Helicopter operations would avoid water and wetland areas, and would not land in the Project Area. Under Alternative 2, the NPS would consult with USFWS for an incidental take permit under the Endangered Species Act to carry out restoration actions throughout the year. Potential impacts from releases of fuels and oils that could affect habitat are the same as under Alternative 1. Potential impacts to special status species from direct contact with a spill or leak during machine fueling or a significant maintenance issue would be **site-specific, short-term, minor to moderate, and adverse**. Under Alternative 2, predator control efficiency would improve by establishing protocols to improve timing and siting of traps, and improve trapping efficiency resulting **in localized, short to long-term moderate to major benefits** to special status species birds. Clearing large woody stands between the wetland and southern trail may attract visitors into the wetland and may temporarily increase human disturbance of breeding birds. Signs of area closure will be posted to minimize this disturbance The wetlands would continue to be closed to general public access; however, traditional cultural uses of the pond under Na Leo Kahiko Cultural Center programs may result in **site-specific, short to long-term negligible adverse** impacts to birds from human presence. Disturbance would be minimized by surveying for nesting birds and adaptively modifying timing and location of human cultural activity. Similarly, large volunteer groups have the potential to disturb birds and the same minimization protocol as above would be used and would include pre-work briefings with instructions on how to avoid disturbing wildlife. Under Alternative 2, active restoration by rescuing, propagating, transplanting, and outplanting native wetlands-vegetation on previously infested sites would result in **site-specific, long-term, major beneficial** effects to special species and their habitat by facilitating restoration of ecological integrity and biodiversity of the wetlands system and a more rapid return to natural hydrologic conditions. Impacts to basking green turtles and monk seals would be the same as those described under Alternative 1. Under Alternative 2, ultimately, nonnative fish would be controlled as part of the long-term restoration and management of ʻAimakapā Fishpond and wetland

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Special Status Species (Continued)	**Cumulative impacts** to special status species would **imperceptibly and beneficially** contribute to reducing regional long-term cumulative impacts to endangered waterbirds.	following a separate environmental review of specific control methods. Removal of Mozambique tilapia would benefit native birds and migratory waterfowl at ʻAimakapā by eliminating direct competition for food and reducing potential for disease transmission (e.g., avian botulism). Control of nonnative fish would result **in site-specific, long-term moderate to major benefits** to endangered waterbirds, shorebirds, and water fowl at ʻAimakapā. Despite the adverse impact of temporary disturbances on individuals of special status species, the restoration of wetlands habitat would have **long-term moderate beneficial population-level effects** from increased breeding and fledging success resulting from increased availability of native habitat with improved ecological integrity, and more efficient predator control, which would **outweigh the negative effects** from disturbance of individuals of these species. **Cumulative impacts** to special status species under this alternative would **beneficially and appreciably** contribute to the regional resiliency and recovery of endangered waterbird populations on Hawaiʻi Island and protect Pacific migratory shorebirds. In combination with Na Leo Kahiko Cultural Center and increased cultural use of the pond, cumulative impacts would be **imperceptibly adverse** from increased human disturbance, but **also beneficial and noticeable** as community awareness and stewardship of fishponds, migratory shorebirds, and waterbirds rises.
Wildlife	Non-special status species wildlife in the ʻAimakapā wetlands area primarily consists of introduced nonnative species (mongoose, feral cats, rodents, pigs, and various birds) and native fish, and aquatic and wetlands invertebrates. Under Alternative 1, removal of nonnative plants in wildlife habitats would continue to be periodic, and limited in area. The adverse impacts to aquatic invertebrates from vegetation control would be from substrate compaction and crushing by vehicles, temporary loss of cover and existing habitat for substrate-dwelling invertebrates during ground-disturbing removal of living root masses. These impacts would be **site-specific, short-term, negligible, and adverse.** Because areas of active restoration are relatively small, this effect would not have a noticeable effect on insect populations or communities. Naturalized nonnative lizards that may inhabit the wetland margins or transit corridors would experience **site-specific negligible short-term adverse** impacts from disturbance and habitat displacement during	Under Alternative 2, wetland areas of nonnative plant infestation would be treated by a combination of methods with an increased use of periodic helicopter operations to carry material via sling-load, and planned treatment/re-treatment timing would occur on an optimal schedule based on monitoring and rates of regrowth or re-establishment of the nonnative plant species. The adverse impacts on aquatic invertebrates from these restoration methods would be the same as described under Alternative 1, with added risk of crushing by heavy equipment resulting in **site-specific, short-term, and negligible to minor adverse** impacts. Impacts to nonnative lizards are the same as under Alternative 1. Potential impacts from releases of fuels and oils that could affect habitat are the same as under Alternative 1. Potential impacts to aquatic wildlife from direct contact with a spill or leak during machine fueling or a significant maintenance issue would be **site-specific, short-term, minor to moderate, and adverse**. Effects of chemical methods, if deemed necessary, would be the same as

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Wildlife (Continued)	vegetation removal or crew transit to and from the wetlands. UTVs and gas-powered tools could potentially release fuels and oils that could affect aquatic species habitat. Project-related equipment would continue to be cleaned of pollutants and invasive species propagules prior to entry to the wetlands and to use BMPs to prevent leaks and spills resulting **in site-specific, short-term negligible adverse** impacts. If the use of wetlands-approved herbicide is deemed necessary under integrated pest management protocols, herbicide chemicals to treat nonnative plant infestations would have potential to enter the aquatic environment and may directly contact some individuals of invertebrate species in the wetland. Herbicides that are EPA-registered for application in aquatic settings pose very low risk to aquatic wildlife because a wide margin of safety exists between concentrations that cause mortality to laboratory test animals and the potential exposure to wildlife from use in their habitat. The use of BMPs and SOPs to prevent spills and overspray, the accuracy of application, and the low impact and low level of toxicity on species and non-target vegetation in their habitat the effects to native fish and aquatic insects would result in **site-specific, short term, negligible to minor, and adverse** impacts to native wildlife. A State of Hawai‘i NPDES permit is required for use of herbicide chemicals in wetlands and would be obtained. The periodic, small-scale removal of nonnative plants will have a **site-specific, negligible, and short to long-term beneficial** effects on native fish and aquatic insects by increasing open-water habitat, and wetland hydrology, and functioning. **Cumulative impacts** to native wildlife **would imperceptibly and beneficially** contribute to reducing regional long-term cumulative impacts to native wildlife.	described in Alternative 1. The large-scale removal of nonnative plants from the wetlands will have a **site-specific, moderate to major, short to long-term beneficial** effect on native fish and aquatic insects by increasing open-water habitat, and wetland hydrology, and functioning. Active plant restoration by rescuing, propagating, transplanting, and outplanting native wetlands vegetation on previously infested sites would result in **site-specific, long-term, and moderate to major beneficial** effects to wildlife and their habitat by facilitating restoration of ecological integrity and biodiversity of the wetlands system and a more rapid return to natural hydrologic conditions. Under Alternative 2, ultimately, nonnative fish would be controlled as part of the long-term restoration and management of ‘Aimakapā Fishpond and wetland following a separate environmental review of specific control methods. Removal of Mozambique tilapia would benefit native wildlife at ‘Aimakapā by eliminating direct competition with native fish for food and breeding space, and reducing potential for disease and parasite transmission. Control of nonnative fish would result **in site-specific, long-term major benefits** to native wildlife at ‘Aimakapā. **Cumulative impacts** to native wildlife species in combination Na Leo Kahiko Cultural Center would beneficially and appreciably contribute to the resiliency and ecological integrity of wetlands on Hawai‘i Island as people, especially *keiki* (children), become increasingly involved in fishpond stewardship.

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Vegetation	Under Alternative 1, wetland areas of nonnative plant infestation would continue to be to be controlled periodically, as funding and staffing allow, and be limited in area. Under this Alternative, native wetland plant habitat would be unlikely to be fully restored because removal is unlikely to keep ahead of vegetation regrowth. Benefits to native plants would range depending on the scale and timing of the projects and **would not have the same intensity of benefit as in Alternative 2.** Under Alternative 1, nonnative plants would be controlled, but native wetland vegetation would not be fully restored. **Site-specific short to long-term negligible beneficial** impacts to native plants would result. Restoration of native plants would rely solely on regeneration from existing native seed sources. Tools and UTV would be cleaned free of nonnative propagules prior to entering the site. If the use of wetlands-approved herbicide is deemed necessary under integrated pest management protocols, the application of chemicals in native plant habitat would result in site-specific, **short-term negligible to minor adverse** impacts on non-target (native) plants because of the accuracy of application methods and Best Management Practices used for application on target species. Manual removal (hand and gas-powered tools) is a low-impact method, but some individuals, or small stands, of native understory inextricably mixed in with larger areas of nonnative paspalum or pickleweed may be sacrificed when removing the nonnative plants resulting in **site-specific**, **short-term negligible adverse** impacts on native plants. Whenever possible, intact stands of native plants will continue to be preserved and protected during operations. Under Alternative 1, no coordinated volunteer corps for ʻAimakapā would be initiated to aid in plant restoration and maintenance, resulting in smaller sized areas of full restoration that are maintained. **Cumulative impacts** to native plants in combination with other nonnative plant removal projects under Park operations, and Na Leo Kahiko Cultural Center, would **imperceptibly and beneficially** contribute to reducing regional long-term cumulative adverse impacts to native plants resulting from introduced species and urban development.	Under Alternative 2, wetland areas of nonnative plant infestation would be treated a combination of methods and planned treatment/re-treatment timing would occur on an optimal schedule based on monitoring and rates of regrowth or re-establishment of the nonnative plant species resulting in **overall benefit to native plant populations**. Effects of chemical methods, if used, would be the same as described in Alternative 1. Large equipment and other tools may transit nonnative plant propagules to the project area from other sites in the park. To minimize infestation, Machinery would be cleaned and free of nonnative propagules prior to entering the site. As described under Alternative 1, intact stands of native plants will be preserved whenever possible to minimize impact and accelerate native plant recovery. However, under Alternative 2, sacrifice of native plants is minimized by rescuing, propagating, and wild-transplanting intact stands or individuals of native plants where possible (i.e., where roots are not inextricably intertwined with nonnative species). Under Alternative 2, active restoration by outplanting native plants from approved partner nurseries or in-park nurseries on previously infested sites would result in **site-specific, long-term, major beneficial** effects to native plant populations by facilitating more rapid restoration of ecological integrity and biodiversity of the wetlands system and a more rapid return to natural plant cover in the wetland. Under Alternative 2, park staff and volunteer corps will tend and maintain stands of native plants resulting in larger maintained restoration areas. Under Alternative 2, ultimately, nonnative fish would be controlled as part of the long-term restoration and management of ʻAimakapā Fishpond and wetland following a separate environmental review of specific control methods. Removal of Mozambique tilapia would benefit native plants such as *Ruppia maritima* at ʻAimakapā by eliminating tilapia as a consumer of and competitor with Hawaiian coots for its seeds, and improving *Ruppia* growth. Control of nonnative fish would result **in site-specific, long-term minor benefits** to native plants at ʻAimakapā. **Cumulative impacts** to native plant species in combination with Park operations and Na Leo Kahiko Cultural Center would **beneficially and noticeably** contribute to the regional resiliency of wetlands and native plant populations on Hawaiʻi Island, and to reducing regional long-term, cumulative adverse impacts from nonnative introductions and urban development.

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Cultural Resources	Under Alternative 1, nonnative, wetland-plant removal around specific historic properties resources would continue to be periodic and limited in area, as funding and staffing allow and would have **minor site-specific beneficial, short-term to long-term direct effects**. Under this Alternative, removal of all nonnative plants within the Project Area is unlikely or will take an extended amount of time. Therefore the optimum preservation of archeological resources, ethnographic resources and the overall cultural landscape of both the Project Area and the area of potential effect (APE) will either take an extended amount of time or will not be fully attained. Pedestrian, UTV and on-water access (e.g., Hawaiian canoe, float, or skiff) would avoid archeological resources. Protective mats and/or constructed, temporary trail surfaces would continue to be used to minimize or eliminate impacts to ground-surface archeological resources such as midden scatters, petroglyphs, trails, and/or pavements. If **adverse** impacts were to occur, they are expected to be **imperceptible to negligible** such as slight displacement of soil and/or cultural material. Under Alternative 1, removal methods of nonnative plants would continue to consist of manual labor with the use of hand tools and small gas-powered tools. As with all NPS projects, an archeologist would continue to monitor project actions as required to ensure no impacts to known archeological sites, and will monitor in areas where ground-disturbing activities (vegetation removal from soils) have potential to impact unknown buried archeological deposits. Impacts to archeological resources, ethnographic resources and the cultural landscape would be **avoided or negligible at most.** Under Alternative 1, plant material may be dried temporarily in upland lava flat areas prior to its complete removal. Staged material will continue to avoid surface features such as stacked stone walls and platforms.	Under Alternative 2, a more systematic and aggressive approach to treating wetland areas of nonnative plant infestation would have more a immediate and successful outcome and would provide **major site-specific to regional, long-term, direct beneficial effects on** archeological resources, ethnographic resources and the overall cultural landscape **of the project area and the area of potential effect.**. Under this Alternative, mechanical methods of removal and treatment would be used in specific areas where activities will have **none to negligible adverse effect** on archeological sites and ethnographic resources; i.e., mechanical methods would not be used on or too close to stacked walls, and an archeologist will monitor project actions as required to ensure no impacts to known archeological sites. An archeologist will monitor in areas where ground-disturbing activities (vegetation removal from soils) have potential to impact unknown buried archeological deposits. Helicopter operations would avoid archeological resources and would not land in the project area. Helicopter flights would hover above staging areas to sling-load material from Staging Area 1 to Staging Area 2. Pedestrian, UTV, machinery, and on-water access (Hawaiian canoe, float, or skiff) and would avoid archeological resources. As under Alternative 1, protective mats and/or constructed, temporary trail surfaces would be used to minimize or eliminate impacts to ground-surface archeological resources. If impacts were to occur, such as slight displacement of soil and/or cultural material, they are expected to **be imperceptible to negligible**. Under Alternative 2, active restoration of native plants will avoid archeological sites such as stacked walls, terraces, and platforms within the wetland. Outplanting areas will be approved by the archeologist. Volunteer community involvement would include pre-work briefings with instructions on how to avoid impacts to archeological resources, ethnographic resources in the project area, and the area of potential effect. Volunteers would be led by NPS staff and/or trained designated person(s). Staging areas would be located adjacent and upland of the wetland along the south shore of ‘‘Aimakapā and at temporary sites within the Project Area on the north and eastern areas. Staging Area 1 would be used for temporary staging and drying of material removed from throughout the wetland. At all locations, drying racks would be constructed and located to avoid archeological resources. Protective mats and/or constructed, temporary surfaces and access routes to and

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Cultural Resources (Continued)	**Cumulative impacts** to the Park's archeological resources, ethnographic resources, and cultural landscape in combination with Park operations (i.e., other projects to remove nonnative plants from archeological sites within the Park), and Na Leo Kahiko Cultural Center activities would **beneficially** contribute to mitigating regional long-term cumulative adverse impacts to cultural resources resulting from introduced species and urban development.	between the drying racks would be used to minimize or eliminate impacts to ground-surface archeological resources. If impacts were to occur, they are expected to be **imperceptible to negligible** such as slight displacement of soil and/or cultural material. Staging areas will be sited in a location that does not include stacked features such as walls, platforms, terraces, etc. Staging Area 2 is an already disturbed area to be used for staging, drying and/or composting of material removed from the wetland. Aquatic species control, once approved, will be conducted in a manner which will have no adverse effect on archeological resources, ethnographic resources and the overall cultural landscape of the project area. **Cumulative impacts** would be the same as under Alternative 1 with greater intensity of **beneficial, and moderate to major regional impacts.**
Visitor Experience	Under Alternative 1, the visitor experience in the park would continue to be affected by the presence of nonnative plants and animals and their effects on the natural and cultural landscape, resulting in **adverse** effects to some visitors. **Adverse** effects to visitor experience associated with control methods for nonnative species would continue to be **site-specific, negligible to minor** resulting from the temporary noise of gas-powered tools and UTVs, and encounters with UTV on park trails during crew access to sites and removal of material. Even limited restoration of 'Aimakapā wetlands will improve visitor experience by enhancing special status species use of the wetlands and result in **minor, site-specific, and beneficial** impacts to visitor experience. Under this alternative, there would be no change to visitor access and programs. Fishpond environs would continue to be closed to access by the general visiting public to protect endangered waterbirds from harassment and regenerating native plants from trampling. Interpretation of the fishpond, and the native plants and animals found there would continue through distribution of site brochures. Commercial bird-watching tours and individual bird-watching from the beach berm outside the wetland areas of the Park would continue. However, a volunteer corps would not be formed to partner in the stewardship and restoration of ''Aimakapā.	Under Alternative 2, wetland areas of nonnative plant infestation would be treated by a combination of methods with an increased use of periodic helicopter operations to carry material via sling-load. Planned treatment/re-treatment timing would occur on an optimal schedule based on monitoring and rates of regrowth or re-establishment of the nonnative plant species and native plants would be actively outplanted. This more systematic and aggressive approach would have more immediate and successful outcome and ultimately would provide **major local, long-term, direct beneficial effects** on visitor experience. Because Alternative 2 would increase areas cleared of infestation in the wetland, and improve ecosystem integrity, the impacts of Alternative 2 on visitor experience would be similar to those discussed for Alternative 1, with **adverse** impacts slightly higher in intensity from temporary, site-specific noise where larger machinery and periodic helicopter transport of plant waste is used, and **beneficial** effects higher from increased wildlife watching opportunities and traditional management opportunities. Periodic closures of the Mauka-Makai Trail between 'Aimakapā and Staging Area 2 during helicopter operations (potentially 1 day per month to 1 day per quarter) will negatively impact park visitors by temporarily restricting areas of the park. Fishpond environs would continue to be closed to individual access by the general visiting public to protect endangered waterbirds from harassment, particularly during nesting, and to protect regenerating native plants from trampling. Newly opened areas and vistas may attract more people into the wetland, potentially causing harassment of native wildlife. However, traditional cultural management of the fishpond and environs are an integral part of Alternative 2 and would be

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
	Cumulative impacts to visitor experience in combination with Park operations and Na Leo Kahiko Cultural Center activities would be **imperceptible**.	encouraged where these practices are feasible, compatible with the mission of the Park, and do not have adverse effects on natural and cultural resources, resulting in **beneficial park-wide and regional, minor to moderate** effects on cultural practitioners' experience. Park interpretation programs would expand to include specific education and outreach about the restoration process and 'Aimakapā's natural and cultural history. Volunteer stewardship opportunities would be created to engage the community in the restoration of 'Aimakapā ideally resulting in a core of individuals with a wide range of knowledge and interests who may desire to demonstrate, teach, or learn Hawaiian cultural pursuits and natural area preservation. These programs result in **beneficial park-wide and regional minor to moderate** effects on visitor experience. Active restoration would decrease infested areas in the wetlands somewhat more quickly than under Alternative 1. Active restoration activities would result in **site-specific to local long-term, minor to moderate beneficial** impacts to the visitor experience. Under Alternative 2, ultimately, nonnative fish would ultimately be controlled as part of the long-term restoration and management of 'Aimakapā Fishpond and wetland following a separate environmental review of specific control methods. Future removal of Mozambique tilapia would benefit native wildlife at 'Aimakapā and in so doing, would **benefit the visitor experience**. Visitor experience may be temporarily adversely affected, depending on the method of control ultimately chosen, because removal of fish from the 12-ac pond is likely to be highly labor intensive for a period of time and will involve high-level of human presence in the pond environs during that time. The effect on visitor experience is anticipated to be **site-specific, short-term, moderate, and adverse**. **Cumulative impacts** to visitor experience in combination with Park operations and Na Leo Kahiko activities would be **beneficial and appreciable** because increased volunteer and education programs would integrate with and build upon Na Leo Kahiko Cultural Center programs and will result in beneficial regional impacts through the involvement of **mālama** (taking care) groups and Hawaiian cultural practitioners.

Impact Topics	Alternative 1 – Continue Current Management & Existing Programs	Alternative 2 – (Proposed Action). Framework for Wetlands Restoration and Management: Increased Planning and Monitoring, Selective Use of Vegetation and Predator Control Methods, Management of Existing Hydrologic Conditions, Enhanced Community Involvement, Active Restoration of Native Plants, and Aquatic Invasive Species Control.
Climate Change	Under Alternative 1, there would be **no change from current levels of greenhouse gas emissions** associated with restoration and management actions at ʻAimakapā Fishpond and wetlands. The NPS would continue to actively engage in long-range climate planning for all park resources. As sea level changes occur, all coastal wetlands will alter and migrate. Under Alternative 1 limited restoration action taken at ʻAimakapā would have only a **site-specific, short to long-term, negligible to no beneficial** effect on increasing the resiliency of endangered waterbird populations to withstand future climate-driven habitat shifts. **Cumulative impacts** of changing climate conditions (e.g., lower rainfall) in combination with urban development and the location of water supply wells upslope of the park has the potential to **appreciably negatively** affect the quality and quantity of groundwater available to the ʻAimakapā ecosystem, and the level of seawater intrusion to the pond and associated anchialine pools. Changing climate conditions will also cause the inland migration of anchialine pools while inundating coastal pools.	Under Alternative 2, there would be a **negligible increase in current levels of greenhouse gas emissions** associated with restoration and management actions at ʻAimakapā Fishpond and wetlands depending on the frequency of use of large machinery and helicopter. Under Alternative 2, the NPS would continue to actively engage in long-range climate planning for all park resources and would establish wetlands monitoring to make recommendations for potential management actions regarding climate change beyond the 15-yr management timeline. Under this alternative the NPS would formulate an action plan with local/federal agencies specifically for a potential breach by storm surge or tsunami of the beach fronting ʻAimakapā Fishpond within the next 15 years. If feasible, the beach would be replenished to close the breach. As sea level changes occur, all coastal wetlands will alter and migrate. Restoration action taken at ʻAimakapā under the Proposed Action would have a **site-specific to regional, short to long-term, moderate to major beneficial** effect on increasing the resiliency of endangered waterbird populations to withstand future climate-driven habitat shifts. **Cumulative impacts** are the same as described in Alternative 1, and in addition, the planned restoration and management of ʻAimakapā will **noticeably to appreciably enhance both local and statewide** breeding populations of endangered waterbirds and increase their resiliency to withstand future climate-driven habitat shifts.

Conclusions

The following conclusions are a brief summary of the potential impacts that are presented by impact topic in Table 3. Please see Table 3 for detailed discussion of these potential impacts, and the *Methodology Section* for definitions of impact type, context, duration, and intensity.

Alternative 1, No action, continue current management and programs.

Under Alternative 1, adverse impacts to geology, soils, topography, and water resources would continue to be site-specific to ʻAimakapā wetlands, are short-term, and range from negligible to minor. There are also site-specific, long-term, beneficial effects to these resources as a result of removing nonnative plant biomass, increasing open water, and improving wetland hydrology. Adverse impacts to special status species, native wildlife, and vegetation would continue to be site-specific, ranging from during the restoration actions to beyond, and from negligible to minor. Beneficial impacts to these resources are site-specific and short to long-term as a result of localized removal of nonnative plants and predator control. The archeological resources, ethnographic resources and the overall cultural landscape of both ʻAimakapā and the Park (the area of potential effect) would continue to experience site-specific, beneficial, short-term to potentially long-term direct effects under continuation of current level of management or nonnative wetland plants at ʻAimakapā. Visitor experience would continue to suffer negligible to minor impacts resulting from continuing presence of nonnative species, and site-specific temporary noise and activity associated with control methods. Alternative 1 would continue to have only a site-specific, short to long-term, negligible to no beneficial effect on increasing the resiliency of endangered waterbird populations to withstand future climate-driven habitat shifts. There would be no change from current levels of greenhouse gas emissions.

Alternative 2 (Proposed Action)

Under the Proposed Action, adverse impacts to geology, soils, topography, and water resources would be site-specific to localized, short-term, and range from negligible to moderate. Potential impacts to wetlands habitat or individuals of special status and native wildlife species from a spill or leak during large equipment fueling or a significant maintenance issue would increase impacts to minor-to-moderate, and adverse. Under Alternative 2, site-specific, long-term, moderate to major beneficial effects on soils, special status species, native wildlife, and vegetation would result from enhanced planning and larger scale actions for the removal of nonnative plant biomass and nonnative animals. These beneficial effects include restored ecosystem structure and function including a shift in soil chemistry and nutrient cycling towards natural system levels, increased open water, improved wetland hydrology, improved habitat for native aquatic insects, and increased native plant restoration. Adverse impacts to special status species, native wildlife, and vegetation would be site-specific, short–term, and range from negligible to moderate. These potential impacts are offset by multiple beneficial effects to these resources, including restoration of ecological integrity and biodiversity of

the wetlands system, and a more rapid return to natural hydrologic conditions. Restoration of wetlands habitat would have long-term, beneficial population-level effects on endangered waterbirds by increasing breeding and fledging success accomplished through increased availability of native habitat with improved ecological integrity, and more efficient predator control. The proposed restoration and management action is a more systematic and aggressive approach than under Alternative 1, and would result in more immediate and successful outcomes for protection and preservation of historic properties in the project area. Additionally, the proposed action would provide site-specific to regional, long-term, direct and major beneficial effects on archeological and ethnographic resources, and on the overall cultural landscape in the project area and the area of potential effect, and would contribute more towards mitigating regional long-term cumulative adverse impacts to West Hawai‘i’s historic properties and landscape resulting from the relentless damage of nonnative plants and loss to urban development. Visitor experience would suffer with greater intensity from temporary noise and activity associated with control methods and helicopter operations, and temporary trail closures. These impacts would be offset somewhat by more rapid improvement in habitat for native wildlife, and through active plant restoration, improving native viewsheds and wildlife viewing. Alternative 2 would result in in beneficial park-wide and regional, minor to moderate effects on visitors and cultural practitioners from expanded interpretation programs and stewardship opportunities. Alternative 2 would have a site-specific to regional, short to long-term, moderate to major beneficial effect on increasing the resiliency of endangered waterbird populations to withstand future climate-driven habitat shifts. There would be a negligible increase of current levels of greenhouse gas emissions from helicopter and large equipment.

List of Preparers

Preparers

Sallie Beavers, NPS
Melanie Truan, UC Davis
Tyler Paikuli-Campbell, NPS,
Jeff, Zimpfer, NPS

Contributors

Bybee, Joz, NPS
Chiron, Janette, NPS
Engilis, Andrew, UC Davis
Gmirkin, Rick, NPS
Godden, Rae, NPS
Gross, Danielle, NPS
Hayes, Malia, NPS-
Ho‘opai, Kendall, NPS
Hu, Darcy, NPS

Jokiel, John, NPS
Lizama, Tanya, NPS
Margriter, Sandra, NPS
Naboa, Deona, NPS
Nico, Leo, USGS
Noon, Kevin, NPS Water Resources Division
Waddington, Scott, Consultant

Agencies, Organizations, and Persons Consulted

Makani Hou o Kaloko-Honokōhau
Kaloko-Honokōhau Descendants
Advisory Council on Historic Preservation
Army Corps of Engineers
Hawai‘i State Historic Preservation Division
Hawai‘i Audubon Society
Hawai‘i Wildlife Center
Hawai‘i Department of Forestry and Wildlife
Hawai‘i Division of Aquatic Resources
U.S. Fish and Wildlife Service, Pacific Islands Office
USGS Pacific Island Ecosystems Research Center
Anamizu, Joy, Army Corps of Engineers
Arakaki, Aric, Ala Kahakai National Historic Trail
Ball, Donna, USFWS
Burrows, Chuck, Kawainui Marsh
Brasher, Anne, USGS
Bruland, Greg, University of Hawai‘i
David, Reginald, Consultant
De Vries, Hugo, Kaelepulu Wetland, O‘ahu
Duvall, Fern, DLNR-DOFAW
Elliott, Linda, Hawai‘i Wildlife Center
Ellis, Dave, O‘ahu National Wildlife Refuge Complex, USFWS
Englund, Ronald, Bishop Museum
Foote, David, USGS
Fletcher, Chip, University of Hawai‘i
Fronda, Rizal, NPS Retired
Harvey, Forrest, NPS Water Resources Division Chief
Hood, Andrew, Wetlands Engineer, Sustainable Resources Group Int’l. Inc.
Hui Mālama Loko i‘a
Jokiel, Theresa
Kolman, Mike, Soil Scientist, MLRA Soil Survey Office Leader, USDA-NRCS
Koob, Greg, State Biologist, Pacific Islands Area, USDA-NRCS
MacKenzie, Richard, USFS
Na Hoa Pili o Kaloko-Honōkohau
Nadig, Aaron, USFWS

Nico, Leo, USGS
Oki, Delwyn, USGS
Pacific Birds Habitat Joint Venture
Reed, Michael, Tufts University
Rounds, Rachel, USFWS
Rubey, Jane, Pacific Birds Habitat Joint Venture
Silbernagel, Michael, James Campbell Wildlife Refuge, O‘ahu
Smith, Gordon, USFWS
Sin, Hans, DLNR-DOFAW
Uyehara, Kim, USFWS
Van Dyke, Peter, Amy Greenwell Botanical Garden & Bishop Museum
Vitousek, Mike, DLNR-SHPD

Appendix A: National Historic Preservation Act Section 106 Terms[1]

A **historic property (or historic resource)** is defined in the National Historic Preservation Act (NHPA) (16 U.S.C. Section 470w(5)) as any "*prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places, including artifacts, records, and material remains related to such a property or resource*." Following National Register Bulletin No. 36, "Guidelines for Evaluating and Registering Archeological Properties" (www.cr.nps.gov/nr/publications/bulletins/arch/).

An **archeological site** is "*a location that contains the physical evidence of past human behavior that allows for its interpretation*." The term **archeological site** refers to those that are eligible for or are listed on the National Register (historic properties) as well as those that do not qualify for the National Register. The commonly used term **cultural resource** does not have a consistent or legal definition.

Significance of a property refers to its ability to meet one of the four National Register criteria (A-D) (www.achp.gov/nrcriteria.html). According to National Register Bulletin No. 15, "How to Apply the National Register Criteria for Evaluation" (www.cr.nps.gov/nr/publications/bulletins/nrb15/), "*[t]he quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association*," and that meet one or more of the four criteria (A-D).

Integrity is the ability of the property to convey this significance through physical features and context. Historic properties are significant because they do meet these criteria and have integrity. Pursuant to Section 101(d)(6)(A) of the NHPA, properties of traditional religious and cultural significance to an Indian tribe or NHO may be deemed eligible for listing on the National Register.

Indian tribes, NHOs, ethnic or religious groups, communities, professional and other organizations, or the public may ascribe a cultural, historical, or religious **value** to an archeological site. The term **value** here refers to the site's worth and importance to them and their experience, regardless of whether the site possesses National Register **significance**. For example, an archeological site may be of historical or cultural value to the Mormons, or to an African-American community (See the description of the African Burial Ground at www.achp.gov/casearchive/casessum03NY1.html), or to the Order Sons of Italy in America, with or without its meeting the criteria for listing in the National Register.

Mitigation is a way to remedy or offset an adverse effect or a change in a historic property's qualifying characteristics in such a way as to diminish its **integrity**. **Treatment** is the act of mitigating those effects, or how one goes about implementing the mitigation measure(s) agreed upon in consultation. Thus, a mitigation plan for the undertaking may contain several treatment plans, one for each property being adversely affected. Data recovery is a common mitigation measure that, through implementation of a treatment plan, retrieves the important information present within an archeological site that makes it eligible before the site's integrity is compromised or destroyed.

[1] Advisory Council on Historic Preservation 2009

Appendix B: Planning Document Excerpts Relevant to ‘Aimakapā Fishpond Management

Kaloko-Honokōhau Advisory Commission Report: The Spirit of Ka-loko Hono-kō-hau (1974)

Page 28:
PRESERVATION PLAN

RECOMMENDATIONS

1. The fishponds and their immediate surroundings should be restored, as nearly as possible, to the conditions that existed before the introduction of foreign influences.

2. A monitoring system should be established for water quality in offshore areas as well as inland water bodies such as springs, wells, and fishponds.

5. The area's remnant Hawaiian ecosystems should be protected from further depreciation and competition by exotic plants and animals.

6. The natural environment should be preserved by protecting outstanding environmental and scenic features and by maintaining the ecological balance of the area.

Page 30:
‘Aimakapā will be restored to the extent at which it will not have an adverse effect on the wildlife that presently inhabits the pond. Further historical research will be necessary to determine what place wildlife such as the *āe‘o* the *āe‘o* (Hawaiian stilt), *koloa* (Hawaiian duck), and the *‘alae-ke‘oke‘o* (Hawaiian coot) actually had in the fishpond during historic and prehistoric times.

Page 34
In order to further preserve and restore the historical integrity of the Ka-loko, Hono-ko-hau settlement area, a long-term plan will be designed to eradicate the exotic vegetation and animal life which now dominate the area. The park will then be replanted with native vegetation, such as the *noni* and *‘ilima* plants and *hala, milo kou,* and coconut trees, all of which had functional uses and are still growing in Ka-loko, Hono-ko-hau. In general, then, the preservation plan of the park is based on the historic-cultural importance of the settlement rather than on individual archeological or environmental features. When all these features are preserved and restored they will become what the Ka-loko, Hono-ko-hau settlement was -- the Hawaiian culture as it was.

Page 41:
INTERPRETATION PLAN

Stabilization and Restoration

A major program will be implemented to analyze and determine which archeological sites within the park should be restored, stabilized, or merely left alone. These determinations would be part of the overall interpretive concept that will complement the cultural demonstrations and assist in the educational program. For example, the restoration and operation of Ka-loko, and ‘Aimakapā fishponds as food producers would be a dominant cultural exhibit in the park. ‘Aimakapā; would also double as a wildlife sanctuary which provides a major scenic and wildlife attraction for park visitors. [see page 30 above]

Page 52:
On-Site
The acquisition and development of Ka-loko, Hono-kō-hau by the National Park Service will allow direct management control over on-site resources. Among other things, this will enable the National Park Service to:

1. Control uses of park lands and adjacent waters;
2. Implement preservation and restoration projects, including (a) the restoration and operation of the fishponds and other historic features; and (b) the re-establishment of the area's endemic plant and animal species;"

Kaloko-Honokohau National Historical Park General Management Plan/EIS 1994
Page 39
Proposed Action
Resource Protection and Management
The Spirit of Ka-loko-Hono-ko-hau study report states that the park's resources have aesthetic, cultural, archeological, historic, and scientific value, and describe them as an irreplaceable public trust. The report's recommendations for resource preservation include establishing a monitoring system for water quality for the park's offshore waters, fishponds, and anchialine pools; eradication of exotic vegetation and animal life; restoring native vegetation; and maintaining the privacy and sacredness of burial sites. Further, the report calls for the clearing of the undergrowth at Kaloko fishpond and the restoration of ʻAimakapā to the extent that the wildlife inhabiting the pond will not be adversely affected. The Spirit report also discusses the implementation of a program to analyze and determine which archeological sites within the park should be left alone, stabilized, or restored. Kaloko and ʻAimakapā fishponds were specifically mentioned for restoration to permit their future use for fish production. ʻAimakapā, however, is to double as a wildlife sanctuary.

Page 66
Proposed Action
"Management Zoning
Natural Environment/Historic Preservation Subzone (55 acres).
ʻAimakapā fishpond is clearly one of the most important cultural features found in the park, yet the pond and adjacent wetlands also provide essential habitat for two and potentially three native Hawaiian water birds -all listed as endangered species under the Endangered Species Act. Consequently, the prescribed zoning for the pond and the adjacent wetlands is to be an overlapping of both the Historic Preservation Subzone and the Natural Environment Subzone. In the case of ʻAimakapā, because of its importance as endangered species habitat, the management emphasis is to be on natural resources. At Kaloko fishpond resource management strategies will focus on the physical restoration of the pond and the restoration of its capability to once again be a producing Hawaiian fishpond. Resource management strategies will also lead to restoring the potential of Kaloko fishpond and the adjacent wetlands to provide breeding habitat for the federally endangered Hawaiian coot and stilt. Management zoning in this particular area will also need to be an overlapping of the Natural Environment Subzone and the Historic Preservation Subzone. For Kaloko fishpond, however, the management emphasis is to be on cultural resources.

Appendix C: Coordinated Management Actions

Various management plans for wetlands and recovery plans for protected species and were consulted in the development of this Management Plan/EA. The NPS will take a coordinated, ecosystem-based approach to improve and protect habitat values for the assemblage of native species at ʻAimakapā and benefit the recovery of endangered species. The following recommended management actions were drawn and combined from the *Recovery Plan for Hawaiian Waterbirds* (USFWS 2011b), the *U.S. Pacific Islands Regional Shorebird Conservation Plan* (Engilis and Naughton 2004), *Hawaiʻi's Comprehensive Wildlife Conservation Strategy* (Mitchell et al. 2005) which also includes flora species of greatest conservation need), the *Strategic Plan for Wetland Conservation in Hawaiʻi* (Henry 2006), the *Kaloko-Honokōhau National Historical Park General Management Plan/EIS* (NPS 1994), and *Vegetation Management Strategies for Three Parks on Hawaiʻi Island* (Pratt 1998) as especially relevant to restoration and management of ʻAimakapā Fishpond. These actions are specifically addressed in *Chapter 2: Alternatives, NPS Proposed Action* section of this Management Plan/EA.

- **Secure water sources and manage water levels to maximize 1) endangered waterbird nesting success, brood survival, and food availability, 2) recruitment of waterbirds, migratory waterfowl and shorebirds to the habitat, and 3) native fish habitat.** At ʻAimakapā Fishpond, water levels cannot currently be managed directly and groundwater input is the water source. However, cooperative participation by the NPS in regional water development and conservation planning can aid in securing groundwater sources to benefit ʻAimakapā wetland functioning.
- **Manage vegetation to maximize 1) endangered waterbird nesting success, brood survival, and food availability, and 2) recruitment of waterbirds, migratory waterfowl, and shorebirds to the habitat.**
    - Encourage desirable plant species.
    - Eradicate or control undesirable plant species.
    - Prevent introduction of invasive nonnative plants including accidental introduction of nonnative plants by people or equipment used in the restoration and management of wetlands.
    - Monitor nonnative plant removal and native plant restoration efforts for adaptive management.
- **Eliminate or reduce and monitor avian predator populations using best management practices available.**
    - Control small mammalian predators (mongooses, feral cats, and rats).
    - The presence of feral cat colony feeding stations adjacent the Park may significantly affect endangered waterbird recovery at ʻAimakapā. The NPS will continue to seek opportunities for public education and cooperative conservation of Hawaiʻi's wildlife with the State of Hawaiʻi, neighboring landowners, and stakeholders operating outside of the Park boundary to eliminate care-taking of feral cat colonies on lands adjacent the National Park.
    - Predators displaced from neighboring lands recently cleared for development is of concern. The NPS will continue to work with USFWS and developers of neighboring properties to encourage programs to control mongoose on those

parcels before and during land clearing activities to protect wildlife within the park from ingress of displaced mongoose and other predators.

- Control / haze cattle egrets.
- Control tilapia.

- **Minimize human disturbance to waterbirds and their habitats, and control human access to waterbird habitats during the breeding season.** Endangered Species Act Section 7 consultations between the National Park Service and the US Fish and Wildlife Service will establish how and when restoration and follow-up maintenance activities may or may not occur in order to protect listed species and their habitat.
- **Minimize the influence of urban encroachment.** Urban encroachment affects predator populations, water source, water quality, and increases harassment of protected species. Cooperative participation by the NPS in regional urban development planning and community education and conservation can aid in in diminishing these threats.
- **Monitor and control avian disease.** Diseases include, but are not limited to avian botulism, cholera, malaria, pox, avian influenza, and West Nile virus.
  - Monitor waterbird populations for early detection of disease outbreaks.
  - Implement a disease monitoring and response protocol.
- **Monitor water quality and hydrology**
  - Restrict introduction of contaminants and minimize contamination of wetland and fishpond habitat by toxic substances/contaminants from point and nonpoint source pollution.
  - Assess water quality and other parameters that influence wetland productivity for avian species.
- **Monitor populations of native plants, endangered waterbirds, migratory waterfowl, shorebirds, and if possible, aquatic invertebrate prey populations used by avian species and fish.**
- **Increase public awareness and understanding of key resource issues:**
  - The importance of Hawai‘i’s wetlands native biodiversity.
  - The perpetuation of traditional Hawaiian cultural uses and relationships to ‘Aimakapā Fishpond and wetlands.
  - The effects of invasive species on Hawai‘i’s wetland ecosystems, and cultural sites and practices; and what individuals can do to prevent invasions.
  - The process of Pacific avian migration, shorebirds as part of Hawai‘i’s biota, threats, and the importance of protection and restoration of habitats for migrant shorebirds.
  - Promote and coordinate community stewardship actions with local education institutions, non-profit groups, and community based groups.
  - Expand understanding of Hawaiian waterbird and wetland ecology through scientific research with university and agency partnerships.

Appendix D: Vegetation Palette

List of existing and potential native plants at ʻAimakapā Fishpond, wetlands, and upland environs.

Hawaiian Name	Scientific Name	Type / Cultural Use	Wetland Indicator Status[1]; Habitat & Outplant Notes
Wetland Plants			
Unknown (widgeongrass)	*Ruppia maritima*	Sea grass / Unknown	**OBL**; aquatic plant; full sun; tolerant of a wide range of salinity and temperatures; grows in low-nutrient sand/coral; decimated by tilapia; food source for *ʻalae keʻokeʻo*
ʻAeʻae	*Bacopa monnieri*	Aquatic perennial herb / Unknown	**OBL**; aquatic and terrestrial mud flats, full/partial sun; tolerant fresh to brackish; clumping/spreading; outplant 6 in to 1 ft apart, will spread to 4 ft; propagate through cuttings; excellent habitat for invertebrate food source for native waterbirds; weed around *Bacopa* stands to create buffer for subsequent clearing of *Paspalum*
Makaloa	*Cyperus laevigatus*	Perennial herb flat sedge / Multiple uses including clothing, cordage, mats, medicinal	**OBL**; wet mudflat substrate; fresh to brackish water; spreads to 8 ft; short-lived; formerly abundant in marsh on north side of ʻAimakapā, still present in smaller stands; suitable to collect 10% seeds for future plantings; seeds are dry, light brown and papery when ripe; will also regenerate in the same location with continuous moisture; best propagated by divisions; Clumps require 10 to 15 stems and must include an underground rhizome; plant clumps from 1 to 3 ft apart - will spread rapidly by rhizomes to form a large fibrous root mat; is subject to crowding by other plants - cylindrical barriers could be used during restoration; subject to depletion from over-collection for mat weaving; an essential breeding habitat plant for proposed endangered damselfly and shelter plant for diurnal ʻ*opae ʻula* including candidate endangered *Metabetaeus lohena*
ʻ*Akaʻakai*	*Schoenoplectus tabernaemontani*	Perennial herb sedge bulrush / Used by early Hawaiians for mulch, mats, thatching, and multiple medicinal uses	**OBL;** Very tall sedge (8-10 ft); aquatic (in water) or wet substrate; full sun; fresh to salt water; spreads >8 ft; long-lived > 5 yrs; outplant in clumps of at least 1 ft wide for rhizomes to spread, space 1 to 3 ft apart; provides food (hard-coated fruits), nesting material, and cover for waterbirds; no record in Park surveys, could be considered for restoration outplanting
Kaluha	*Bolboschoenus*	Perennial herb	**OBL**; aquatic to terrestrial; moist to wet substrate; will tolerate waterlogged soil; full

[1] Percentages are frequency at which species are found in wetlands: Obligate wetland species (OBL) > 99%, facultative wetland species (FACW) 67-99% , facultative species (FAC) 34-66%, facultative upland species (FACU) 1-33%, and upland plant species (UPL) < 1% (Erickson and Puttock 2006).

Hawaiian Name	Scientific Name	Type / Cultural Use	Wetland Indicator Status[1]; Habitat & Outplant Notes
	maritimus	sedge / Unknown	and partial sun; grows with a soil pH of 6.0-9.0 in fine clay, silty loam, or sand and is tolerant of alkaline and saline soils; roots form a thick interwoven mass that helps with soil erosion in wetlands sites and filters waste products from the water; outplant at 1 to 1.5 ft spread; best establishment comes from planting plugs (either from the greenhouse or wild transplants) will fill in within one growing season; soil should be kept saturated & can handle from 2 to 3 in of standing water during the establishment year; Wild plants for transplant can be collected and transplanted directly into the desired site; care should be taken not to collect plants from weedy areas and the hole left at the collection site may fill with undesirable species; will reseed on site; seeds can be stored in refrigerator for future sowing small hairs on seeds can irritate the skin; formerly common near edge of open water at ‘Aimakapā; provides a food source, and nesting cover for native waterbirds;
‘Ahu‘awa	*Cyperus javanicus*	Indigenous perennial herb sedge / Cultivated by early Hawaiians for cordage, lei, multiple medicinal uses, dye brushes, strainers	**FACW**; can grow in dry, moist and wet conditions, and in standing water to ~8 in; fresh to brackish water; flood tolerant; full and partial sun; spread of >2 ft; short-lived <5 yrs; will naturally reseed; stands can be divided propagation & outplanting; outplant 2 to 4 ft apart; leaf blades are very sharp; used as food, nesting material and shelter by native waterfowl;
Unknown (manyspike flatsedge)	*Cyperus polystachyos (Pycreus polystachyos)*	Annual or perennial herb flat sedge / Unknown	**FACW**; grows in dry and wet soils in open habitat; rare in park, found on transects North & South of ‘Aimakapā 1996; produces numerous tiny seeds consumed by many different waterbird species
Mau‘u aki‘aki	*Fimbristylis cymosa*	Perennial herb fimbry sedge / Unknown	**FAC**; full sun; grows on sandy beaches, cracks or soil pockets in lava & among rocks, tolerates waterlogged soil; found on pahoehoe south of ‘Aimakapā 1996; spreads 4 to 8 in; long-lived
Unknown	*Fimbristylis dichotoma*	Perennial herb fimbry sedge / Unknown	**FAC;** full sun; does best in moist to wet situations, will grow, flower, and fruit with roots submerged in water; short-lived < 5yrs, plants will reseed; outplant spacing 1 ft apart; reported by Canfield (1990) described as widespread in a variety of habitats in Park, but not seen in Park during 1992-93 survey
‘Ākulikuli	*Sesuvium portulacastrum*	Succulent perennial herb / All fleshy parts said to be edible (raw or cooked)	**FAC**; soil range dry to wet; fresh to brackish salinity; full sun; outplant 6 to 12 in apart; spreads from 1 and 4 feet or more; excellent habitat for invertebrate food source for native waterbirds. Important shelter plant for anchialine pool invertebrates.
Kīpūkai	*Heliotropium*	Succulent perennial herb /	**FAC**; salt tolerant waterlogged marshy or sandy soils; full sun; spreads from 1 to 4 feet

Hawaiian Name	Scientific Name	Type / Cultural Use	Wetland Indicator Status[1]; Habitat & Outplant Notes
	curassavicum	Dried, tea brewed as a tonic; medicinally used as ointment for weeping sores	or more; lives < 5 yrs; not currently found at ‘Aimakapā
Pōhuehue	*Ipomoea pes-caprae subsp. brasiliensis*	Indigenous perennial vine / Cordage, food (famine), lei, medicinal *with caution*	**FAC**; full sun; well drained substrate; vines spread 7 to 15 ft; long-lived >5 yrs; grows on sandy beaches, lowland marshes, and occasionally inland
‘Aki‘aki	*Sporobolus virginicus*	Indigenous perennial grass / Leaves, culms and roots used medicinally	**FAC;** terrestrial; occurs on coastal dunes and other coastal sites just above the high tide mark to about 50 ft; Abundant in 1987 sandy back of strand at *makai* edge of ‘Aimakapā and on pahoehoe on NW side; occasional on sandy strand SW of ‘Aimakapā (Canfield 1990:19); likely grows mixed with *Paspalum* in ‘Aimakapā wetlands (Pratt&Abbot:42); does very well as a dune stabilizer; propagate by rhizomatous slips
Alena	*Boerhavia repens*	Perennial herb / Early Hawaiians used the large roots for medicinal purposes	**FAC**; salt tolerant, prostrate herb; dry substrate; spreading; found on beach near Kaloko Pond, but not ‘Aimakapā in 1992-3; potential for outplant on upland pahoehoe
Upland Plants			
Ohelo kai	*Lycium sandwicense*	Perennial shrub / Berries used for lei	**FACU**; dry terrestrial substrate, full sun; spread to >6 ft; However, at ‘Aimakapā found in wetland among stands of pickleweed, which it resembles; avoid chemical spray drift, use wicking treatments for pickleweed where it associates with *Lycium*.
Naupaka kahakai	*Scaevola sericea* (syn: *Scaevola taccada*)	Perennial shrub / Medicinal uses (fruit and bark); food (fruit; journey or famine); lei	**FACU**; terrestrial, dry substrate; full sun; shrub spreads to 15 ft or more; long-lived; in 1996 common on margin of ‘Aimakapā. Common on margins of anchialine pools where it serves as a shelter plant and possible breeding habitat for anchialine pool invertebrates.
Pā‘ū o Hi‘iaka	*Jacquemontia ovalifolia* subsp. *sandwicensis*	Perennial herb vine / Multiple medicinal uses; dried leaves and stems made into tea	**UPL**; terrestrial, dry substrate; full and partial sun; found on pahoehoe south shore ‘Aimakapā; 3 to 10 ft spread; outplant 12 to 18 in apart; long-lived >5yrs

Sources: Erickson and Puttock (2006); Pratt and Abbott (1996); and Canfield (1990). Horticultural and ethnobotanical information derived from Native Plants Hawai‘i database, University of Hawai‘i (http://nativeplants.hawaii.edu/plant/; Accessed June 2014) and USDA Plants Profile (http://plants.usda.gov/core/profile; Accessed June 2014).

Appendix E: Avian Disease Monitoring & Response

Diseases that affect endangered waterbirds include avian botulism, avian cholera, avian malaria, pox, avian influenza, and West Nile virus. Botulism type C of the bacterium *Clostridium botulinum* is a natural toxin commonly found in the soil that does not affect humans but is deadly for native and migratory waterbirds. Avian botulism is a pervasive threat in Hawaiian wetlands therefore disease monitoring is an essential part of ʻAimakapā wetland area management. Morin (1996a) documents the only recorded outbreak of *Clostridium botulinum* type C at ʻAimakapā Fishpond to date. Affected species included *ʻalae keʻokeʻo* (Hawaiian coot) and *aeʻo* (Hawaiian stilt), as well as migratory waterfowl, primarily northern shoveler (*Anas clypeata*) and northern pintail (*Anas acuta*). Continuous rigorous removal of fish and bird carcasses eventually controlled the outbreak. The *ʻalae keʻokeʻo* population was more heavily affected than the *aeʻo* population (Morin 1996a).

Being observant of "unusual" behavior in birds and of the presence of animal carcasses is the key to early disease detection. Unusual behavior includes: birds showing an inability to fly or poor flight, depressed behavior or weakness, inability to walk, or hold up their head. Disease response measures at ʻAimakapā include removal and treatment of sick birds, and removal of all carcasses: birds, fish, reptile, mammal, and invertebrate–e.g., snails, worms, crabs). The *C. botulinum* bacteria need protein to produce its toxin and carcasses are an excellent source; removal may prevent, interrupt, or stop the toxin production. Decaying organic matter and rotting vegetation are other potential sources of energy; therefore, care must be taken to remove these materials to upland areas during vegetation control and restoration.

In Hawaiʻi, avian botulism appears to occur year-round without seasonal pattern. Spores of *C. botulinium* are widely distributed throughout wetland sediments and are also in the tissue of wetland animals. Little is known about the optimal combination of environmental factors that cause an outbreak. Conditions that elevate wetland sediment temperatures and decrease dissolved oxygen, such as shallow water and decaying material, may increase outbreak risk. Physical factors such as temperature, pH, salinity, and oxidation-reduction potential also appear to influence the risk of outbreaks, particularly when pH is 6.2 to 10.5 and water temperature is 86-99º F.

The Kaloko-Honokohau NHP avian botulism management and response actions described below will be taken to prevent outbreaks and to restrict the disease's spread and severity.

1) Pre-outbreak. Frequent canvassing of wetlands to scout for sick or dead birds. All park staff who regularly work at, patrol, or pass by Aimakapa will be trained to scan for sick or dead birds and fish as part of their regular duties. When found, notify Resource Management (RM) and immediately remove the animal or carcass for treatment or laboratory analysis. Animal carcass PPE kits are provided by RM to all roving park staff. The Standard Operating Procedure for injured, stranded, or dead wildlife and the *Hawaiian Avian Botulism Guidelines* (Hawaiʻi Wildlife Center 2013) will be followed and are located on the Park's server at S:\Wildlife Stranding SOPs.

2) During outbreak. If an outbreak is underway, canvassing of wetlands will increase to twice a day, and all sick birds hiding in vegetation must be found. Increase monitoring at carcass deposition hot-spots (downwind shoreline areas) during critical times for early detection. Dead birds (up to five) in good condition will be collected and refrigerated. The USGS National Wildlife Health Center Honolulu Field Station on Oʻahu will be contacted (808-792-9521) to

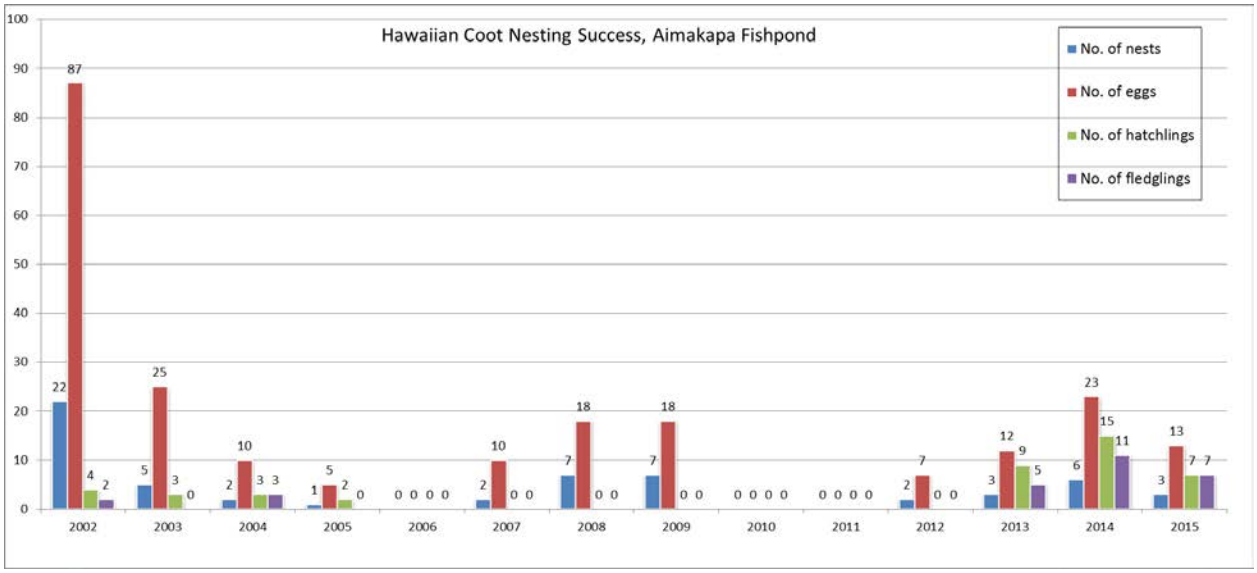
arrange carcass submittals prior to shipment. Collection and shipping instructions are also located at S:\Wildlife Stranding SOPs. Treatment for sick birds will be coordinated with the US Fish and Wildlife Service (808-792-9400) and the Hawai‘i Wildlife Center (53-324 Lighthouse Rd, Kapa‘au, North Kohala; 808- 884-5000).

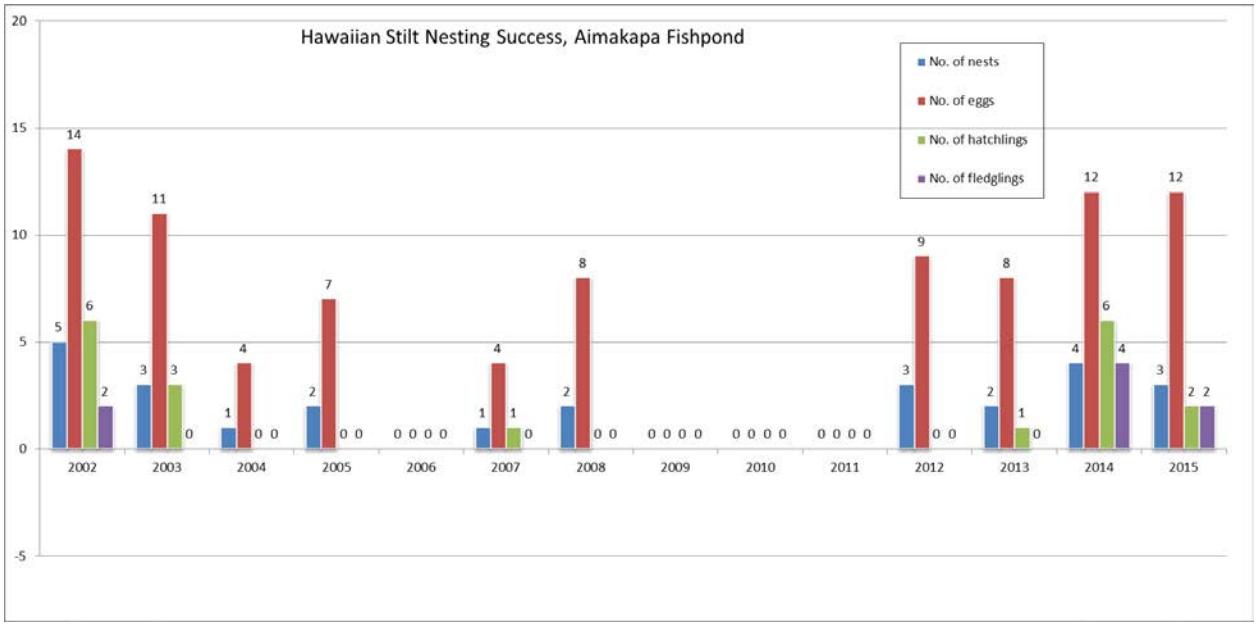
If determined to be necessary after consultation with the U.S. Fish and Wildlife Service (USFWS), birds can be hazed (flushed out or chased away) from ‘Aimakapā to keep them away from contaminated sites until the botulism bacteria can be cleared. Hazing constitutes a “take” under the Endangered Species Act and therefore must be conducted in consultation with the USFWS and with approved authorizations when dealing with listed endangered waterbirds in Hawaiian wetlands.

Resources and Training: The USGS National Wildlife Health Center Honolulu Field station (http://www.nwhc.usgs.gov/hfs/Botulism.jsp) and the Pacific Birds Habitat Joint Venture (http://www.pacificbirds.org/) have additional information and contacts, avian botulism data forms, and carcass collection instructions. Park staff will continue to receive training on how to prevent and respond to avian botulism outbreaks from the Hawai‘i Wildlife Center http://www.hawaiiwildlifecenter.org/.

Appendix F: Hawaiian Coot and Hawaiian Stilt Reproductive Success at ʻAimakapā Fishpond 2002-2014

Data are from Kona Coast Waterbird Surveys (Waddington 2002 to 2015). Nesting success for both waterbirds increased following a pilot study for removal of nonnative vegetation at ʻAimakapā in 2012 and 2013 (Truan and Metzler 2015).





References

Ansari, S. and T. Thair. 2012. Developing coastal wetland restoration techniques to enhance coastal habitats at Āhua Reef, Hickam AFB, Oʻahu, Hawaiʻi. SWCA Environmental Consultants, 1001 Bishop Street, Ste. 2800, Honolulu, Hawaiʻi. https://www.dodlegacy.org/Legacy/project/productdocs/11-320_SWCA_Technical_Report_FINAL_6eeff552-f44d-46fc-9c78-82c24d03ac79.pdf

Antonelis, G. A., J.D. Baker, T.C. Johanos, R.C. Braun, and A. L. Harting. 2006. Hawaiian monk seal (*Monachus schauinslandi*): Status and conservation issues. Atoll Research Bulletin 543:75-101.

Apple, R. A. and G. A. Macdonald. 1966. The rise of sea level in contemporary times at Honaunau, Kona, Hawaii. Pacific Science XX:125-136.

Apple, R. A. and W. J. Kukuchi. 1975. Ancient Hawaii shore zone fishponds: an evaluation of survivors for historical preservation. Office of the State Director, National Park Service, U. S. Department of the Interior, Honolulu, Hawaiʻi.

Arendt, W. J. 1988. Range expansion of the Cattle Egret (*Bubulcus ibis*) in the Greater Caribbean Basin. Colonial Waterbirds 11:252-262. http://www.jstor.org/stable/1521007

Arthur, K. E. and G. H. Balazs. 2008. A comparison of immature green turtles (*Chelonia mydas*) diets among seven sites in the main Hawaiian islands. Pacific Science 62:205–217.

Athens, J. S. and J. V. Ward. 2006. ʻAimakapā Fishpond: Paleoenvironment at Kaloko-Honokōhau National Historical Park, North Kona, Hawaiʻi Island. International Archaeological Research Institute, Inc. 2081 Young St. , Honolulu, Hawaiʻi.

Bazzano, J. 2007. Herpetological inventory in West Hawai`i national parks: Pu`uhonua o Hōnaunau National Historical Park Kaloko-Honokōhau National Historical Park Pu`ukoholā Heiau National Historic Site. Technical Report 141, Pacific Cooperative Studies Unit, University of Hawaiʻi at Mānoa, Honolulu, Hawaiʻi. http://manoa.hawaii.edu/hpicesu/techrep.htm

Bienfang, P. 2007. Assess nutrient sources, fluxes, and water quality of ponds within the Kaloko-Honokohau National Historical Park. Final Report, Hawaii-Pacific Islands Cooperative Ecosystem Studies Unit.

Black, S. H. 2005. Species Profile: *Manduca blackburni.in* M. D. Shepherd, D. M. Vaughan, and S. H. Black, editors. Red List of Pollinator Insects of North America. CD-ROM Version 1 (May 2005). The Xerces Society for Invertebrate Conservation, Portland, Oregon

Bogardus, T. 2015. Using Automatic Rat Traps for Management Unit Wide Ecosystem Benefit. Abstract 8-2, page 96. 23rd Annual Hawai‘i Conservation Conference, August 3-6, 2015, Hilo, Hawai‘i. http://www.hawaiiconservation.org/images/uploads/conference/ABSTRACT+FINAL.compressed.pdf

Bonaccorso, F. J. 2011. U.S. Geological Survey, Personal Communication.

Bond, S., Jr., and R. Gmirkin. 2003. Restoring a Part of Hawai‘i’s Past: Kaloko Fishpond Restoration. Ecological Restoration 21:284-289.

Brock, R. E. and A. K. H. Kam. 1997. Biological and water quality characteristics of anchialine resources in Kaloko-Honokohau National Historical Park. Technical Report 112, Cooperative National Park Resources Studies Unit, University of Hawai‘i at Manoa, Honolulu, Hawai‘i. http://scholarspace.manoa.hawaii.edu/bitstream/handle/10125/7396/112.pdf?sequence=1

Canfield, J. E. 1990. Description and map of the plant communities of Kaloko-Honokōhau National Cultural Park Technical Report 73, Cooperative National Park Resources Studies Unit, University of Hawai‘i, Honolulu, Hawai‘i. http://manoa.hawaii.edu/hpicesu/techrep.htm

Carson, M. T. and T. Rieth. 2008. Archeological excavations at sites 50-10-27-2252, -2253, -2254, -2255, -2256, and -2258 in Kaloko-Honokōhau National Historical Park, Hawai‘i Island. International Archaeological Research Institute, Inc., 2081 Young St., Honolulu, Hawai‘i.

Ching, F. K. W. and P. H. Rosendahl. 1968a. Archeological surface survey of the Kailua-Kawaihae Road (Section II, Honokōhau to Keahole Point) and the Keahole Point Airport. Prepared for the State Department of Transportation, Division of State Parks, Department of Land and Natural Resources, State of Hawai‘i.

Ching, F. K. W. and P. H. Rosendahl. 1968b. Archeology of North Kona: from the Ahupua‘a of Kealakehe to the Ahupua‘a of Puukala. Prepared for the State Department of Transportation, Division of State Parks, Department of Land and Natural Resources, State of Hawai‘i.

Cluff, D. F. 1971. An archeological survey of the seaward portion of Honokōhau 1 and 2, North Kona, Hawai‘i Island. Departmental Report Series 69-5, Department of Anthropology, Bishop Museum Press, Honolulu, Hawai‘i.

Cogan, D., K. Schultz, D. Benitez, G. Kudray, and A. Ainsworth. 2011. Vegetation Inventory Project: Kaloko-Honokōhau National Historical Park. Natural Resource Report NPS/KAHO/NRR—2011/462, National Park Service, Fort Collins, Colorado.

http://science.nature.nps.gov/im/inventory/veg/project.cfm?ReferenceCode=2177208

Cordy, R., J. Tainter, R. Renger, and R. Hitchcock. 1991. An ahupuaʻa study: The 1971 archeological work at Kaloko Ahupuaʻa, North Kona, Hawaiʻi, archeology at Kaloko-Honokōhau National Historical Park. Western Archeological and Conservation Center Publications in Anthropology No. 58, National Park Service, U.S. Department of the Interior.

Council on Environmental Quality. 1997. Environmental Justice Guidance under the National Environmental Policy Act. Executive Office of the President, Washington, D.C. http://www3.epa.gov/environmentaljustice/resources/policy/ej_guidance_nepa_ceq1297.pdf

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31, U.S. Fish and Wildlife Service, Washington, D.C.

Diamond, J. M. 1984. The avifaunas of Rennell and Bellona Islands. Natural History of Rennell Island, British Solomon Islands 8:127-168. Danish Science Press Copenhagen

Douglas, C. J. and S. C. Hotchkiss. 1998. Appendix A: The pollen record at ʻAimakapā Fishpond Pages 184-204 *in* Vegetaion Managment Strategies for Three National Historical Parks on Hawaiʻi Island, Technical Report 121. Cooperative National Park Resources Studies Unit, University of Hawaiʻi at Mānoa, Honolulu, Hawaiʻi.https://irma.nps.gov/App/Reference/Profile/94234/

Duarte, K. and J. Kauahikaua. 1999. Use of magnetic methods in the investigation of an ancient Hawaiian fishpond: ʻAimakapāʻa Fishpond, Hawaiʻi. Open-File Report 99-515, U.S. Geological Survey, Hawaiian Volcano Observatory, Hawaiʻi National Park, Hawaiʻi. http://pubs.er.usgs.gov/publication/ofr99515

Duffy, D. C. and P. Capece. 2012. Biology and Impacts of Pacific Island Invasive Species. 7. The Domestic Cat (Felis catus). Pacific Science 66:173-212.

Durst, M. and C. Glidden. 1999. Archeological investigations of the Honokōhau Ahupuaʻa of Kaloko-Honokōhau National Historical Park, North Kona, Hawaiʻi, 1992-1998.

Eldredge, L. G. 1994. Perspectives in aquatic exotic species management in the Pacific Islands. Volume 1, Introductions of commercially significant aquatic organisms to the Pacific Islands. Inshore Fisheries Research Project Technical Document No. 7, South Pacific Commission, Noumea, New Caledonia. http://www.botany.hawaii.edu/basch/uhnpscesu/pdfs/sam/Eldredge1994AS.pdf

Eldredge, L. G. 2000. Non-indigenous freshwater fishes, amphibians, and crustaceans of the Pacific and Hawaiian islands. Pages 173-190 *in* G. Sherley, editor. Invasive species in the Pacific: A technical review and draft regional strategy SPREP South Pacific Regional Environment Programme Apia, Samoa.http://www.issg.org/database/reference/Invasive_strategy_and_species.pdf

Ellis, D. 2013. Refuge Manager, James Campbell NWR, Oahu, US Fish & Wildlife Service, Personal Communication.

Elzinga, C. L., D. W. Salzer, J. W. Willoughby, and J. P. Gibbs. 2001. Monitoring Plant and Animal Populations. Wiley-Blackwell Malden, Massachusetts

Emory, K. P. and L. J. Soehren. 1971. Archeological and Historical Survey, Honokōhau Area, North Kona, Hawai'i. Prepared for State Department of Land and Natural Resources. Departmental Report Series 61-1, Bishop Museum Press, Honolulu, Hawai‘i.

Engilis, A., Jr. and T. K. Pratt. 1993. Status and population trends of Hawaii's native waterbirds, 1977-1987. The Wilson Bulletin 105:142-158.

Engilis, A., Jr. 2013. University of California at Davis, Personal Communication. .

Engilis, J., A., and M. Naughton. 2004. U.S. Pacific Islands Regional Shorebird Conservation Plan. U.S. Shorebird Conservation Plan. U.S. Department of the Interior, Fish and Wildlife Service, Portland, Oregon. http://www.botany.hawaii.edu/basch/uhnpscesu/pdfs/sam/Engilis2004.pdf

Englund, R. A. 1999. The impacts of introduced poeciliid fish and Odonata on the endemic *Megalagrion* (Odonata) damselflies of Oahu Island, Hawaii. Journal of Insect Conservation 3:225-243.

Engott, J. A. 2011. A water-budget model and assessment of groundwater recharge for the Island of Hawai‘i U.S. Geological Survey Scientific Investigations Report 2011–5078, U.S. Geological Survey, Honolulu, Hawai‘i. http://pubs.usgs.gov/sir/2011/5078/

Erickson, T. A. and C. F. Puttock. 2006. Hawai‘i Wetland Field Guide. Bess Press Honolulu, Hawai‘i

Fletcher III, C. H., E. E. Grossman, B. M. Richmond, and G. A. E. 2002. Atlas of Natural Hazards in the Hawaiian Coastal Zone. Geologic Investigations Series I-2761, U.S. Geological Survey, Denver, Colorado. http://pubs.usgs.gov/imap/i2761/

Foote, D. 2015. U.S. Geological Survey, Personal Communication.

Fraser, H. R., V. Parker-Geisman, and G. R. Parish, IV. 2007. Hawaiian hoary bat inventory in national parks on the islands of Hawai‘i, Maui, and Moloka‘i.

Technical Report 140, Pacific Cooperative Studies Unit, University of Hawaiʻi at Mānoa, Department of Botany, Honolulu, Hawaiʻi. http://scholarspace.manoa.hawaii.edu/bitstream/handle/10125/27411/140.pdf?sequence=1

Fronda, R., M. Lane-Kamahele, and B. Harry. 2008. Removal of alien red mangrove from Kaloko-Honokohau National Historical Park. Technical Report 162, Pacific Cooperative Studies Unit, University of Hawaiʻi at Mānoa, Department of Botany Honolulu, Hawaiʻi. http://manoa.hawaii.edu/hpicesu/techr/162/v162.pdf

Giambelluca, T. W., Q. Chen, A. G. Frazier, J. P. Price, Y.-L. Chen, P.-S. Chu, J. K. Eischeid, and D. M. Delparte. 2013. Online Rainfall Atlas of Hawaiʻi. Accessed online http://dx.doi.org/10.1175/BAMS-D-11-00228.1

Gibbs, A., S. Cochran, J. Logan, and E. Grossman. 2007. Benthic habitats and offshore geological resources of Kaloko-Honokōhau National Historical Park, Hawaiʻi: U.S. Geological Survey Scientific Investigations Report 2006-5256 U.S. Geological Survey, Reston, Virginia. http://pubs.usgs.gov/sir/2006/5256/

Gillies, C. A. and D. Williams. 2013. DOC tracking tunnel guide v2.5.2: Using tracking tunnels to monitor rodents and mustelids. Department of Conservation, Science & Capability Group, Hamilton, New Zealand. http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-animal-pests-using-tracking-tunnels-to-monitor-rodents-and-mustelids.pdf

Gomes, A. 2010. Kona's Housing Room? Honolulu Star-Advertiser, Oct 17.

Greene, L. W. 1993. A Cultural History of Three Traditional Hawaiian Sites on the West Coast of Hawaiʻi Island. Denver Service Center, National Park Service, U.S. Department of the Interior.

Grossman, E. E., J. B. Logan, M. K. Presto, and C. D. Storlazzi. 2010. Submarine groundwater discharge and fate along the coast of Kaloko-Honoköhau National Historical Park, Island of Hawaiʻi, Part 3, Spatial and temporal patterns in nearshore waters and coastal groundwater plumes, December 2003–April 2006. U.S. Geological Survey Scientific Investigations Report 2010-5081. http://pubs.usgs.gov/sir/2010/5081/

Hapke, C. J., R. Gmirkin, and B. M. Richmond. 2005. Coastal change rates and patterns: Kaloko-Honokohau National Historical Park, Hawaiʻi Open-file Report 2005-1069, U.S. Geological Survey, Santa Cruz, California. http://pubs.usgs.gov/of/2005/1069/of2005-1069.pdf

Hawaiʻi State Department of Health Clean Water Branch (DOH-CWB). 2014. 2014 State Of Hawaiʻi Water Quality Monitoring And Assessment Report: Integrated Report

To The U.S. Environmental Protection Agency and The U.S. Congress Pursuant To Sections Section 303(d) and Section 305(b), Clean Water Act (P.L. 97-117). http://health.hawaii.gov/cwb/files/2013/05/2014_Draft-Integrated-Report_public-comment.pdf

Hays, W. S. T. and S. Conant. 2007. Biology and impacts of Pacific island invasive species. 1. A worldwide review of effects of the small Indian mongoose, *Herpestes javanicus* (Carnivora: Herpestidae). Pacific Science 61:3-16.

Henry, A. R. 2006. Strategic Plan for Wetland Conservation in Hawai‘i, First Revision January 2006. Prepared for The Pacific Coast Joint Venture, Ducks Unlimited, Inc., Honolulu, Hawai‘i. http://www.pacificbirds.org/wp-content/uploads/2014/12/HWJVStrategicPlan-3.pdf

Hirth, H. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). Biological Report 97(11) U.S Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Hoag, J. C. 2000. Harvesting, propagating, and planting wetland plants. Accessed online 9/28/2015 http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmcarwproj14.pdf

Holthuis, L. B. 1973. Caridean shrimps found in land-locked saltwater pools at four indo-west Pacific localities (Sinai Peninsula, Funafuti Atoll, Maui and Hawaii Islands), with the description of one new genus and four new species. Zoologische Verhandelingen 128:3-48.

Hono-kō-hau Study Advisory Commission. 1974. The spirit of Ka-loko Honō-ko-hau: a proposal for the establishment of a Ka-loko Honō-ko-hau National Cultural Park, Island of Hawai‘i, State of Hawai‘i. Hono-kō-hau Study Advisory Commission, National Park Service, Kailua-Kona, Hawai‘i. http://www.nps.gov/kaho/learn/management/loader.cfm?csModule=security/getfile&pageid=295700

Hoover, D. and C. Gold. 2005. Assessment of coastal water resources and watershed conditions in Kaloko-Honokōhau National Historical Park, Hawai‘i. Technical Report NPS/NRWRD/NRTR-2005/344, Water Resources Division, National Park Service, Ft. Collins, Colorado. http://www.nature.nps.gov/water/nrca/assets/docs/kaho_coastal.pdf

International Union for Conservation of Nature (IUCN). 2015. The IUCN Red List of Threatened Species. Version 2014.3. Accessed online 14 March 2015, Accessed online at www.iucnredlist.org

Jansen, P. 2011. The Goodnature A24 automatic rat & stoat kill trap evaluation of humaneness. Porirua, New Zealand. http://goodnature.co.nz/img/Goodnature%20A24%20stoat%20nawac.pdf

Jenkins A. P., Jupiter S. D., I. Qauqua, and J. Atherton. 2009. The importance of ecosystem-based management for conserving aquatic migratory pathways on tropical high islands: a case study from Fiji. Aquatic Conservation: Marine and Freshwater Ecosystems 20:224-238.

Johnson, A. G., C. R. Glenn, W. C. Burnett, R. N. Peterson, and P. G. Lucey. 2008. Aerial infrared imaging reveals large nutrien-rich groundwater inputs to the ocean. Geophysical Research Letters 35:(L15606). doi 10.1029/2008GL034574

Junqueira, E. 2001. A marine archeological investigation at a partially collapsed seawall located adjacent to ʻAimakapā pond at Honokōhau Historical Park.Graduate Certificate in Maritime Archaeology and History, University of Hawaiʻi at Mānoa, Honolulu, Hawaiʻi

Juvik, S. P. and J. O. Juvik, editors. 1998. Atlas of Hawaiʻi. 3rd edition. University of Hawaiʻi Press, Honolulu, Hawaiʻi.

Kelly, M. 1971. KEKAHA: ʻAINA MALOʻO, Historical survey and background of Kaloko and Kukiʻo ahupuaʻa, North Kona, Hawaii. Report 71-2 Revised edition, October 1971, Bernice P. Bishop Museum, Honolulu, Hawaiʻi.

Kikuchi, W. K. and J. C. Belshé. 1971. Examination and evaluation of fishponds on the leeward coast of the Island of Hawaii. Compiled for the Hawaiʻi County Planning Commission, Hilo, Hawaiʻi.

Knee, K., J. Street, E. E. Grossman, and A. Paytan. 2008. Submarine ground water discharge and fate along the coast of Kaloko-Honokohau National Historical Park, Hawaiʻi; Part II, Spatial and temporal variations in salinity, radium-isotope activity, and nutrient concentrations in coastal waters, December 2003-April 2006. U.S. Geological Survey Scientific Investigation Report 2008-5128, U.S. Geological Survey, Reston, Virginia. http://pubs.usgs.gov/sir/2008/5128/

Kolman, M. 2010. Natural Resource Conservation Service, Hawaii, Personal Communication.

Lever, C. 1996. Naturalized fishes of the world. Academic Press, San Diego.

Levin, L. A., C. Neira, and E. D. Grosholze. 2006. Invasive cordgrass modifies wetland trophic function. Ecology 87:419-432.

Lowe, S., M. Browne, S. Boudjelas, and M. De Poorter. 2004. 100 of the world's worst invasive alien species: a selection from the global invasive species database, updated and reprinted version The Invasive Species Specialist Group of the

Species Survival Commission (SSC) of the World Conservation Union (IUCN), Aukland, New Zealand. Accessed online June 15, 2015. http://www.issg.org/database/species/reference_files/100English.pdf

Maciolek, J. A. and R. E. Brock. 1973. Aquatic survey of Kona Coast ponds, Hawaii Island. Terminal Report for U.S. Department of the Interior Bureau of Sport Fisheries and Wildlife Contract No. 14-16-001-4896. https://irma.nps.gov/App/Reference/Profile/10708

Maciolek, J. A. and R. E. Brock. 1974. Aquatic surveys of the Kona Coast ponds; Hawaii Island. Sea Grant Advisory Report AR-74-04, University of Hawaiʻi Sea Grant Program, Honolulu, Hawaii. https://irma.nps.gov/App/Reference/Profile/10708

MacKenzie, R. A. and G. L. Bruland. 2012. Nekton communities in Hawaiian coastal wetlands: the distribution and abundance of introduced fish species. Estuaries and Coasts 35:212-226.

Maison, K. A., I. Kinan-Kelly, and K. P. Frutchey. 2010. Green turtle nesting sites and sea turtle legislation throughout Oceania. Technical Memorandum. NMFS-F/SPO-110, National Marine Fisheries Service, Pacific Islands Regional Office, U.S. Department of Commerce, Honolulu, Hawaiʻi. http://spo.nmfs.noaa.gov/tm/110.pdf

Maly, K. and O. Maly. 2002. He wahi moʻolelo ʻohana no Kaloko me Honokōhau ma kekaha o nā Kona– A collection of family traditions describing – customs, practices and beliefs of the families and lands of Kaloko and Honokōhau, North Kona, Island of Hawaiʻi Oral History Report prepared for Kaloko-Honokōhau National Historical Park, Kumu Pono Associates, LLC, Kailua-Kona, Hawaiʻi

Marrack, L. and P. O'Grady. 2014. Predicting impacts of sea level rise for cultural and natural resources in five National Park units on the Island of Hawaiʻi. Technical Report No. 188, The Hawaiʻi-Pacific Islands Cooperative Ecosystems Studies Unit & Pacific Cooperative Studies Unit, University of Hawaiʻi at Mānoa Honolulu, Hawaiʻi. http://manoa.hawaii.edu/hpicesu/techr/188/v188.pdf

Mercer, T. 2015. Hawaiian monk seal use of Kaloko-Honokohau National Historical Park, Hawaii. PIFSC Internal Report IR-15-035

Mitchell, C., C. Ogura, D. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. Hawaiʻi's Comprehensive Wildlife Conservation Strategy. Department of Land and Natural Resources, Honolulu, Hawaiʻi. http://dlnr.hawaii.gov/wildlife/files/2013/09/CWCS-Full-Document-2005Oct01.pdf

Mitsch, W. J. and J. G. Gosselink. 2000. SPECIAL ISSUE - The Values of Wetlands: Landscapes and Institutional Perspectives. The value of wetlands: importance of

scale and landscape setting. Ecological Economics 35:25-33. ftp://131.252.97.79/Transfer/ES_Pubs/es%20articles%20-%20new/mitsch_02_es_wetlands.pdf

Moore, J. G. and D. A. Clague. 1991. Geologic map of Hualalai Volcano, Hawaii. U.S. Geological Survey Miscellaneous Investigations Series Map 1-2213, (scale 1:50,000). US Geological Survey Reston, Virginia. http://pubs.er.usgs.gov/publication/i2213

Morin, M. P. 1994. Hawaiian fishponds and endangered waterbirds on the Kona coast. Transactions of the Western Section of the Wildlife Society 30:66-71.

Morin, M. P. 1996a. Response of a remnant population of endangered waterbirds to avian botulism. Transactions of the Western Section of the Wildlife Society 32:23-33.

Morin, M. P. 1996b. Birds of Kaloko-Honokōhau National Historical Park. Technical Report 104, Cooperative National Park Resources Studies Unit, University of Hawai‘i at Manoa, Honolulu, Hawai‘i. http://manoa.hawaii.edu/hpicesu/techrep.htm

Morin, M. P. 1998. Endangered waterbird and wetland status, Kaloko-Honokōhau National Historical Park National Historical Park, Hawai‘i Island. Technical Report 119, Cooperative National Park Resources Studies Unit, University of Hawai‘i at Mānoa, Manoa, HI. http://manoa.hawaii.edu/hpicesu/techrep.htm

Nadig, A. 2015. U.S. Fish and Wildlife Service, Personal Communication.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS-USFWS). 1998. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, Maryland. http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_green_pacific.pdf

National Marine Fisheries Service and U. S. Fish and Wildlife Service (NMFS-USFWS). 2013. Hawksbill sea turtle (Eretmochelys imbricata) 5-Year Review: Summary and Evaluation, National Marine Fisheries Service Silver Spring, Maryland. http://www.nmfs.noaa.gov/pr/pdfs/species/hawksbillseaturtle2013_5yearreview.pdf

National Marine Fisheries Service (NMFS). 2007. Recovery Plan for the Hawaiian Monk Seal (*Monachus schauinslandi*). Second Revision National Marine Fisheries Service, Silver Spring, Maryland. http://www.nmfs.noaa.gov/pr/pdfs/recovery/hawaiianmonkseal.pdf

National Oceanic and Atmospheric Administration (NOAA). 2014. Sea Level Trends Online website. Accessed online July 18, 2014, http://tidesandcurrents.noaa.gov/sltrends/sltrends.html.

National Park Service. 1962. Honokōhau Settlement. National Historic Landmarks Program http://www.nps.gov/nhl/find/statelists/hi/HI.pdf

National Park Service. 1991. Reference Manual 77: Natural Resource Management. National Park Service, U.S. Department of the Interior, Washington, D.C. http://www.nature.nps.gov/rm77/

National Park Service. 1994. General Management/Plan Environmental Impact Statement: Kaloko-Honokōhau National Historical Park. U.S. Department of the Interior, Kailua-Kona, Hawai‘i. Available on file at Kaloko-Honokōhau National Historical Park

National Park Service. 1998. NPS-28: Cultural Resource Management Guideline. U.S. Department of the Interior, Washington, D.C. http://www.nps.gov/parkhistory/online_books/nps28/28contents.htm

National Park Service. 2006. Management Policies 2006. U.S. Department of the Interior, Washington, D.C. http://www.nps.gov/policy/MP2006.pdf

National Park Service. 2011. Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-Making. National Park Service, U.S. Department of the Interior, Washington, D.C. http://www.nps.gov/policy/DOrders/DO_12.pdf

National Park Service. 2013a. Kaloko-Honokōhau Cultural Center Environmental Assessment, National Park Service, U.S. Department of the Interior, Kailua-Kona, Hawai‘i. Available on file at Kaloko-Honokohau National Historical Park

National Park Service. 2013b. Notification and initiation of Section 106 consultation: ‘Aimakapā Wetlands Management Plan/EA, Kaloko-Honokōhau National Historical Park, Kailua-Kona, Hawai‘i. National Park Service Letter to Mr. William A. Aila, Jr., State Historic Preservation Officer and Chairperson, DLNR. March 1, 2013. On file at Kaloko-Honokōhau National Historical Park

National Park Service. 2014. Superintendent's Compendium. Kaloko-Honokōhau National Historical Park, Kailua-Kona, Hawai‘i Accessed online March 13, 2015. www.nps.gov/kaho/parkmgmt/laws-and-policies.htm

National Park Service. 2015a. National Historic Preservation Act Section 106 Consultation, National Park Service - Kaloko-Honokōhau National Historical Park, Mālama ‘Aimakapā: ‘Aimakapā Fishpond Wetlands Restoration Management Plan, Honokōhau Ahupua‘a, North Kona, Island of Hawai‘i TMK: (3) 7-4-008:010. National Park Service letter to Ms. Suzanne Case, State Historic Preservation Officer and Chairperson, DLNR. November 17, 2015. On file at Kaloko-Honokōhau National Historical Park

National Park Service. 2015b. National Park Service Public Use Statistics Office. Accessed online March 13, 2015, Accessed online at https://irma.nps.gov/Stats/

Nelson, N. and R. Gmirkin. 2001. An archeological survey of the KAHO 157 Project: A new visitors contact station, parking lot, and associated structures. National Park Service, Kaloko-Honokōhau National Historical Park, Kailua-Kona, Hawai‘i.

Nelson, S. G. and L. G. Eldredge. 1991. Distribution and status of introduced cichlid fishes of the genera *Oreochromis* and *Tilapia* in the islands of the South Pacific and Micronesia. Asian Fisheries Science 4:11-22. http://www.asianfisheriessociety.org/publication/archivedetails.php?id=97

Nico, L. and M. Neilson. 2015. *Oreochromis mossambicus*. USGS Nonindigenous Aquatic Species Database. Revision Date: 4/26/2013. Accessed online June 17, 2015 http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=466

Nico, L. G., H. L. Jelks, and R. A. Englund. 2014. Progress Update: Development and assessment of eradication plan alternatives to remove tilapia from the Aimakapa Fishpond Wetland Complex, Kaloko-Honokohau National Historical Park, Hawaii. January 19, 2014.

Nol, P., J. L. Williamson, T. E. Rocke, and T. M. Yuill. 2004. Detection of Clostridium botulinum Type C cells in the gastrointestinal tracts of Mozambique Tilapia (*Oreochromis mossambicus*) by polymerase chain reaction. Journal of Wildlife Diseases 40:149-175.

O’Hare, C. and S. T. Goodfellow. 1992. Kohana-Iki Resort, phased archeological mitigation program, Phase II—Data Recovery. Land of Kohana-Iki, North Kona District, Island of Hawai‘i Paul H. Rosendahl, Ph.D., Inc., Hilo, Hawai‘i.

Oki, D. S., G. W. Tribble, W. R. Souza, and E. L. Bolke. 1999. Ground-Water Resources in Kaloko-Honokohau National Historical Park, Island of Hawaii, and Numerical Simulation of the Effects of Ground-Water Withdrawals. Water-Resources Investivations Report 99-4070, U.S. Geological Survey, Honolulu, Hawai‘i.

Paikuli-Campbell, R. T. and T. Lizama. 2015. Mālama ‘Aimakapā Fishpond Wetlands Restoration Project Area Archeological Survey. Internal Report, Kaloko-Honokohau National Historical Park, National Park Service, Kailua-Kona, Hawai‘i.

Parsons, M. L., W. J. Walsh, C. J. Settlemier, D. J. White, J. M. Ballauer, P. M. Ayotte, K. M. Osada, and B. Carman. 2008. A multivariate assessment of the coral ecosystem health of two embayments on the lee of the island of Hawai‘i. Marine Pollution Bulletin 56:1138-1149.

Paton, P. W. C., A. Taylor, and P. R. Ashman. 1986. Blue-winged teal nesting in Hawaii. The Condor 86.

Peters, D., L. Wilson, S. Mosher, J. Rohrer, J. Hanley, A. Nadig, M. Silbernagle, M. Nishimoto, and J. Jeffrey. 2011. Small Indian mongoose -- management and eradication using DOC 250 kill traps, first lessons from Hawaii. Page 3 *in* C. R. Veitch, M. N. Clout, and D. R. Towns, editors. Island Invasives: eradication and management. IUCN, Gland, Switzerland

Pias, K., C. L., and E. A. 2015. Rodent trapping to protect Kaua‘i’s forest birds: results of an experiment to assess efficacy of Goodnature A24s. Abstract 8-4, p. 97. 23rd Annual Hawai‘i Conservation Conference, August 3-6, 2015, Hilo, Hawai‘i. http://www.hawaiiconservation.org/images/uploads/conference/ABSTRACT+FINAL.compressed.pdf

Pinzari, C. A., F. J. Bonaccorso, and K. Montoya-Aiona. 2014. Hawaiian hoary bat occupancy at Kaloko-Honokōhau National Historical Park Technical Report HCSU-051, Hawaii Cooperative Studies Unit, University of Hawai‘i, Hilo, Hawai‘i. http://hilo.hawaii.edu/hcsu/documents/TR51_Pinzari_Kaloko_bats_occupancy_2014.pdf

Pless, P. 2005. Use of imazapyr herbicide to control invasive cordgrass (*Spartina spp*.) in the San Francisco Estuary: Water quality, biological resources, and human health and safety. Prepared for California Coastal Conservancy, San Francisco Estuary Invasive Spartine Project, Leson & Associates, P.O. Box 10075 Berkeley, California. http://www.spartina.org/referencemtrl/SF-Imazapyr-EA.pdf

Polhemus, D. A. 1993. Conservation of aquatic insects: Worldwide crisis or localized threats? . American Zoologist 33:588-598.

Polhemus, D. A. 1995. The orangeblack Hawaiian Damselfly, *Megalagrion xanthomelas* (Odonata: Coenagrionidae): Clarifying the Current Range of a Threatened Species. Records of the Hawaii Biological Survey For 1995. Bishop Museum Occasional Papers: No 45. Bishop Museum Press, Honolulu, Hawai‘i.http://hbs.bishopmuseum.org/pdf/op45-30-53.pdf

Polhemus, D. A. and A. Asquith. 1996. Hawaiian damselflies: A field identification guide. Bishop Museum Press, Honolulu, Hawai‘i.

Poutu, N. and B. Warburton. 2005. Effectiveness of the DOC 150, 200, and 250 traps for killing stoats, ferrets, Norway rats, ship rats, and hedgehogs. Landcare Research Contract Report: LC0405/109, Landcare Research, Lincoln, New Zealand. http://www.predatortraps.com/downloads/doctrapshumanereport.pdf

Pratt, H. D. and I. L. Brisbin, Jr. 2002. Hawaiian Coot (*Fulica alai*), The Birds of North America Online (A. Poole, Ed.). Ithica: Cornell Lab of Ornithology, Accessed online September 14, 2014. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/697b doi:10.2173/bna.697b

Pratt, L. W. and L. L. Abbott. 1996. Distribution and abundance of alien and native plant species in Kaloko-Honokōhau National Historical Park. Technical Report 103, Cooperative National Park Resources Studies Unit, University of Hawai‘i-Mānoa, Honolulu, Hawai‘i. http://manoa.hawaii.edu/hpicesu/techr/103.pdf

Pratt, L. W. 1998. Vegetation management strategies for three National Historical Parks on Hawai‘i Island. Technical Report 121, Cooperative National Park Resources Studies Unit, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i. http://manoa.hawaii.edu/hpicesu/techrep.htm

Pyle, R. L. and P. Pyle. 2009. The Birds of the Hawaiian Islands: Occurrence, History, Distribution, and Status. B.P. Bishop Museum, Honolulu, HI.

Raine, A., C. Nagle, and J.-C. Watson. 2015. Is it possible to reduce rat predation of endangered seabirds on Kaua‘i using available control methods? Abstract 8-5, p. 98. 23rd Annual Hawai‘i Conservation Conference, August 3-6, 2015, Hilo, Hawai‘i. http://www.hawaiiconservation.org/images/uploads/conference/ABSTRACT+FINAL.compressed.pdf

Reinecke, J. E. 1930. Survey of Sites on West Hawai‘i [also, Archeology of Kona, Hawai‘i]. MS, in the files of the State Historic Preservation Division, Department of Land and Natural Resources, State of Hawai‘i

Renger, R. C. 1970. Archeological Reconnaissance of Coastal Kaloko and Kukio I, North Kona, Hawai‘i. Departmental Report Series 70-10, Department of Anthropology, Bishop Museum Press, Honolulu, Hawai‘i.

Renger, R. C. 1974. Human adaptation to marginal coastal environments: the archeology of Kaloko, North Kona, Hawai‘i.Ph.D. Dissertation, University of California Santa Barbara, California.

Richmond, B. M., A. E. Gibbs, and S. A. Cochran. 2008. Geologic Resource Evaluation of Kaloko-Honokohau National Historical Park, Hawai‘i ; Geology and Coastal Landforms. U.S. Geological Survey Open-File Report 2008-1191, U.S. Geological Survey, Reston, Virginia. http://pubs.usgs.gov/of/2008/1191/

Rieger, J., J. Stanley, and R. Traynor. 2014. Project Planning and Management for Ecological Restoration. Island Press, Washington D.C.

Robinson, J. A., J. M. Reed, J. P. Skorupa, and L. W. Oring. 1999. Black-necked Stilt (*Himantopus mexicanus*), The Birds of North America Online (A. Poole, Ed.). Ithica: Cornell Lab of Ornithology, Accessed online March 1, 2015. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/449 doi:10.2173/bna.449

Rocke, T. E. and M. Friend. 1999. Avian botulism. Pages 217-281 *in* M. Friend and J. C. Franson, editors. Field Manual of Wildlife Diseases. U.S. Geological Survey, National Wildlife Health Center, Madison, Wisconsin

Rocke, T. E., P. Nol, C. Pelizza, and K. K. Sturm. 2004. Type C botulism in pelicans and other fish-eating birds at the Salton Sea. Studies in Avian Biology 17:136-140.

Rubega, M. A. and J. A. Robinson. 1996. Water salinization and shorebirds: emerging issues. International Wader Studies 9:45-54.

Schuster, L. C. 1996. Pickleweed control project at Kaloko-Honokōhau National Historical Park. Internal Report, Kaloko-Honokōhau National Historical Park, National Park Service, Kailua-Kona, Hawai‘i.

Shallenberger, R. J. 1977. An ornithological survey of Hawaiian wetlands, Vol. 1. Contract DACW 84-77-C-0036, U.S. Army Corps of Engineers, Ahuimanu Productions, Honolulu, Hawai‘i. https://irma.nps.gov/App/Reference/Profile/88439

Silbernagle, M. 2010. U.S. Fish and Wildlife Service, Personal Communication.

Sparks, A. K. 1963. Survey of the oyster potential of Hawaii. Department of Land and Natural Resources, Divison of Fish and Game, Honolulu, Hawaii. https://irma.nps.gov/App/Reference/Profile/2193577

Spennemann, D. H. R. 2002. Traditional milkfish aquaculture in Nauru. Aquaculture International 10:551-562.

Stasack, E. and D. Stasack. 2001. Rock art recording report, Locus 1, Kaloko-Honokōhau National Historical Park,Honokōhau iki Ahupua‘a, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E., D. Stasack, and S. Bond, Jr. 2003. Kaloko-Honokōhau National Historical Park: Rock Art Recording Report, Locus 2 (State Site No. 50-10-27-21010). Report prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E. and D. Stasack. 2004a. Rock Art Recording Report, State Site No. 50-10-27-2168, Kaloko-Honokōhau National Historical Park, Kaloko ahupua‘a, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E. and D. Stasack. 2004b. Rock art recording report, Locus 3A (State Site No. 50-10-27-2263), Kaloko-Honokōhau National Historical Park, Honokōhau iki and Kealakehe Ahupua‘a, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E. and D. Stasack. 2005a. Rock art recording report, State Site No. 50-10-27-2248, Kaloko-Honokōhau National Historical Park, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E. and D. Stasack. 2005b. Rock art recording report, State Site No. 50-10-27-2267, Kaloko-Honokōhau National Historical Park, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E. and D. Stasack. 2007. Poho, a transcendental reliquary? Paper presented at 20th Annual Society for Hawaiian Archeology Conference, Kailua-Kona, Hawai‘i.

Stasack, E. 2010. University of Hawai‘i, Emeritus, Personal Communication.

Stasack, E. and D. Stasack. in prep.-a. Rock Art Recording Report, State Site No. 50-10-27-21008, Kaloko-Honokōhau National Historical Park, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E. and D. Stasack. in prep.-b. Rock Art Recording Report, State Site No. 50-10-27-21007, Kaloko-Honokōhau National Historical Park, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stasack, E. and D. Stasack. in prep.-c. Rock Art Recording Report, State Site No. 50-10-27-23353, Kaloko-Honokōhau National Historical Park, North Kona District, Island of Hawai‘i. Prepared for Kaloko-Honokōhau National Historical Park.

Stinson, D. W., M. W. Ritter, and J. D. Reichel. 1991. The Mariana Common Moorhen: Decline of an Island Endemic. The Condor 93:38-43. doi 10.2307/1368603

Tango, L. K., D. Foote, K.N. Magnacca, S.J. Foltz, and K. Cutler. 2012. Biological inventory of anchialine pool invertebrates at Pu‘uhonua o Hōnaunau National Historical Park and Pu‘ukoholā Heiau National Historic Site, Hawai‘i Island. Pacific Cooperative Studies Unit Technical Report No. 181, The Hawai‘i-Pacific Islands Cooperative Ecosystem Studies Unit, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i. http://manoa.hawaii.edu/hpicesu/techrep.htm

Telfair II, R. C. 2006. Cattle Egret (*Bubulcus ibis*), The Birds of North America Online (A. Poole, Ed.). Ithica: Cornell Lab of Ornithology, Accessed online March 15, 2015. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/113 doi:10.2173/bna.113

Thornberry-Ehrlich, T. 2011. Kaloko-Honokōhau National Historical Park: geologic resources inventory report. Natural Resource Report NPS/NRPC/GRD/NRR—2011/384, National Park Service, Ft. Collins, Colorado. http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

Tomonari-Tuggle, M. J. and H. D. Tuggle. 2006a. Archeological overview and assessment for the three West Hawai‘i Parks, National Park Service; Task 3: Preparation of overview and assessment. International Archeological Research Institute, Inc., Honolulu, Hawai‘i.

Tomonari-Tuggle, M. J. and H. D. Tuggle. 2006b. Archeological survey of lands surrounding Kaloko Fishpond, Kaloko-Honokōhau National Historical Park (KAHO) International Archeological Research Institute, Inc., Honolulu, Hawai‘i.

Truan, M. and C. Metzler. 2015. Investigate effective strategies to protect archeological sites from destructive alien plant species and improve wetland habitat. Draft Report, Museum of Wildlife and Fish Biology, University of California Davis, California.

U.S. Department of Agriculture Natural Resources Conservation Service. 2010. Custom Soil Resource Report for Island of Hawaii Area, Hawaii, Kaloko-Honokohau National Historic Park. Natural Resource Conservation Service.

U.S. Department of Agriculture Soil Conservation Service. 1973. Soil Survey of Island of Hawaii, State of Hawaii. U.S. Department of Agriculture in Cooperation with Univerisity of Hawaii Agricultural Experiment Station, Washington, D.C. http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/hawaii/HI801/0/hawaii.pdf

U.S. Fish and Wildlife Service. 2005. Recovery Plan for the Blackburn’s Sphinx Moth (*Manduca blackburni*). U.S. Fish and Wildlife Service, U.S. Department of the Interior, Portland, Oregon. https://ecos.fws.gov/docs/recovery_plan/050926.pdf

U.S. Fish and Wildlife Service. 2011a. Ōpe‘ape‘a or Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) 5-Year Review Summary and Evaluation, U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office Honolulu, Hawai‘i. http://ecos.fws.gov/docs/five_year_review/doc3865.pdf

U.S. Fish and Wildlife Service. 2011b. Recovery Plan for Hawaiian Waterbirds, Second Revision U.S. Fish and Wildlife Service, Portland, Oregon. http://www.fws.gov/pacific/ecoservices/endangered/recovery/plans.html

U.S. Fish and Wildlife Service. 2013. Draft Environmental Assessment Implementation of a control order for cattle egrets and barn owls in Hawaii. US Fish and Wildlife Service, Arlington, Virginia. http://www.regulations.gov/#!documentDetail;D=FWS-HQ-MB-2013-0070-0002

U.S. Geological Survey. 2005. Inventory of anchialine pools in Hawai‘i’s national parks. USGS Fact Sheet FS 2005-3129, U.S. Geological Survey, Pacific Islands Ecosystem Research Center, Hawai‘i National Park, Hawai‘i. http://www.usgs.gov/ecosystems/pierc/assets/anchialine_pools.pdf

VanderWerf, E. 2015. Performance of Goodnature automated predator traps to protect forest bird and sea bird nests on O‘ahu. Abstract 8-3, p. 97. 23rd Annual Hawai‘i Conservation Conference, August 3-6, 2015, Hilo, Hawai‘i. http://www.hawaiiconservation.org/images/uploads/conference/ABSTRACT+FINAL.compressed.pdf

Vitousek, P. M., J. D. Aber, R. W. Howarth, L. G. E., P. A. Matson, D. W. Schindler, W. H. Schlesinger, and D. G. Tilman. 1997. Human alteration of the global nitrogen cycle: sources and consequences. Ecological Applications 7:737-750. http://www.esajournals.org/doi/pdf/10.1890/1051-0761(1997)007%5B0737%3AHAOTGN%5D2.0.CO%3B2

Vitousek, S., M. M. Barbee, C. H. Fletcher, B. M. Richmond, and A. S. Genz. 2010. Pu'ukoholā Heiau National Historic Site and Kaloko-Honokōhau Historical Park, Big Island of Hawai‘i : coastal hazard analysis report. Natural Resource Technical Report NPS/NRPC/GRD/NRTR-2010/387, National Park Service, U.S. Department of Interior, Fort Collins, Colorado. http://www.nature.nps.gov/geology/coastal/documents/NRTR_SVA_KUHEandPUHE_FINAL_nrpc_LOW_RES.pdf

Waddington, J. S. 2002. Kona Coast water bird surveys September 2001 - August 2002. Report to Ducks Unlimited, Inc., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2003. Kona Coast waterbird and shorebird surveys September 2002 - August 2003. Report to Ducks Unlimited, Inc., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2005a. Kona Coast waterbird and shorebird surveys September 2003-August 2004. Report to Ducks Unlimited, Inc., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2005b. Kona Coast waterbird and shorebird surveys September 2004-August 2005. Report to Ducks Unlimited, Inc., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2006. Kona Coast waterbird and shorebird surveys September 2005 - August2006. Report to Ducks Unlimited, Inc., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2007. Kona Coast waterbird surveys September 2006 - August 2007. Kailua-Kona, Hawai‘i.

Waddington, J. S. 2008. Kona Coast waterbird surveys September 2007 - August 2008. Kailua-Kona, Hawai‘i.

Waddington, J. S. 2009. Kona Coast waterbird surveys September 2008 - August 2009. Kailua-Kona, Hawai‘i.

Waddington, J. S. 2010. Kona Coast waterbird surveys September 2009 - August 2010. Kailua-Kona, Hawai‘i.

Waddington, J. S. 2011. Kona Coast waterbird surveys September 2010 - August 2011. Prepared for Cyanotech Corporation, Kailua-Kona, Hawai‘i.

Waddington, J. S. 2012. Kona Coast waterbird surveys September 2011 - August 2012. Prepared for Cyanotech Corporation, Kailua-Kona, Hawai‘i.

Waddington, J. S. 2013. Kona Coast water bird surveys September 2012 - August 2013. Prepared for Cyantotech Corporation, Ho‘omaluō LLC., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2014. Kona Coast water bird surveys September 2013 - August 2014. Prepared for Cyanotech Corporation, Ho‘omaluō LLC., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2015a. Kona Coast water bird surveys September 2014 - August 2015. Prepared for Cyanotech Corporation, Ho‘omaluō LLC., Kailua-Kona, Hawai‘i.

Waddington, J. S. 2015b. Wildlife Biologist, Personal Communication.

Wagner, W. L., M.M. Bruegmann, D.M. Herbst, and J. Q. C. Lau. 1999. Hawaiian vascular plants at risk: 1999. Bishop Museum Occasional Papers 60:1-58. http://hbs.bishopmuseum.org/pdf/op60.pdf

Walker, G. P. L. 1990. Review Article: Geology and Volcanology of the Hawaiian Islands. Pacific Science 44:315-347. http://scholarspace.manoa.hawaii.edu/handle/10125/1287

Walsh, P. and H. H. Hammatt. 1995. An archeological inventory survey of the new Queen Kaahumanu Highway right-of-way between Palani Road and Keahole within the ahupua‘a of Keahuolu and Kalaoa 1-4, Kekaha, North Kona, District, Hawai‘i Island. Cultural Surveys Hawai‘i, Kailua, Hawai‘i.

Wisconsin Dept. of Natural Resources. 2012. Webpage: Control methods for invasive species. Wisconsin Dept. of Natural Resources, Accessed online 05/07/2014. http://dnr.wi.gov/topic/invasives/control.html

Wolfe, E. W. and J. Morris. 1996. Geologic map of the Island of Hawai‘i. Geologic Investigations Series Map I-2524-A. (scale 1:100,000). U.S. Geological Survey, U.S. Department of the Interior, Reston, Virginia. http://pubs.usgs.gov/imap/2524a/report.pdf

Wyban, C. A. 1992. Tide and Current: Fishponds of Hawai‘i. University of Hawai‘i Press, Honolulu, Hawai‘i.

Wyban, C. A. 1996. Feasibility Study for Kaloko Fishpond, Kaloko-Honokōhau National Historical Park, Island of Hawai‘i. Kailua-Kona, Hawai‘i.

Young, L. C., E. A. Vanderwerf, C. Mitchell, E. Yeun, C. J. Miller, D. G. Smith, and C. Swenson. 2012. The use of predator proof fencing as a management tool in the

Hawaiian Islands: a case study of Ka‘ena Point Natural Area Reserve. Technical Report 180, Pacific Cooperative Studies Unit, University of Hawai‘i, Honolulu, Hawai‘i. http://manoa.hawaii.edu/hpicesu/techrep.htm