Kakahai'a National Wildlife Refuge
Comprehensive Conservation Plan

Prepared by:
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and

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September 2011

Approved: _____ 9/28/11
Acting Regional Director, Region 1 Date
Portland, Oregon

U.S. Fish and Wildlife Service
Kakahai'a National Wildlife Refuge
Comprehensive Conservation Plan
Approval Submission

In accordance with the National Wildlife Refuge System Administration Act, as amended, the U.S. Fish and Wildlife Service completed a Comprehensive Conservation Plan (CCP) for Kakahai'a National Wildlife Refuge (Refuge). The purpose of this CCP is to specify a management direction for the Refuge for the next 15 years. The goals, objectives, and strategies for improving Refuge conditions – including the types of habitat we will provide, partnership opportunities, and management actions needed to achieve desired future conditions – are described in the CCP. The Service's preferred alternative for managing the Refuge is described in this CCP and the effects on the human environment were described in the Draft CCP and Environmental Assessment.

This CCP is submitted for the Regional Director's approval by:

Glynnis Nakai, Project Leader
Maui National Wildlife Refuge Complex
09-20-11
Date

Concur: Barry W. Stieglitz
Barry Stieglitz
Project Leader, Hawaiian and Pacific Islands NWRC
9/22/11
Date

Concur: Robin West
Robin West
Regional Chief, National Wildlife Refuge System
9/28/11
Date

Finding of No Significant Impact
for the
Kakahaiʻa National Wildlife Refuge Comprehensive Conservation Plan
Maui County, Hawaiʻi

The U.S. Fish and Wildlife Service (Service) has completed a Comprehensive Conservation Plan (CCP) and Environmental Assessment (EA) for Kakahaiʻa National Wildlife Refuge (Refuge). The CCP will guide management of the Refuge for 15 years. The CCP/EA describes our proposals for managing the Refuge and their effects on the human environment under three alternatives, including the no action alternative.

Decision

Based on our comprehensive review and analysis in the CCP/EA, we selected Alternative C for implementation, because it will guide management of the Refuge in a manner that:

- Achieves the mission of the National Wildlife Refuge System, and the purposes, vision, and goals of the Refuge.
- Maintains and restores the ecological integrity of the Refuge habitats and populations.
- Addresses the important issues identified during the CCP scoping process.
- Addresses the legal mandates of the Service and the Refuge.
- Is consistent with the scientific principles of sound wildlife management and endangered species recovery.
- Facilitates priority public uses appropriate and compatible with the Refuge purpose and the Refuge System mission.

Summary of the Actions to be Implemented

Implementing the selected alternative will have no significant impacts on the environmental resources identified in the CCP/EA. Refuge management under the selected alternative will restore habitat for endangered species and resources of concern, and improve the Refuge's capability to provide food for migrating and wintering waterbirds, including shorebirds and waterfowl. Improving the Refuge's coastal and wetland habitats will increase the value of these lands and waters for a variety of native plants and wildlife.

The availability and quality of wildlife-dependent recreation on the Refuge will improve under the selected alternative, but within a regional context, the cumulative change would be small. A summary of the CCP actions we will implement follows.

Under Alternative C, we will restore the 15-acre Old Pond and 5.5 acres of New Pond. Physical restoration of the Old Pond will include: removal of aggressive pest species, dredging accumulated sediment, reconfiguring bathymetry and radial levees, reconstructing perimeter levees, replacing the water control structure, and replacing the pump between the two ponds. Restoration of Old Pond will provide open water and emergent habitat for breeding, foraging, and nesting ʻalae keʻokeʻo with minimum supplemental water due to the presence of natural groundwater springs.

Management actions include a compilation of data on the wetlands and initiation of research to evaluate the geomorphology, hydrology, and elevation in preparation for a restoration design that would meet the needs of two focal species: ae'o and 'alae ke'oke'o. A new well, pump, water distribution line, and control outlet for New Pond will be constructed and existing levees will be reconstructed. The capability of flooding and dewatering the ponds will provide permanent and seasonal habitat for ae'o and 'alae ke'oke'o, and indirectly benefit migratory waterbirds. All monitoring activities would resume with the presence of wetland function. If feasible, a predator-proof fence will be installed to minimize or eliminate predators from entering the wetlands.

The Service will work with the Hawai'i Department of Transportation on planning and design to modify the culvert passing under Kamehameha V Highway to allow water from the upper watershed and periodic dewatering of the wetlands to flow to the ocean naturally without blockage from sand. We will contract a comprehensive archaeological and cultural investigation for the Refuge and surrounding lands prior to expanding restoration efforts beyond previously disturbed lands.

Maintaining the wetlands at Kakahai'a NWR will require a regular on-site staff presence. The opportunities for visitors to engage in wildlife-dependent recreation may expand depending on staffing, and, at a minimum, a kiosk will be constructed on the earthen platform along the Refuge entrance road. Volunteer groups will be coordinated to assist staff with restoration and maintenance activities.

Public Involvement and Changes Made to the Selected Alternative Based on Comments

We incorporated a variety of public involvement techniques in developing and reviewing the CCP/EA. This included three planning updates, several meetings with partners, and public review and comment on the Draft CCP/EA. The Service responses to public comments are provided in the CCP, in Appendix K.

Based on the public comments we received and considered, Alternative C as described in the Draft CCP/EA has been slightly modified to clarify our management strategies to seek new partnerships with other government agencies, nongovernmental organizations, and private individuals to leverage our funding and staffing capabilities.

Conclusions

Based on review and evaluation of the information contained in the supporting references, I have determined that implementing Alternative C as the CCP for Kakahai'a National Wildlife Refuge is not a major Federal action that would significantly affect the quality of the human environment within the meaning of section 102(2)(c) of the National Environmental Policy Act of 1969. Accordingly, we are not required to prepare an environmental impact statement.

Acting Regional Director

9/28/11
Date

Supporting References

U.S. Fish and Wildlife Service. July 2011. Kakahaiʻa National Wildlife Refuge, Draft Comprehensive Conservation Plan and Environmental Assessment.

U.S. Fish and Wildlife Service. September 2011. Kakahaiʻa National Wildlife Refuge Comprehensive Conservation Plan.

Note: This Finding of No Significant Impact and supporting references are available for public review at Maui National Wildlife Refuge Complex, Milepost 6 Mokulele Highway, Kīhei, Hawaiʻi 96753, and U.S. Fish and Wildlife Service, Hawaiian and Pacific Islands National Wildlife Refuge Complex, 300 Ala Moana Boulevard, Room 5-231, Honolulu, Hawaiʻi 96850. These documents can also be found on the Internet at http://pacific.fws.gov/planning/. Interested and affected parties are being notified of our decision.

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Tables

Figures

Appendices

Note to Reviewers: Throughout the CCP document, all attempts have been made to use appropriate diacriticals related to the Hawaiian language (i.e., ‘okina and kahakō). However, places where diacriticals may not appear occur in the maps and literature cited. Due to limitations of the Geospatial Information System software used for the maps developed in the plan, some diacriticals may be missing where place names or legend text appear.

Readers’ Guide

Native species discussed in this document are referred to by their Hawaiian names. Common English names and scientific nomenclature can also be found in the glossary in Appendix A. The U.S. Fish and Wildlife Service endeavors to be accurate in its use of the Hawaiian language and correctly spell Hawaiian words, including the diacritical marks that affect the meaning and aid in pronunciation. This guide is provided to simplify pronunciation for the reader.

When Captain Cook arrived in the Hawaiian Islands in 1778, the Hawaiians had a totally oral tradition. In 1820, missionaries standardized a written version of the Hawaiian language that features eight consonants and five vowels.

Consonants

H - as in English
K - as in English
L - as in English
M - as in English
N - as in English
P - as in English
W - after i and e pronounced v
- after u and o pronounced like w
- at the start of a word or after a, pronounced like w or v
(‘) - ‘okina - a glottal stop

Vowels

A - pronounced like the a in far
E - pronounced like the e in bet
I - pronounced like the ee in beet
O - pronounced like the o in sole
U - pronounced like the oo in boot

Special Symbols

Two symbols appear frequently in Hawaiian words: the ‘okina and the kahakō. These two symbols change how words are pronounced. The ‘okina itself looks like an upside-down apostrophe and is a glottal stop – or a brief break in the word. An example of this in English is in the middle of the expression “uh-oh.” The ‘okina is an official consonant – just as any of the other consonants.

The kahakō is a stress mark (macron) that can appear over vowels only and serve to make the vowel sound slightly longer. The vowels ā, ē, ī, ō, and ū sound just like their non-stress Hawaiian vowels with the exception that the sound is held slightly longer. Missing the ‘okina or kahakō can greatly change not only the how a word sounds, but also its basic meaning. A popular example of how an ‘okina and a kahakō can change the meaning of a word is “pau”:

- pau = finished, ended, all done
- pa‘u = soot, smudge, ink powder
- pa‘ū = moist, damp
- pā‘ū = skirt

Refuge Place Names

Kakahai‘a	*(kah-kah-hah-EE-ah)*	meaning: fish slicing
Kawela	*(kah-VEH-lah)*	meaning: the heat

Waterbirds

Ae‘o (EYE oh)

Hawaiian Stilt *Himantopus mexicanus knudseni*

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Indigenous

Laura Beauregard

‘Alae ke‘oke‘o (ah-lye KAY oh KAY oh)

Hawaiian Coot *Fulica alai*

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic

Laura Beauregard

‘Auku‘u (ow-KOO oo)

Black-crowned Night-Heron *Nycticorax nycticorax hoactli*

SPECIES STATUS:
State recognized as Indigenous

Laura Beauregard

Koloa maoli (ko-LOWah MAOW-lee)

Hawaiian Duck *Anas wyvilliana*

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic

Brenda Zaun

Migrant Shorebirds

'Akekeke (ah-kay-KAY-kay)

Ruddy Turnstone *Arenaria interpres*

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan - High Concern

Michael Walther

Hunakai (hoo-nah-KYE)

Sanderling *Calidris alba*

SPECIES STATUS:
State recognized as Indigenous
Hunakai means "sea foam." Their habit of running along the receding waves on the shore in search of small sand crabs apparently reminded early Hawaiians of the sea foam or hunakai left behind by the waves. It shares the name with a coastal plant.

Michael Walther

Kōlea (KOHH-lay-ah)

Pacific Golden Plover *Pluvialis fulva*

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan - High Concern

Michael Walther

'Ūlili (OOO-lee-lee)

Wandering Tattler *Heteroscelus incanus*

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan - Moderate Concern

Michael Walther

Native Plants

'Ākulikuli (AAH-koo-lee-KOO-lee)

Sea Purslane *Sesuvium portulacastrum*

SPECIES STATUS:
State recognized as Indigenous

Laura Beauregard

Hala (HAH-lah)

Screw Pine *Pandanus tectorius*

SPECIES STATUS:
State recognized as Indigenous

Laura Beauregard

Kaluhā (kah-loo-HAHH)

Saltmarsh Bulrush *Bolboschoenus maritimus*

SPECIES STATUS:
State recognized as Indigenous

Laura Beauregard

Kīpūkai (KEE-POO-kye)

Seaside Heliotrope *Heliotropium curassavicum*

SPECIES STATUS:
State recognized as Indigenous

Forest & Kim Starr

ʻAlae keʻokeʻo chick Laura Beauregard/USFWS

Chapter 1. Introduction

Kakahaiʻa National Wildlife Refuge (NWR or Refuge) is a coastal freshwater pond situated along the south coast of Molokaʻi (Figure 1.1, page 1-13). The Refuge is managed as part of the Maui National Wildlife Refuge Complex (Complex) headquartered on the Island of Maui. This 44.6 acre Refuge was set aside in 1976 to protect and manage endangered Hawaiian waterbirds aeʻo (Hawaiian stilt) and ʻalae keʻokeʻo (Hawaiian coot) and their habitats.

1.1 Purpose and Need for the CCP

The purpose of the CCP is to provide the Service, the Refuge System, partners, and citizens with a management plan for improving fish and wildlife habitat conditions and Refuge infrastructure, for wildlife and public use on Kakahaiʻa NWR over the next 15 years. An approved CCP will ensure that the Service manages to achieve the Refuge purpose, vision, goals, and objectives to help fulfill the mission of the Refuge System.

The CCP is needed for a variety of reasons. Primary among these is the need to establish improved habitat conditions on the Refuge's wetland habitats, which are degraded by invasive plants and animals. The plan also recognizes and identifies threats to the endangered aeʻo and ʻalae keʻokeʻo, including predation by nonnative mammals, limited water supply, and human disturbance. There is also a need to analyze potential Refuge public use programs for wildlife-dependent priority public uses and to determine what improvements or alterations should be made in the pursuit of a high-quality visitor experience. Finally, there is a need to describe the steps that should be taken to better protect the habitats and wildlife through strategies to accomplish our goals.

1.2 Planning and Management Guidance

The Service, an agency within the Department of the Interior, is the principal Federal agency responsible for conserving, protecting, and enhancing fish, wildlife, and plants and their habitats. Refuge management is guided by Federal laws, Executive orders, Service policies, and international treaties. Fundamental guidelines are found in the mission and goals of the Refuge System and the designated purpose of the Refuge as described in establishing legislation, Executive orders, or other documents establishing, authorizing, or expanding a refuge.

Key concepts and guidance of the Refuge System derive from the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee) (Administration Act), the Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, Title 50 of the Code of Federal Regulations (CFR), and the Fish and Wildlife Service Manual (FW). The Administration Act is implemented through regulations covering the Refuge System, published in Title 50, subchapter C of the CFR. These regulations govern general administration of units of the Refuge System.

1.2.1 U.S. Fish and Wildlife Service Mission

The mission of the Service is “working with others, to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people.” National natural resources entrusted to the Service for conservation and protection include migratory birds, endangered and threatened species, interjurisdictional fish, wetlands, and certain marine mammals. The Service also manages national fish hatcheries, enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists with State and Territorial fish and wildlife programs, and helps other countries develop wildlife conservation programs.

1.2.2 National Wildlife Refuge System

The Refuge System is the world’s largest network of public lands and waters set aside specifically for conserving wildlife and protecting ecosystems. From its inception in 1903, the Refuge System has grown to encompass over 550 national wildlife refuges in all 50 States, and waterfowl production areas in 10 States, covering more than 150 million acres of public lands and waters. More than 40 million visitors annually fish, hunt, observe and photograph wildlife, or participate in environmental education (EE) and interpretive activities on national wildlife refuges.

1.2.3 National Wildlife Refuge System Mission and Goals

The mission of the Refuge System is “to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.” The goals of the Refuge System, as articulated in the Mission, Goals, and Purposes policy (601 FW1), follow:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered;

- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges;
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts;
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and EE and interpretation); and
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

1.2.4 National Wildlife Refuge System Administration Act of 1966

The Administration Act, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), requires us to develop a CCP for each national wildlife refuge in an open public process. The Administration Act states that the Secretary shall provide for the conservation of fish, wildlife, plants, and their habitats within the Refuge System, and ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained. House Report 105–106 accompanying the Improvement Act states ''…the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first.'' As later made clear in the Biological Integrity, Diversity, and Environmental Health (BIDEH) policy (601 FW 3), "the highest measure of biological integrity, diversity, and environmental health is viewed as those intact and self-sustaining habitats and wildlife populations that existed during historic conditions."

Each refuge must be managed to fulfill the Refuge System mission as well as the specific purpose(s) for which it was established. The Administration Act requires the Service to monitor the status and trends of fish, wildlife, and plants on every refuge. Additionally, six wildlife-dependent recreational uses are granted special consideration in the planning, management, establishment, and expansion of units of the Refuge System: hunting, fishing, wildlife observation and photography, and EE and interpretation. When determined compatible on a refuge-specific basis, these six uses assume priority status among all public uses of the refuge in question. The overarching goal is to enhance wildlife-dependent recreation opportunities and access to high-quality visitor experiences on refuges, while managing refuges to conserve fish, wildlife, plants, and their habitats. The Service is directed to make extra efforts to facilitate wildlife-dependent visitor opportunities.

When preparing a CCP, refuge managers must evaluate all general public, recreational, and economic uses proposed or occurring on a refuge for appropriateness and compatibility. No refuge use may be allowed or continued unless it is determined to be appropriate and compatible. Generally, an appropriate use is one that contributes to fulfilling refuge purposes, the Refuge System mission, or goals and objectives described in an approved refuge management plan. A compatible use is defined as a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purpose(s) of the refuge. Current Appropriate Use Findings and Compatibility Determinations for existing and proposed uses for Kakahaiʻa NWR are in Appendix B.

The Administration Act also requires that, in addition to formally established guidance, the CCP must be developed with the participation of the public. Public comments play a role in identifying issues, guiding alternatives considered during development of the CCP, and selecting a preferred

alternative. It is Service policy to develop CCPs in an open public process; the agency is committed to securing public input throughout the process.

1.3 Relationship to Previous and Future Refuge Plans

Planning has been a part of Refuge operations since establishment. Current management plans include:

- Interim Management Plan - 2001
- Wildland Fire Management Plan - 2005
- Integrated Pest Management Plan - 2008
- Refuge Safety Plan - 2010
- Highly Pathogenic Avian Influenza Disease Contingency Plan - 2009
- Avian Botulism Disease Contingency Plan - 2008
- Emergency Preparedness Response Plan (updated annually) - 2011
- Continuity of Operations Plan (updated annually) - 2011
- Station Hazardous Communications Plan (updated annually) - 2011

1.3.1 Future planning

The CCP will be revised every 15 years or earlier if monitoring and evaluation determine that changes are needed to achieve the Refuge purposes, vision, goals, or objectives. The CCP provides guidance in the form of goals, objectives, and strategies for Refuge program areas but may lack some of the specifics needed for implementation. Step-down management plans will therefore be developed for individual program areas, as needed, following completion of the CCP. Step-down plans require appropriate NEPA compliance.

1.4 Refuge Establishment and Refuge Purpose

1.4.1 Legal Significance of the Refuge Purpose

The purpose for which a refuge was established or acquired must form the foundation for planning and management decisions. The purpose(s) of a refuge are specified in or derived from the law, proclamation, Executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit.

Unless the establishing law, order, or other document indicates otherwise, purposes dealing with the conservation, management, and restoration of fish, wildlife, and plants, and the habitats on which they depend take precedence over other purposes in the management and administration of any unit. Where a refuge has multiple purposes related to fish, wildlife, and plant conservation, the more specific purpose will take precedence in instances of conflict. When an additional unit is acquired under an authority different from the authority used to establish the original unit, the addition takes on the purpose(s) of the original unit, but the original unit does not take on the purpose(s) of the newer addition.

1.4.2 Refuge Establishment and Purpose

Kakahaiʻa NWR was established in 1976 under the authority of the Endangered Species Act of 1973 (ESA). The Refuge was funded through the Land and Water Conservation Act of 1965. Refuge purposes are the driving force in the development of the refuge vision statements, goals, objectives, and strategies in the CCP and are critical to determining the appropriateness and compatibility of all existing and proposed refuge uses. Kakahaiʻa NWR was established with the purpose "… to conserve (A) fish or wildlife which are listed as endangered species or threatened species, or (B) plants."

Table 1.1 Refuge Acquisition History for Kakahaiʻa NWR

Date	Acquisition Authority	Comments
03/15/1976	Endangered Species Act of 1973	Fee title acquisition of 41.95 acres. Initial acquisition.
10/17/1977	Endangered Species Act of 1973	Conservation Easement on 2.31 acres.
06/21/1978	Endangered Species Act of 1973	Conservation Easement on 0.35 acres.

1.5 Refuge Goals

Goals and objectives are the unifying elements of successful refuge management. They identify and focus management priorities, resolve issues, and link to refuge purpose(s), Service policy, and the Refuge System mission. A CCP describes management actions that help bring a refuge closer to its vision. A vision broadly reflects refuge purpose(s), Refuge System mission and goals, other statutory requirements, and larger-scale plans as appropriate. Wildlife, habitat, and visitor services management goals then define general targets in support of the vision, followed by objectives that direct efforts into incremental and measurable steps toward achieving those goals. Finally, strategies identify specific tools and actions to accomplish objectives. The Refuge vision statement is found on the inside front cover of this document. The following are our goals; their order does not imply any priority in this CCP.

Nā Pahuhopu Puʻuhonua Holoholona

1. Kīaʻi a mālama i nā ʻāina pālialia a me ālialia wai maoli nohokau a me nā pālialia noho manawa no ka mālama ʻana i ka mōʻaukala ola pono o nā manuwai Hawaiʻi ʻane make loa.

2. Kīaʻi, hoʻōla hou, a mālama i nā kaianoho lihikai no ka pono no ka hoʻopunana ʻana o nā honu kai, manu kai, a me ka kūkahi o kēia mau kaiaola pio pau wale.

3. Hoʻola hou, kīaʻi, a hoʻoponopono in ā ululāʻau ʻoiwi i mea e pale hoʻokaʻawale ai i nā pilikia o uka mai nā ʻāina kumu wai mai.

4. ʻOhiʻohi i nā waiwai ʻepekema (nānā, noiʻi, a me ka hoʻāʻo ʻana) no ke kākoʻo ʻana i nā makemake o ka mālama ʻia ʻana ma ka pahuhopu helu 1 a helu 3 no ka puʻuhonua holoholona.

5. Hoʻomākaukau i kumu waiwai nui no nā kaianoho mākaukau no na holoholona ʻāhiu, a e kokua hoʻi i ka lehulehu ma ka hoʻonāʻauao a aʻo mai iā lākou e pili ana i nā iʻa, nā holoholona hihiu, a me nā waiwai nohona ʻōiwi o kēia wahi nei i kapa ʻia o Kakahaiʻa NWR.

6. Hoʻomākaukau hoʻi i polokalamu waiwai loa no ke aʻo ʻana i nā haumāna e pili ana i nā kumuhana kūpono a me ka hana lima pu ma nā kaianoho holoholona hihiu.

Refuge Goals

1. Restore and maintain seasonal and permanent wetland habitats to meet the life history needs of endangered Hawaiian waterbirds.

2. Protect, restore, and manage coastal habitat for the integrity of the fragile ecosystem.

3. Protect, restore, and manage forest habitat to provide a buffer from upper watershed impacts.

4. Gather scientific information (survey, research, and assessments) in support of adaptive management decisions on the Refuge under goals 1-3.

5. Provide high-quality wildlife-dependent recreation, interpretation, and outreach opportunities to enhance public understanding, appreciation, and enjoyment of the native wildlife, natural communities, and cultural history of the Kakahaiʻa NWR.

6. Provide students and teachers high-quality hands-on environmental education programs that foster a connection with nature and the Refuge.

1.6 Relationship to Ecosystem Planning Efforts

When developing a CCP, the Service considers the goals and objectives of existing national, regional, and ecosystem plans; State/Territorial fish and wildlife conservation plans; and other landscape-scale plans developed for the same watershed or ecosystem in which the refuge is located. To the extent possible, the CCP is expected to be consistent with these existing plans and assist in meeting their conservation goals and objectives (602 FW 3.3). This section summarizes some of the key plans that were reviewed by members of the planning team during CCP development.

Hawai'i's Comprehensive Wildlife Conservation Strategy, 2005. With passage of the Commerce, Justice, and State Appropriations Act of 2001, Congress mandated each State and Territory to develop its own comprehensive wildlife conservation strategy. *Hawai'i's Comprehensive Wildlife Conservation Strategy* thoroughly reviews the status of the full range of the State's native terrestrial and aquatic species, over 10,000 of which are found nowhere else on Earth. Hawai'i's Species of Greatest Conservation Need include all native terrestrial animals, all endemic aquatic animals, additional indigenous aquatic animals identified as in need of conservation attention, a range of native plants identified as in need of conservation attention, and all identified endemic algae. This list includes: a terrestrial mammal (1), birds (77), terrestrial invertebrates (~5,000), freshwater fishes (5), freshwater invertebrates (12), anchialine pond-associated fauna (20), marine mammals (26), marine reptiles (6), marine fishes (154), marine invertebrates (197), and flora (over 600). Details on all the listed wildlife taxa are provided in fact sheets that contain information for taxa, closely related groups of species, and species facing similar threats.

Hawai'i Nongame Management Program (Draft), 2000. The goal of the Hawai'i Nongame Management Program is to manage, preserve, and protect the native avifauna and their habitats for their intrinsic, recreational, scientific, and educational values and to provide opportunities for the residents and visitors to Hawai'i to use and enjoy these resources. A major focus of the program is on management and recovery of endangered species, including projects to monitor, manage habitat, and recover populations and control of predators affecting endangered species. Other nongame projects include increased surveillance of nonnative pests, construction of facilities and infrastructure to promote management or recreational opportunities to enjoy nongame resources, and maintenance of those facilities.

Draft Revised Recovery Plan for Hawaiian Waterbirds, (Second Draft of Second Revision), May 2005. The ultimate goal of the recovery program is to restore and maintain multiple self-sustaining populations of Hawaiian waterbirds within their historic ranges. The recovery of the endangered waterbirds focuses on the following objectives:

- Increasing population numbers to Statewide baseline levels (consistently stable or increasing with a minimum of 2,000 birds for each species);
- Establishing multiple, self-sustaining breeding populations throughout each species' historic range;
- Establishing and protecting a network of both core and supporting wetlands that are managed as habitat suitable for waterbirds, including the maintenance of appropriate hydrological conditions and control of pest plants;
- For all four species, eliminating or controlling the threats posed by introduced predators, avian diseases, and contaminants; and
- For the koloa maoli (Hawaiian duck), removing the threat of hybridization with feral mallards.

U.S. Pacific Islands Regional Shorebird Conservation Plan, 2004. Conservation and restoration of shorebird habitats is 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. Monitoring and research needs include assessment of population sizes and trends; assessment of the timing and abundance of birds at key wintering and migration stopover sites; assessment of habitat use and requirements at wintering and migration areas; exploration of the geographic linkages between wintering, stopover, and breeding areas; and evaluation of habitat restoration and management techniques to meet the needs of resident and migratory species. Education and public outreach are critical components of this plan. Resource management agencies of Federal, Territorial, Commonwealth, and State governments will need to work together with military agencies, nongovernmental organizations, and the scientific community. On a larger scale, coordination at the international level will be key to the conservation of vulnerable species, both migratory and resident.

Pacific Coast Joint Venture, Hawai'i, 2006**.** This strategic plan for waterbirds and wetlands identifies management strategies for a diversity of resident and migratory species with varying life history requirements across multiple sites to fulfill archipelago-wide conservation goals to "protect, restore, increase, and enhance all types of wetlands, riparian habitats, and associated uplands throughout the Pacific Coast region to benefit birds, fish and other wildlife" (Henry 2006). To accomplish this goal, six strategies are employed: protection, restoration, enhancement and management advocacy, outreach, and research.
Habitat goals for the Pacific Coast Joint Venture **(**PCJV) strategic conservation plan in Hawaiʻi represent long ranging concepts that provide direction for conservation objectives and actions. They are based on the strategies identified by the PCJV and support goals identified by other avian conservation plans for Hawaiʻi.

Molokaʻi Community Plan, 2001. One of nine community plans for the County of Maui describing planning goals, objectives, policies and implementation strategies to guide decision-making, this plan is currently under revision. It provides specific direction in addressing the goals, objectives and policies contained in the County's General Plan, while recognizing the values and unique attributes of Molokaʻi in order to enhance the region's overall living environment. The environmental goal is to "*Preserve, protect and manage Molokaʻi's exceptional natural land and water resources to ensure that future generations may continue to enjoy and protect the island environment."* Many of the Molokaʻi Community Plan objectives apply to the Refuge, including:

- *Protect and encourage the restoration of native habitats through government and private conservation, land management and educational programs.*
- *Restore the environmental integrity of Molokaʻi's land resources through development of a comprehensive reforestation program utilizing native species.*
- *Manage, protect and preserve shoreline dune formations throughout the region.*
- *Manage, protect, and where appropriate, restore reef habitats, fish ponds and other coastal resources unique to the Island of Molokaʻi.*
- *Protect and manage coastal water quality through best management land treatment practices.*
- *Recognize and preserve traditional access and uses of the environment to address subsistence needs of the residents of Molokaʻi.*

- *Encourage the development of environmentally sensitive drainage master plans which consider development opportunities and constraints in flood prone areas, stream channels and gulches.*
- *Encourage alternative means of pest control in order to limit the use of chemical pesticides.*
- *Require fire prevention and suppression strategies as a means of protecting and preserving Moloka'i's land and coastal water resources.*
- *Promote the inclusion of environmental education within the curriculum at all educational levels to foster respect for Moloka'i's land, water and marine resources.*

1.7 Planning and Issue Identification

In September 2009, approximately 250 copies of Planning Update 1 were mailed and hand-distributed to interested individuals, local conservation groups, research organizations; County, State, and Federal government agencies; and the Office of Hawaiian Affairs (OHA).
Planning Update 1 described the planning process, Refuge purpose, and draft wildlife and habitat, and public use goals, and preliminary issues to be considered in the CCP.

1.7.1 Public Scoping Sessions

The public scoping period for this CCP opened November 2009. A public meeting was held in Kaunakakai, Moloka'i on November 4, 2009. At the meeting, the Refuge staff explained the CCP planning process; the Refuge purpose(s), vision, and management; and preliminary management issues, concerns, and opportunities. We received written comments and answered questions that addressed a number of issues and concerns from residents. Planning Update 2 (mailed February 2010) summarized the comments we received and listed preliminary management issues we used to draft alternatives and refine goals and objectives.

The core planning team evaluated the issues and the topics documented during scoping. Issues (defined as matters of controversy, dispute, or general concern over resource management activities, the environment, land uses, or public use activities) are important to the planning process to help identify topics to be addressed in the plan, pinpoint the types of information to gather, and help define alternatives for the plan. In Planning Update 3 (mailed March 2011), we described the three alternatives being considered with the preferred alternative identified.

Planning Update #4 and the Draft CCP and Environmental Assessment (EA) were published in August 2011 with a public comment period running from August 19-September 19, 2011. A public meeting on the Draft CCP/EA was held in Kaunakakai, Moloka'i on September 7, 2011. Concurrent with mailing, Planning Updates 1-4 were also posted on the Refuge Website (http://www.fws.gov/Kakahaia).

1.7.2 Issues Addressed in the CCP

***Restoration of the Wetlands*:** The continuous encroachment of pest plants, particularly California bulrush, has been a serious dilemma. Strategic planning is needed to efficiently remove and restore the wetlands and provide for endangered waterbirds and migratory species that once thrived. The Refuge will prepare a comprehensive Habitat Management Plan that will outline the restoration

activities needed to remove and reconfigure Old Pond back to an open water pond that is naturally fed by springs. This work is likely to include deconstruction of the radial levees that were constructed in 1983; these levees pose a threat to the integrity of the pond by limiting water flow, capturing sediment, and are host to non-wetland vegetation.

New Pond was intended to provide shallow water habitat for wading birds, primarily aeʻo; however, the original plan to receive water from Old Pond is not ideal and requires a separate source of water. Prior to construction of a water source, we need to identify the soil type and New Pond's capability to hold water.

***Staff Presence on the Refuge and in the Community*:** Refuge staff, operation, and management of Kakahaiʻa NWR are based at Keālia Pond NWR on Maui. A Maintenance Worker makes a day trip to Molokaʻi every other week to check on the property and perform work, primarily pest plant control (fence line, New Pond). When the wetland is restored, the Refuge will need on-site staff or increased visits to maintain the wetlands and ensure the habitat does not revert to its existing condition. Strategic and efficient planning to restore Old Pond is necessary given the year-round growing season for California bulrush and natural source of underground springs.

***Wildlife and Habitat Resources*:** In the absence of quality habitat, endangered waterbirds are no longer present on the Refuge, except after heavy rains when water pools in New Pond for a short period of time (typically less than 1 week). The Service is concerned with threats posed to native habitats and wildlife at Kakahaiʻa from pest plants like California bulrush and pickleweed, and pest animals such as rats, Indian mongooses, and cats.

***Coastal Erosion*:** The coastal property within the Refuge has undergone heavy erosion over the past decade. The reasons are unknown and emphasize the need to consult with coastal geologists and identify methods of securing the integrity of the coastal property without impacts to other adjacent areas. Refuge staff will seek partnerships to address effects of climate change.

Information about unlawful removal of sand at the culvert adjacent to the Refuge road was revealed at the scoping meeting. Whether or not the removal is being performed by the State, County, or individuals, the Refuge will investigate this to ensure the proper information is distributed and install signs along the Refuge's coastal property citing County ordnance.

***Visitor Services Activities*:** The absence of staff at Kakahaiʻa NWR makes it difficult to allow public access on a daily basis and the Refuge will continue issuing Special Use Permits (SUP) to allow non-government educational organizations to provide school group access. Within the past number of years, these groups have decreased due to the absence of waterbirds.

Figure 1.1 – Main Hawaiian Islands

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Figure 1.2 – Refuge Land Status & Boundary

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Chapter 2. Refuge Management Direction

2.1 Considerations in the Design of the CCP

In thinking through appropriate actions for this long-term conservation plan, the planning team reviewed and considered a variety of resource, social, economic, and organizational aspects important for managing the Refuge. As is appropriate for a national wildlife refuge, resource considerations were fundamental in developing the CCP. House Report 105-106 accompanying the Improvement Act states ". . .the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first."

Local, State, and Federal agencies and elected officials were contacted by the planning team to ascertain priorities and problems as perceived by others. The team also contacted Refuge users, nonprofit groups, and community organizations to ensure that their comments and ideas were considered during CCP development.

2.2 General Guidelines

To reduce the length and redundancy of the individual objective descriptions, common elements are presented below.

2.2.1 Implementation Subject to Funding Availability

Actions will be implemented over a period of 15 years as funding becomes available. Routine maintenance, repair, replacement, and improvement of existing facilities will continue, also dependent on funding. Annual priorities will follow CCP guidelines, although funding initiatives, unforeseen management issues, and budgets may vary from year to year. The CCP will be reviewed every year and updated as necessary throughout its life.

2.2.2 Interagency Coordination and Collaboration

Ecosystem planning efforts discussed in Chapter 1, Section 1.6 involve collaboration among Federal, State, and local agencies toward mutual goals. The Service will continue to maintain regular discussions and partnership with the DLNR, and we will seek out other State and local agencies, non-profit, and private individuals. Topics for discussion continue to be the endangered waterbirds at Kakahaiʻa NWR and surrounding private and public lands, wetland restoration, and wildlife monitoring. Current partners include: U.S. Geological Survey (USGS), the Nature Conservancy (TNC), Molokaʻi Invasive Species Committee (MoISC), the Natural Resource Conservation Service (NRCS) and the Molokaʻi-Lanaʻi Soil and Water Conservation District.

2.2.3 Threatened and Endangered Species Protection and Recovery

Protection of threatened and endangered (T&E) species is common across all alternatives. It is Service policy to give priority consideration to the protection, enhancement, and recovery of these

species on national wildlife refuges. The protection of federally listed species is mandated through Section 7 of the ESA, called "Interagency Cooperation," is the mechanism by which Federal agencies ensure the actions they take, including those they fund or authorize, do not jeopardize the existence of any listed species. To ensure adequate protection, the Refuge is required to review all activities, programs, and projects occurring on lands and waters of the Refuge to determine if they may affect listed species. If the determination is that an action may affect an endangered species, then the Refuge conducts a formal review, known as a consultation, to identify those effects and means to mitigate those effects.

2.2.4 Historic and Cultural Resource Protection

Cultural resources on refuge lands receive protection and consideration in accordance with Federal cultural resources laws, Executive orders, and regulations, as well as policies and procedures established by the Department of the Interior (DOI) and the Service. Refuge management actions will support the State of Hawaiʻi's vision statement "to promote the use and conservation of historic and cultural resources for the education, inspiration, pleasure and enrichment of the public in a spirit of stewardship and trusteeship for future generations" (State Historic Preservation Plan 2010-2014).

The Native American Graves Protection and Repatriation Act (NAGPRA) is a Federal law passed in 1990 that provides a process for museums and Federal agencies to return certain Native American cultural items — human remains, funerary objects, sacred objects, or objects of cultural patrimony — to lineal descendants, and culturally affiliated Indian tribes and Native Hawaiian organizations. A Native Hawaiian organization includes any organization that: (a) serves and represents the interests of Native Hawaiians, (b) has as a primary and stated purpose of the provision of services to Native Hawaiians, and (c) has expertise in Native Hawaiian Affairs, and includes the Office of Hawaiian Affairs and Hui Malama i na Kupuna ʻo Hawaiʻi Nei. The DOI has interpreted this definition to also include the Hawaiian island burial councils and various ʻohana (extended families).

During early planning of any projects, the Refuge will provide the Service Regional Historic Preservation Officer (RHPO) a description and location of all projects and activities that affect ground and structures, including project requests from third parties. Information will also include any alternatives being considered. The RHPO will analyze these undertakings for potential to affect historic properties and enter into consultation with the State Historic Preservation Officer (SHPO) and other parties as appropriate. The Refuge will also ask the public and local government officials to identify any cultural resource impact concerns. This notification is generally done in conjunction with the review required by NEPA or Service regulations on compatibility of uses.

2.2.5 Fire Management

The suppression of wildfires and the use of prescribed or controlled fire are a long-standing part of resource protection, public safety, and habitat management on national wildlife refuges. The Fire Management Plan (Appendix F) provides detailed guidance for the suppression and use of prescribed fire. That plan's actions and effects are incorporated through reference in this CCP. The plan outlines wildfire response and prescribed fire objectives, strategies, responsibilities, equipment and staffing; burn units; implementation; monitoring; and evaluation.

2.2.6 Participation in Planning of Regional Development Activities

The Service will actively participate in planning and studies for ongoing and future industrial and urban development, contamination, and other potential concerns that may affect the Refuge’s wildlife resources and habitats. The Service will continue to cultivate working relationships with pertinent State and Federal agencies to stay abreast of current and potential developments and will utilize effective outreach tools and technologies and EE as needed to raise awareness of the Refuge’s resources. The Refuge will participate in local community initiatives to protect, steward, and enhance natural landscapes and wildlife habitat.

2.2.7 Adaptive Management

Based upon 522 Departmental Manual (DM) 1 (Adaptive Management Implementation policy), Refuge staff shall utilize adaptive management for conserving, protecting, and, where appropriate, restoring lands and resources. Within 43 CFR 46.30, adaptive management is defined as a system of management practices based upon clearly identified outcomes, where monitoring evaluates whether management actions are achieving desired results (objectives). The recently published DOI Adaptive Management Technical Guide also defines adaptive management as a decision process that “promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.”

Adaptive management accounts for the fact that complete knowledge about fish, wildlife, plants, habitats, and the ecological processes supporting them may be lacking. The role of natural variability contributing to ecological resilience also is recognized as an important principle of adaptive management. It is not a “trial and error” process, but rather emphasizes learning while doing based upon available scientific information and best professional judgment considering site-specific biotic and abiotic factors on Refuge lands. Adaptive management results in effective monitoring and evaluation of the CCP.

Part of measuring the success of and adaptively managing the Refuge also includes the formal 15-year revision of the CCP. The revision will be initiated by the Service and will involve many of the same steps as this CCP, including comprehensive review of management plans and research; working closely with partners; and engaging the public.

2.2.8 Integrated Pest Management

In accordance with DOI policy 517 DM 1 and Service policy 569 FW 1, an integrated pest management (IPM) approach will be utilized, where practicable, to eradicate, control, or contain pest and invasive species (herein collectively referred to as pests) on Refuge lands. The IPM will involve using methods based upon effectiveness, cost, and minimal ecological disruption, which considers minimum potential effects to nontarget species and the refuge environment. Pesticides may be used where physical, cultural, and biological methods or combinations thereof are impractical or incapable of providing adequate control, eradication, or containment. If a pesticide will be needed on Refuge lands, the most specific chemical available for the target species will be used unless considerations of persistence or other environmental and/or biotic hazards will preclude it. In accordance with 517 DM 1, pesticide usage will be further restricted because only pesticides registered with the Environmental Protection Agency (EPA) in full compliance with the Federal Insecticide, Fungicide, and Rodenticide

Act and as provided in regulations, orders, or permits issued by EPA, that it is registered for use in the State of Hawaiʻi, may be applied on lands and waters under Refuge jurisdiction.

Environmental harm by pest species refers to a biologically substantial decrease in environmental quality as indicated by a variety of potential factors, including declines in native species populations or communities, degraded habitat quality or long-term habitat loss, and/or altered ecological processes. Environmental harm may be a result of direct effects of pests on native species, including preying and feeding on them; causing or vectoring diseases; preventing them from reproducing; outcompeting them for food, nutrients, light, nest sites, or other vital resources; or hybridizing with them so frequently that within a few generations, few if any truly native individuals remain. Environmental harm also can be the result of an indirect effect of pest species. For example, decreased waterfowl use may result from pest plant infestations reducing the availability and/or abundance of native wetland plants that provide forage during the winter.

Throughout the life of the CCP, most proposed pesticide uses on Refuge lands will be evaluated for potential effects to Refuge biological resources and environmental quality. Pesticide uses with appropriate and practical best management practices (BMP) for habitat management as well as facilities maintenance will be approved for use on Refuge lands where there likely will be only minor, temporary, and localized effects to species and environmental quality based upon non-exceedance of threshold values in chemical profiles. However, pesticides may be used on Refuge lands where substantial effects to species and the environment are possible (exceed threshold values) in order to protect human health and safety (e.g., mosquito-borne disease). For more information on strategies related to control of pests, see Appendix E.

2.2.9 National Environmental Policy Act Compliance

Since this CCP is programmatic in many issue areas, it may not contain the necessary detail on every future action outlined to adequately present and evaluate all physical, biological and socioeconomic impacts. Thus, before certain objectives or actions are implemented, a decision will be made in coordination with the Regional NEPA Coordinator on whether separate step-down NEPA compliance (categorical exclusions, environmental assessments, or an environmental impact statement) are needed.

2.2.10 Law Enforcement

Officers' Responsibilities
Fish and wildlife law enforcement issues on lands and waters of the Kakahaiʻa NWR are under the jurisdiction of the Service Zone Officer based in Honolulu. The role of the Zone Officer is to conduct and document law enforcement incidents and coordinate and/or meet with all refuge project leaders, law enforcement supervisors, and refuge officers. The Hawaiian and Pacific Islands Zone Officer is highly mobile and is frequently deployed temporarily to various areas throughout the State of Hawaiʻi and across the Pacific Region. The need for a dedicated Refuge Officer for the Complex has been identified in the Implementation Plan (Appendix C).

Officers' Authority
The Zone and Refuge Officers are primarily responsible for enforcing refuge and wildlife laws, including but not limited to the:

- Administration Act;

- Lacey Act;
- Archaeological Resources Protection Act;
- Endangered Species Act;
- Migratory Bird Treaty Act; and
- Marine Mammal Protection Act.

Zone and Refuge Officers are also empowered to enforce all criminal laws, including traffic violations, drugs, and warrants for arrest as they relate to trespass, hunting, fishing, and the taking of wildlife on Federal lands, and in some instances boating safety related to refuge lands and waters. Service Officers work joint patrols and coordinate with the State Division of Conservation and Resources Enforcement (DOCARE), Maui Police Department, and the Sheriff Division of the State Department of Public Safety.

2.2.11 Refuge Revenue Sharing Payments

Annual payments to the County of Maui under the Refuge Revenue Sharing Program in lieu of property taxes will continue according to the established formula and subject to payments authorized by Congress.

2.2.12 Regulatory Compliance

Activities under all alternatives requiring additional review, permits and clearances (e.g., Section 106 of the National Historic Preservation Act, ESA Section 7 endangered species consultation, 401 water quality permits, etc.) will undergo appropriate review and obtain permits and/or clearances as needed.

2.2.13 Volunteer Opportunities

Volunteer opportunities occur in all alternatives. These are recognized as components of the successful management of public lands and may become vital to the implementation of refuge programs, plans, and projects, especially in times of declining budgets. Currently, the Refuge hosts intermittent volunteer projects with 40 volunteers.

2.2.14 Climate Change

Climate change is expected to place enormous pressure on coastal refuges particularly vulnerable to sea level rise (SLR) resulting from melting glaciers and thermal expansion of oceans. Estimates by the Intergovernmental Panel on Climate Change (IPCC) project that global sea level will rise 0.6-2 feet by the end of the century. This threatens to erode shorelines, inundate low-lying areas, and contaminate freshwater resources through saltwater intrusion. Other impacts of climate change include species’ range shifts, phenological changes, decoupling of species assemblages, hydrological changes, and changes in disturbance regimes. Such impacts could result in dramatically different ecosystem compositions than currently exist on the refuges, and planning decisions will consider this issue.

There is overwhelming scientific consensus that the earth’s climate is rapidly changing and that the primary cause of global warming is human-caused increases in greenhouse gas emissions. Much less

is understood about the complex effects that a rapidly changing climate will have on ecosystems and wildlife. The Service is participating in the Pacific Islands Climate Change Cooperative (PICCC) to develop protocols for monitoring the status and trends of fish, wildlife, and plants in relation to climate changes. A collaborative program throughout the region will best equip stakeholders to discern changes in abundance or distribution of indicator species. Because regional data accumulation and analysis is requisite, we will coordinate efforts with other Federal agencies, State agencies, conservation organizations, universities, local landowners, and climate change scientists. Such coordinated studies and monitoring data benefit our understanding and appropriate response to changes throughout the region.

2.3 Summary of CCP Actions

As funding and staffing levels permit, we will restore the 15-acre Old Pond and 5.5 acres of New Pond. Physical restoration of the Old Pond will include: removal of California bulrush and other aggressive pest species, dredging accumulated sediment, reconfiguring bathymetry and radial levees, reconstructing perimeter levees, replacing the water control structure, and replacing the pump between the two ponds. Restoration of Old Pond will provide open water and emergent habitat for breeding, foraging, and nesting ʻalae keʻokeʻo with minimum supplemental water due to the presence of natural groundwater springs.

Management actions include a compilation of available data on the ecology of the wetlands and initiation of research to evaluate the geomorphology, hydrology, and elevation in preparation for a restoration design that would meet the needs of two focal species: aeʻo and ʻalae keʻokeʻo. A new well, pump, water distribution line, and control outlet for New Pond will be constructed and existing levees will be reconstructed. The capability of flooding and dewatering the ponds will provide permanent and seasonal habitat for aeʻo and ʻalae keʻokeʻo, and indirectly benefit migratory waterbirds. All monitoring activities would resume with the presence of wetland function. If feasible, a predator-proof fence will be installed to minimize or eliminate predators from entering the wetlands.

The Service will work with the Hawaiʻi Department of Transportation (HDOT) on planning and design to modify the culvert passing under Kamehameha V Highway to allow water from the upper watershed and periodic dewatering of the wetlands to flow to the ocean naturally without blockage from sand. We will contract a comprehensive archaeological and cultural investigation for the Refuge and surrounding lands prior to expanding restoration efforts beyond previously disturbed lands.

Maintaining the wetlands at Kakahaiʻa NWR will require a regular on-site staff presence. The opportunities for visitors to engage in wildlife-dependent recreation may expand depending on staffing, and, at a minimum, a kiosk will be constructed on the earthen platform along the Refuge entrance road. Volunteer groups will be coordinated to assist staff with restoration and maintenance activities.

Table 2.1.

Kakahaiʻa NWR Management Summary		
Key Themes	**Objectives**	**Target Acreage Restored and Management Actions**
HABITATS	**1.1** Seasonal wetland habitat for aeʻo	5.5-7 acres
	1.2 Permanent wetland habitat for ʻalae keʻokeʻo	14 acres
	2.1 Coastal strand	2 acres
	2.2 Grassland	2.3 acres
	3.1 Dry forest	7 acres
SCIENTIFIC DATA	**4.1** Conduct inventory and monitoring	Monitor nesting success; impacts of pest plants & animals; water quantity and quality; and abundance of endangered waterbirds
	4.2 Conduct research projects	Study most effective IPM strategies; climate change research projects
	4.3 Conduct scientific assessments	Assess water resources, assess bathymetric configurations; develop climate change assessment protocols; evaluate SLAMM analyses; and conduct comprehensive cultural resource survey
VISITOR SERVICES	**5.1** Wildlife observation and photography	Up to 500 visitors/year
	5.2 Interpretation, outreach, partnerships, and volunteer programs	Up to 10 programs/year
	6.1 Expand EE partnerships	5-12 programs/year

2.4 Kakahai‘a NWR Management

‘Alae ke‘oke‘o nest USFWS

Goals and objectives are the unifying elements for successful, adaptive refuge management. They identify and focus management priorities, resolve issues, and link to refuge purpose(s), Service policy, and the Refuge System mission. The goals for the Kakahai‘a NWR are presented on the following pages. Each goal is followed by one or more objectives that pertain to it. The goal order does not imply any priority in this CCP. Some objectives pertain to multiple goals and have simply been placed in the most reasonable spot. Similarly, some strategies pertain to multiple objectives and for clarity these strategies are listed under each relevant objective.

Following the goals, objectives, and strategies, a brief rationale is provided. This rationale generally describes how management strategies will be implemented to achieve the intended objectives. The rationale may also, where necessary, discuss means to minimize potential impacts to nontarget species and habitats. It also provides further background information pertaining to the importance of an objective relative to legal mandates for managing units of the Refuge System, including refuge purpose, trust resource responsibilities (federally listed threatened and endangered species and migratory birds), and maintaining/restoring biological integrity, diversity, and environmental health.

2.4.1 GOAL 1.

Restore and maintain seasonal and permanent wetland habitats to meet the life history needs of endangered Hawaiian waterbirds.

Objective 1.1: Restore and maintain seasonal wetland habitat for aeʻo.
Restore and maintain 5.5 acres of seasonal wetland habitat for aeʻo throughout the year in New Pond with the following characteristics: • A mix of saturated and dry mudflat with small, low islands with dimensions of at least 30 ft diameter and 5:1 side slopes; • 75% of the bottom with undulating, irregular topography that creates exposed unsaturated substrate (e.g., shoreline, islands) with gradual slopes during drawdown for nesting sites adjacent to foraging habitat; • Levees with 4:1 slopes to provide loafing and foraging habitat; • Open water (<4-6 in. depth) and mudflat (saturated and unsaturated) with <30% cover of vegetation (e.g., sprangletop, kaluhā, makaloa) as a mosaic to provide protection from wind and adequate foraging areas; • 80% water coverage for breeding aeʻo; • Predation of less than 1% of aeʻo adults documented per year, to achieve nest success of 70% or greater; • <10% pest plants (California bulrush, California grass, and Indian marsh fleabane); • No tilapia present; • Abundant aquatic invertebrates with densities of 400-600 invertebrates/yd^2; and • No human disturbance during aeʻo breeding season (April-July).
Strategies for Achieving the Objective
Control pest plants using mowing, brush cutting, excavation, water level management, prescribed fire, and herbicides (see IPM, Appendix E)
Propagate and plant native species to establish natural vegetative cover on pond levees and slopes
Use IPM techniques to promote a mosaic of vegetation/open water
Develop wetland restoration plan and design
Construct water source (well, pump, water distribution line) for supplemental flooding by 2014
Pulse water during flooding, drawdown, and nonbreeding season to promote abundance and availability of invertebrates
Allow periodic dewatering from September-December to recycle nutrients and promote invertebrate abundance and diversity
Control predators using spring traps, bait stations, and water level management
Eliminate visitor access to nesting areas during breeding activity
Use heavy equipment to rebuild levees (4:1 slopes) by 2015
Use heavy equipment to form and maintain islands by 2015
Replace New Pond water control structures by 2015
Install new piezometers by 2013
Slow drawdown of water to eliminate fish and promote invertebrate/algal growth and plant response
Station employee (Maintenance Worker or Biologist) at Kakahaiʻa NWR to oversee Refuge programs by 2014

Rationale

Originally, New Pond was flooded from water pumped from Old Pond; however, the encroachment of California bulrush throughout Old Pond has resulted in an unavailability of water. Construction of a well and installation of a pump with electrical service is needed to provide forage, resting, and nesting habitat as well as use water level to control pest plants and promote invertebrate diversity and abundance. Aeʻo require different loafing and foraging habitats during the breeding and nonbreeding seasons. Recently hatched chicks (less than 14 days old) require shallow water of less than 2 inches to forage. During the remainder of the year, fledglings and adults can forage in water as deep as 6 inches.

Seasonally regulating water depth stimulates germination of desirable and beneficial plant species, controls pest plants, and provides a variety of macroinvertebrates for young and adult aeʻo to feed upon, thereby creating and maintaining maximized production and carrying capacity of the wetlands. In addition to providing forage, seasonally regulated water depths provide a mosaic of open water and vegetation as microhabitat for thermoregulation. Dewatering the pond during nonbreeding season is beneficial for recycling nutrients and allowing staff to perform IPM (herbicide and mechanical treatment) before flooding. This drying cycle enhances soil aeration and invertebrate productivity. Invertebrates are the primary food source for waterbirds but labor intensive to monitor. Random sampling and subsampling of sieved invertebrates will provide densities of species composition and abundance, and response to IPM techniques.

Management techniques including, mowing, herbicide application, prescribed fire, rototilling and water level management are all techniques suitable for creating the desired mosaic of vegetation, open water, and mudflats. These practices also benefit a variety of other wetland-dependent species including ʻalae keʻokeʻo, wintering waterfowl (dabbling ducks), and shorebirds. The pond would be flooded from a groundwater well or from Old Pond, and ocean water is not likely to inundate the pond.

Declining water levels increase areas of suitable nesting habitat. Aeʻo breeding season drawdowns maximize the number of nests that an area can support. The target distance between nest site to vegetation and water is approximately 0-20 feet. These slow breeding season drawdown rates also stimulate ample numbers and diversity of invertebrates throughout the brood rearing period, allowing adults with broods to establish feeding territories and reduce inter-brood conflicts that can result in injury or death to young chicks.

Aeʻo are very easily disturbed during the nesting season. One behavior of the adult is to depart the nest when perceived danger is detected, leaving the nest, eggs, or young exposed to ground or avian predators and the weather. Eggs can also be destroyed by prolonged exposure to high temperature, wind chill, and rain, all of which occur frequently in Hawaiʻi. Human disturbance must be minimized during the nesting period to reduce the risk of nest abandonment.

Aeʻo nests, eggs, and young are vulnerable to a variety of predators including rats, mongooses, dogs, cats, cattle egrets, and ʻaukuʻu. It is critical to control predators during the nesting season, thereby increasing nesting and fledging success. During this period, control will include two layers of perimeter trapping at a maximum distance of 218 yards apart, with traps placed 109 yards apart, or less. Predator control during the nonbreeding season is reliant on available staff (permanent or contracted) to monitor the program; therefore, trapping effort will be minimal (live traps and bait stations) along the perimeter of the ponds.

Objective 1.2: Restore and maintain permanent wetland habitat for ʻalae keʻokeʻo.
Restore and manage 15 acres of permanent wetland habitat for loafing and foraging ʻalae keʻokeʻo in Old Pond throughout the year with the following characteristics: • Low native, vegetation cover (<4 in) on levees for foraging and loafing; • Abundant aquatic invertebrates with densities of 400-600 invertebrates/yd^2 ; • <50 ft. width of emergent vegetation along shorelines; • Open water (<18 in.) and/or mudflat interspersed with 30-60% cover of emergent vegetation and algae that provides seeds and green browse, concealment, and thermal cover; • 20 ft. of open water between levees and emergent vegetation to protect nests from predation; • 4:1 slope on levees; • >90% reduction of marsh fleabane, California bulrush, and California grass; • 50:50 percentage of open water to emergent vegetation; • Extended hydro periods to promote epiphytic invertebrates (e.g., dragonflies); • <25% cover of annual pest plants; • Documented predation level of less than 1% ʻalae keʻokeʻo annually; • Brood rearing within 150 ft. from nesting habitat ; • Stable water levels (1.0-2.5 ft. depth) during ʻalae keʻokeʻo laying and incubation (December-April); and • No human disturbance during nesting season.
Strategies Applied to Achieve Objectives
Prepare restoration plan for Old Pond with engineering specifications and estimated costs by 2013
Clear vegetation and maintain open water around staff gages and piezometers
Implement partial to complete access closures on levees to minimize human disturbance during breeding season
Use IPM strategies including mechanical/physical, water levels, prescribed fire, chemical, and biological to control pest plants (Appendix E)
Identify methods to isolate groundwater springs
Implement predator controls including spring traps, bait stations, shooting, vegetation management, and water level management
Repair and maintain boundary fence and wetland perimeter fence
Install predator-proof fence along perimeter of ponds by 2016
Remove interior levees and accumulated sediment in Old Pond and recontour pond bottom to create microtopography for varying water level conditions by 2015
Remove pest plant species from levees and restore elevation, width, and slopes by 2015
Replace Old Pond water control structures by 2015
Install additional piezometers to monitor groundwater levels by 2013
Install water level recorder in Old Pond by 2015
Replace pump between Old and New Ponds, if feasible, by 2015
Propagate and plant native species on levees, levee slopes, and within ponds for erosion control and forage
Periodic dewatering areas of the pond to recycle nutrients, aerate soil, manage vegetation, and stimulate invertebrate response
Design and construct sediment basin along north boundary to minimize sedimentation entering the ponds by 2014

Rationale

Natural weather patterns, runoff, and subsurface ground water movement control the hydrology of the wetlands. Old Pond is naturally fed by groundwater springs resulting in a permanent hydrological unit. This natural watering is advantageous in that pumping is not required; however, California bulrush has become well established and currently covers more than 90 percent of the pond. The pond currently has no open water available to ʻalae keʻokeʻo. Restoration of Old Pond for endangered and migratory waterbirds needs to incorporate an evaluation of the groundwater aquifer, topography, geotechnical data, and identification of methods to isolate the springs (e.g., temporary cofferdams) to allow the enclosed area to be pumped out, creating a dry work environment for the major work to proceed. The levees extending into the pond (radials) produce exposed areas where dryland species (e.g., kiawe, monkeypod, and Indian marsh fleabane) have become established. These radial levees need to be removed to improve the function of the wetland.

The ideal wetland, a mosaic of open water and native vegetation, provides thermoregulation cover during periods of high wind and rain, as well as increasing pair bond and brood rearing habitat. Where possible, drawdown of water will promote growth of native sedges and invertebrates. Eradicating California bulrush and obtaining water control will result in proper management of the soils to enhance macro and other aquatic invertebrate production.

Low vegetation on levees creates important habitat for ʻalae keʻokeʻo as well as other species. Maintaining vegetation height of less than 4 inches provides foraging areas where ʻalae keʻokeʻo can graze on short grass and feed on associated invertebrates. Levees are used as loafing habitat by shorebirds. Planting of native vegetation along levee slopes also prevents erosion and provides nesting structure and visual obscurity for nest territories.

A diversity of wetland habitats are beneficial for ʻalae keʻokeʻo during the nonbreeding season, from saturated mudflats to emergent wetlands where birds can forage on seeds and seek cover. ʻAlae keʻokeʻo are primarily herbivores, but opportunistically forage on epiphytic invertebrates, especially during egg laying and early growth (chick) stages. When preparing the pond for nesting, water levels are maintained at a constant level to provide adequate nest sites that are secure from predation. Fluctuating water levels would require nesting adults to continually expend energy to build the nest up or have it isolated on dry ground and subject to greater predation.

During brood-rearing periods, however, water levels would be pulsed to provide physical barriers between brood territories and stimulate macroinvertebrates that are eaten by adults in breeding condition and also fed to developing chicks. These invertebrates are an important protein source for proper development. Water levels are managed to help achieve a ratio of 50:50 vegetation to open water. Providing a mosaic of open water and desirable plant species promotes the greatest number of nesting and brood-rearing territories, while minimizing intraspecific strife between family units. It is important to maintain restricted access to minimize human disturbance during the nesting period. This includes visits from the general public, tours/educational groups, and Refuge staff.

2.4.2 GOAL 2.

Protect, restore, and manage coastal habitat for the integrity of the fragile ecosystem.

Objective 2.1: Protect and maintain ocean shoreline habitat.
First restore and thereafter maintain 2 acres of the ocean shoreline habitat along Kamehameha V Highway. Implement methods to protect the coastal strand from further erosion to provide a protective barrier to the Refuge wetlands and highway. The coastal strand will be restored and maintained for the following characteristics: • Patchy distribution of low growing (2-8 in), native woody species (e.g., ʻilima, naupaka kahakai, and pilo) as a mosaic to naturally construct a dune system; • 30-40% cover of native grasses (e.g., ʻakiʻaki) and herbaceous vegetation (e.g., ʻakulikuli and kīpūkai) along shoreline; • <25% of woody pest plant species (e.g., Indian marsh fleabane, kiawe, and koa haole); and • <70% cover of herbaceous pest plant species (saltbush) and grasses (buffel grass, swollen finger grass).
Strategies Applied to Achieve Objectives
Install signs referencing regulations prohibiting removal of sand from shoreline by 2012
Use appropriate IPM techniques to eradicate pest plant species that would not result in additional erosion
Plant native coastal species to ameliorate erosion
Install temporary sand fencing to facilitate restoration of impacted shoreline by 2013
Consult with coastal specialists on the future impacts of climate change

Rationale

Management of Kakahaiʻa NWRs coastal property is a collaborative effort with the County of Maui and has been managed as a park since the Refuge's establishment in 1976. Nonnative grasses, kiawe trees, coconut trees, and marsh fleabane are currently maintaining the integrity of the soils/sand. Removing all of these established (rooted) plants from the coast without immediate replacement would be detrimental to the integrity of this site. Additional planting of native species along the beach will protect the existing area and provide structure upon which sand can build.

Coastal dune communities are important to several rare and endangered plant and (potentially) animal species. Coastal dunes are also fragile and easily altered by human activity. Coastal strand habitat also provides foraging and loafing habitat for migratory bird species such as the ʻulili (wandering tattler), kōlea (Pacific golden plover), hunakai (sanderling), and ʻakekeke (ruddy turnstone). Given the soil texture, relative position to the shoreline, and desirable plant species; the strand provides suitable subterranean nest burrow habitat for ʻuaʻu kani. The coastal strand habitat at Kakahaiʻa may also be suitable for ʻīlio-holo-i-kaʻuaua pupping and rearing and by honu ʻea (hawksbill sea turtle) and honu (Hawaiian green turtle) for laying eggs and basking.

Objective 2.2: Restore and maintain coastal grassland habitat.
First restore and thereafter maintain 2.3 acres of grassland habitat along both sides of the entrance road on the west side of the Refuge with the following characteristics: • Patchy distribution of low growing (2-8 in), native woody species (e.g., ʻilima and pilo); • 30-40% cover of native grasses (e.g., ʻakiʻaki and pili); • <25% of woody pest plant species (e.g., Indian marsh fleabane, kiawe, and koa haole); and • <70% cover of herbaceous pest plant species (e.g., saltbush) and grasses (buffel grass, swollen finger grass).
Strategies Applied to Achieve Objectives
Remove/control pest plant species by 2013
Plant native species
Implement native hydroseeding and/or hydromulching project, if feasible, by 2014

Rationale
The dominant grass in Hawaiʻi prior to nonnative grasses was probably pili. ʻAkiʻaki grass is salt-tolerant and can be grown adjacent to the beach and for roads that use nonpotable water, which tends to have higher salinity in Hawaiʻi (pers. comm. Chris Dacus). Hydroseeding can be significantly less expensive than hand planting. HDOT has provided grant funding for University of Hawaiʻi Professor Joe DeFrank for native hydroseed experiments, currently underway at other locations on the Island. There is potential for a future collaboration opportunity at the Refuge.

Restoration of native grassland plants within the fenced area of the Refuge will benefit ʻalae keʻokeʻo that graze on grass adjacent to wetlands.

2.4.3 GOAL 3.

Protect, restore, and manage forest habitat to provide a buffer from upper watershed impacts.

Objective 3.1: Restore and maintain native dry forest habitat.
Restore and maintain up to 7 acres of native dry forest habitat with the following characteristics: • 50 ft width of trees around ponds to protect from upper watershed impacts; • >40% native plants consistent with historic dry forest habitats; and • <60% pest plants and annual grasses.
Strategies Applied to Achieve Objectives
Maintain 50 ft buffer zone of kiawe trees around ponds until replacement with native plants is feasible
Use IPM techniques to control/eradicate pest plants in buffer zone
Develop/implement restoration program, to include outplanting of native species by 2016

Rationale
Much of the Refuge is currently covered with pest trees and shrubs which provide a buffer from the upper watershed (e.g., slows down water and allows groundwater seepage, filters sediments and pollutants before entering the ponds). This area is dominated by dense stands of nonnative kiawe and haole koa trees. The seed dispersal from these nonnative pest species does have a negative impact on the wetland habitat. While native plants are desirable, the existing vegetation provides a buffer to shield endangered waterbird habitats from urban disturbances. Suspended

sediments in stream flows from the upper watershed primarily derive from urban development and settle in the Refuge wetlands.

One of the most significant influences leading to the degradation and loss of native Hawaiian habitats has been the relentless influx of pest plants, many of these highly invasive. The Refuge plans to work with partners to gradually restore a viable natural native plant community through removal of pest plants and outplanting of native plants that were part of the historic vegetative community.

2.4.4 GOAL 4.

Gather scientific information in support of adaptive management decisions on the Refuge under Goals 1-3.

Objective 4.1: Conduct inventory, monitoring, and research to document progress and evaluate management strategies to guide management decisions.
Conduct high-priority inventory and monitoring activities that evaluate resource management and public use activities to facilitate adaptive management. These surveys contribute to the enhancement, protection, use, preservation, and management of wildlife populations and their habitats on- and off-refuge. Specifically, they can be used to evaluate achievement of resource management objectives identified in this CCP. These surveys have the following attributes: • Data collection techniques would have zero to minimal animal mortality or disturbance and zero to minimal habitat destruction; • Collect minimum number of samples (i.e., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) to meet statistical analysis requirements for identification and/or experimentation in order to minimize long-term or cumulative impacts; • Use proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary, to minimize the potential spread or introduction of pest species; and • Projects will adhere to scientifically defensible protocols for data collection, where available and applicable.
The following is a prioritized list of survey activities to support resource management decisions on the Refuge
Monitor water quantity (surface water and groundwater)
Identify the primary sources of sediment loads and solutions to minimize accumulation at lower elevations
Identify the sources of water entering the Refuge and mechanisms to enhance water quantity
Inventory and monitor bird abundance with monthly census to obtain descriptive statistics of counts and trends
Monitor breeding ʻalae keʻokeʻo from December-March for reproductive success (incubation period is 25 days-requires on-site staff)
Monitor breeding aeʻo from April-July for reproductive success (requires on-site staff)
Research potential for hydroseeding/mulching native grasses
Monitor vegetation response to IPM techniques
Monitor mongoose and rat abundance with tracking tunnel surveys at least every 60-90 days
Conduct studies to determine desirable native plant community based on local site conditions (e.g., soil type, elevation, groundwater table, and proximity to shore)

Prioritized list of survey activities (continued)
Contract a comprehensive archaeological and cultural investigation for the Refuge and surrounding lands
Monitor human activities at the coastal park for potential effects that jeopardize the integrity of the coastal strand (e.g., erosion)
Monitor banded aeʻo and ʻalae keʻokeʻo
Monitor water quality (abiotic parameters: pH, temperature, salinity, conductivity, turbidity, dissolved O_2)
Maintain and monitor weather station

Rationale

The Administration Act requires us to ''… monitor the status and trends of fish, wildlife, and plants in each refuge.'' Surveys are used primarily to evaluate resource response to assess progress toward achieving Refuge management objectives derived from the Refuge System mission, refuge purpose(s), and maintenance of biological integrity, diversity, and environmental health. Determining resource status and evaluating progress toward achieving objectives is essential to implementing adaptive management on DOI lands as required by policy (522 DM 1). Specifically, results of surveys would be used to refine management strategies, where necessary, over time in order to achieve resource objectives. Surveys would provide the best available scientific information to promote transparent decisionmaking processes for resource management over time on Refuge lands.

Inventory, monitoring, and research studies are essential to high-quality habitat and population management. Conducting censuses for endangered waterbirds and compiling data is critical to evaluate population status and measure progress towards goals. Similarly, other waterbird populations, habitat conditions and habitat management practices, including restoration efforts must be monitored to evaluate their status and effectiveness. Population trends can be used to evaluate habitat effectiveness and guide management actions.

Refuges must collect site-specific information and conduct defensible research to provide information for devising, guiding and adapting management practices. Monitoring habitat conditions provides valuable support and sound decisionmaking as applied to Refuge resource management and also contributes to the Service's ability to modify management practices (adaptive management). Applied research on the Refuge will help address management issues and questions, in theory, will result in improved management decisions on both the Refuge and on a regional basis. The Refuge has always maintained a close working relationship with several State and local agencies, and universities to advance the knowledge base of a variety of habitats and plant and wildlife species.

Kakahaiʻa NWR is bisected by Kamehameha V Highway resulting in a coastal area set apart from the wetlands. This area is not fenced and is accessible to the public. Use of this area includes: picnicking (currently two concrete picnic tables) and access to the ocean for kayaking and fishing. Human activities in the coastal area will be monitored to ensure the impacts are not detrimental to the habitat (e.g., erosion, vandalism).

Objective 4.2: Conduct scientific assessments.
Throughout the life of the CCP, conduct scientific assessments to provide baseline information to expand knowledge regarding the status of Refuge resources to better inform resource management decisions. These scientific assessments will contribute to the development of Refuge resource objectives and they would also be used to facilitate habitat restoration through selection of appropriate habitat management strategies based upon site-specific conditions. • Utilize accepted standards, where available, for completion of assessments; and • Scale and accuracy of assessments would appropriate for development and implementation of Refuge habitat and wildlife management actions.
Strategies Applied to Achieve Objectives
Coordinate with Regional Office staff to adjudicate water rights (surface and groundwater)
Complete a water resources assessment, to include natural springs
Evaluate SLAMM analyses (and other studies) for climate change planning
Conduct a full topographic survey for habitat restoration design
Analyze and evaluate sediment cores for profiling, soil composition, and characteristics
Collaborate with HDOT to evaluate, design, and reconstruct the Kamehameha V Hwy. culvert to prevent flooding and allow natural drainage from the upper watershed
Initiate sampling of invertebrates (sieve) to assess species composition and density by 2016
Investigate the pros and cons of allowing high storm surges from the ocean to periodically inundate the wetland

Rationale

In accordance with a policy for implementing adaptive management on DOI lands (522 DM 1), appropriate and applicable environmental assessments are necessary to determine resource status, promote learning, and evaluate progress toward achieving objectives whenever using adaptive management. These assessments would provide fundamental information about biotic (e.g., vegetation data layer) as well as abiotic processes and conditions (e.g., soils, topography) that are necessary to ensure that implementation of on-the-ground resource management achieve resource management objectives identified under Goals 1-3.

Kawela's upper watershed has undergone changes in land use over the decade with increased housing development. High volumes of suspended sediments in flood waters enter the north side of Kakahai'a NWR during winter months resulting in levee damage and sedimentation in the ponds. A comprehensive hydrological assessment at Kakahai'a NWR is needed to evaluate wetland needs. An evaluation of the groundwater source is essential since Old Pond receives its water from this source.

The culvert under Kamehameha V Highway that connects the upper watershed and pond drainages to the ocean is naturally plugged by sand due to its low elevation. This sand plug blocks the flow of water, resulting in flooding of the Refuge's road and the highway. During periods of heavy precipitation, the DOT removes the sand plug to allow drainage. Unless the highway and culvert is redesigned this flooding will continue to occur. In efforts to reach the objective of restoring Old and New Ponds for the benefit of endangered waterbirds and the need to control water levels, this issue will be a hindrance and needs to be addressed.

2.4.5 GOAL 5.

Provide high-quality wildlife-dependent recreation, interpretation, and outreach opportunities to enhance public understanding, appreciation, and enjoyment of the native wildlife, natural communities, and cultural history of the Kakahaiʻa NWR.

Objective 5.1: Provide opportunities for wildlife observation and photography.
Provide visitors with the opportunity for self-guided wildlife observation and photography to increase their knowledge and appreciation for wetland ecosystems and endangered species. • Focus on wetland ecology and the endangered waterbirds that rely upon these wetlands; • Provide viewing opportunities from outside the fence when the Refuge is unstaffed; and • Directly link opportunities to EE and interpretation programs.
Strategies Applied to Achieve Objectives
Develop a Visitor Services Plan (VSP) by 2016
Install Kakahaiʻa NWR entrance sign
Complete the Refuge brochure and bird species checklist
Replace two Refuge signs at the coastal property in collaboration with County of Maui (Kakahaiʻa Park)
Construct elevated platform (earthen) and kiosk along Refuge entrance road for wildlife viewing
Construct parking area along entrance road for kiosk
Design interpretive panels for kiosk
Open Refuge to the public when staff is present
Evaluate the need, location, and logistics for photo blinds on/adjacent to the ponds.

Rationale

Currently, Kakahaiʻa NWR is unstaffed and closed to the public. Refuge staff (1-2 people) make day trips from Maui every other week to perform habitat management activities. In past years, endangered Hawaiian waterbirds and migratory species were prevalent in the wetlands. Future public use is contingent on the level of habitat restoration that is completed because without the wetlands and presence of waterbirds, there is no viewing opportunity.

A step-down VSP is needed to evaluate the existing and potential public uses on the Refuge. As part of the VSP, a viewing area and interpretive panels will be incorporated into the Kakahaiʻa NWR entrance road design. During the nesting seasons for endangered ʻalae keʻokeʻo (December-May) and aeʻo (April-August), human activities at the viewing area will be evaluated to determine whether or not waterbirds are impacted, and if disturbance is observed, the area may need to be blocked from access. Opportunities for recreational wildlife photographers at Kakahaiʻa NWR will be authorized in the form of a SUP during the nonbreeding season only because staff may not be present to monitor impacts to waterbirds.

Staff oversight of the Refuge is from the headquarters located at Keālia Pond NWR on Maui. The addition of one employee (e.g., Maintenance Worker or Biologist) to work 90% of the time at Kakahaiʻa NWR with duties including habitat management, predator control, and working with volunteers would facilitate oversight of proposed increases in public use.

Objective 5.2: Provide interpretation, outreach, and volunteer programs.
Expand the Refuge's interpretation and outreach programs to foster appreciation and stewardship for the wetland resources and reach a wider diverse audience. Participate in partnerships and other collaborative efforts that incorporate Refuge restoration into other ecosystem-based opportunities.
Strategies Applied to Achieve Objectives
Maintain agreement with the County of Maui to assist with management of the coastal park
Work cooperatively with the Sedimentation Partnership
Participate in off-site community events including the annual Earth Day event on Molokaʻi, beach cleanups with Community Work Day Program, etc.
Support volunteerism through partnerships with The Nature Conservancy, AmeriCorps, and other community groups
Maintain and update the information on the Refuge website
Work with Kokua Kakahaiʻa to engage new volunteers to promote and assist with the Refuge's purpose and vision
Work with partners in the East Molokaʻi watershed to implement studies and monitoring projects
Recruit and maintain a volunteer program to assist with habitat, biological, maintenance, visitor services, and EE programs
Install and maintain panels interpreting the wetlands, waterbirds, historical and cultural information in the Kakahaiʻa viewing kiosk
Incorporate Refuge interpretive information into the Maui Visitors Bureau products
Provide public presentations and interpretive tours on wetland ecology and wildlife, coastal habitats, and cultural history

Rationale

Restoration of the Refuge to a viable healthy wetland with waterbird habitat is a prerequisite to public use and volunteer programs. Many local residents are unfamiliar with Kakahaiʻa NWR and do not know where the Refuge is located. The Refuge should be visible within the community to help foster support for the Refuge. Molokaʻi residents have a fairly strong volunteer ethic and they are willing to help out if they know what is available to them.

The Refuge's support group, *Kokua Kakahaiʻa*, is comprised of long-time residents with a common interest in the restoration of the wetlands. This group has provided critical support for the Refuge in the past and would be an asset to help achieve our goals in the future. The Refuge's volunteer opportunities need to be advertised, and we should continue to participate in community events. Interpretive panels at Kakahaiʻa will offer messages to viewers about the importance of wetlands and information about the wildlife that depend upon them.

2.4.6 GOAL 6.

Provide a quality environmental education program with specific learning objectives and diverse hands-on opportunities.

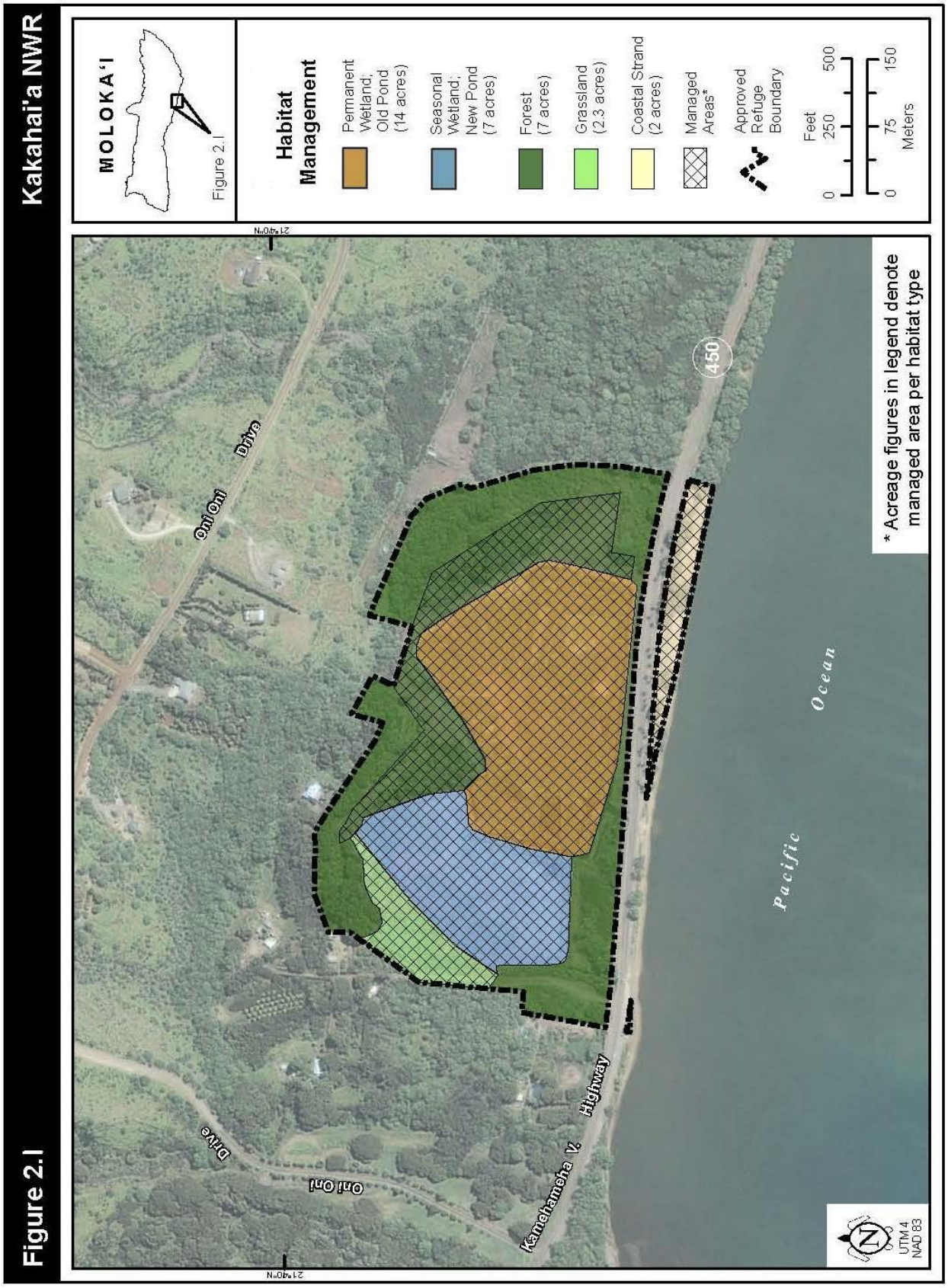
Objective 6.1: Provide quality environmental education (EE).
Expand EE partnerships that connect children with nature and focus on the functions of wetlands and coastal ecosystems as part of watersheds. Quality curriculum includes: • Supports national and State Department of Education (DOE) Standards; • Provides interdisciplinary opportunities that link natural resources through all subject areas; • Incorporates the Refuge System mission and Refuge purpose; • Involves the local community, volunteers, friends group, and partners; • Involves hands-on learning opportunities and stewardship components; • Incorporates current conservation issues and concerns; and • Located both on- and off-Refuge.
Strategies Applied to Achieve Objectives
Evaluate and provide SUPs to agencies and nongovernmental organizations providing EE on the Refuge
Participate in partnerships to provide educational opportunities focusing on island ecosystems
Participate in workshops to present teachers with the tools and resources available to them on natural resource topics
Develop site-specific materials and tools for educators' use
Provide formal learning experiences in support of teachers' curricula and DOE requirements

Rationale

Many opportunities exist for us to work together with educational partners to enhance Refuge programs and also provide coordination and assistance to other local programs, with respect to watersheds and ecosystems. School groups on Molokaʻi do not have the same opportunities for diverse learning experiences as the other main Hawaiian Islands so teachers may welcome a chance to engage the students at the Refuge. Teachers may not have the time and resources to compile pre- and post-visit materials; therefore, the Refuge can provide packets geared for different age groups for teachers to incorporate the visit into their curriculum. Hands-on experiences and inclusion of career opportunities into presentations can help direct students into natural resource disciplines.

Over the past 10 years, there have been inquiries from teachers interested in accessing Kakahaiʻa NWR, many of which were forwarded to our EE partners under a SUP. Currently, the primary environmental focus is on invasive species. The potential for the teachers and students to connect with nature at Kakahaiʻa NWR is a feasible goal once the wetlands are restored. The Complex has limited staffing and is only able to accommodate teachers' requests on a case-by-case basis. Partnerships with EE organizations have been an effective tool to promote the Refuge System mission with outside educators who have been thoroughly trained to instruct students. Refuge staff work with partners to ensure the information is appropriate and updated.

Figure 2.1 –Habitat Management



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Kakahaiʻa overview USFWS

Chapter 3. Physical Environment

3.1 Refuge Introduction

Kakahaiʻa NWR is located in East Molokaʻi along the southeastern coast of the island, in the rain shadow of the mountains. The Refuge contains a 15-acre coastal freshwater marsh with a spring-fed pond on a narrow plain just above sea level at the foot of volcanic hills. An additional 5.5-acre managed impoundment was constructed in 1983 to provide shallow-water habitat for wading birds. Kamehameha V Highway bisects the southern ocean shoreline portion of the Refuge.

3.2 Climate

The Island of Molokaʻi is approximately 38 miles long and 10 miles wide and is oriented east to west. The island is mountainous in its eastern part, with a maximum elevation of 4,970 feet; however most of the island is less than 1,000 feet above sea level. There are three general regions: East Molokaʻi, which includes Wailau (East Molokaʻi volcano), the highest point on the island; the Hoolehua Plain; and West Molokaʻi, which includes the much smaller Maunaloa (West Molokaʻi volcano). The topography and orientation of the island have a profound influence on climate. The

northeastern side of the island is exposed to prevailing trade winds and is very wet and forested. There is a rain shadow effect from the mountain range, creating arid conditions elsewhere.

Native Hawaiians recognized only two 6-month seasons: a warm season with drier weather and more reliable trade winds and a cooler wetter season with more storms and fewer trade winds. Modern analysis of climate records indicates the soundness of the Hawaiian system of seasons. The wet season is now considered to extend seven months from October-April and the dry season from May-September. During the wet season, there may be two, three, or as many as seven major storm events a year. Such storms typically bring heavy rains and are often accompanied by strong Kona winds that blow from the south. Rainfall is rare during the May-September dry season, which is typically warm and windy.

Maximum mean annual rainfall is more than 150 in/yr near the summit of Wailau in the northeastern part of the island (Giambelluca et al. 1986). Over Maunaloa, maximum mean annual rainfall is about 25 in/yr. Mean annual rainfall is less than 16 in/yr along the coastal areas of the southern and western parts of the island. There is no weather data available for the Refuge itself. The only local weather station with a fairly complete record is the Moloka‘i Airport COOP station, located in the center of the island in the Hoolehua Plain area. Annual precipitation for 1958-2009 averaged about 26 in/yr but has varied greatly from 11-43 in/yr (Figure 3.1). Gaps represent years with missing data.

Figure 3.1. Annual cycle of average monthly precipitation (top) and total annual precipitation with 5-year moving average (bottom) at Moloka‘i Airport, HI 1958-2009.

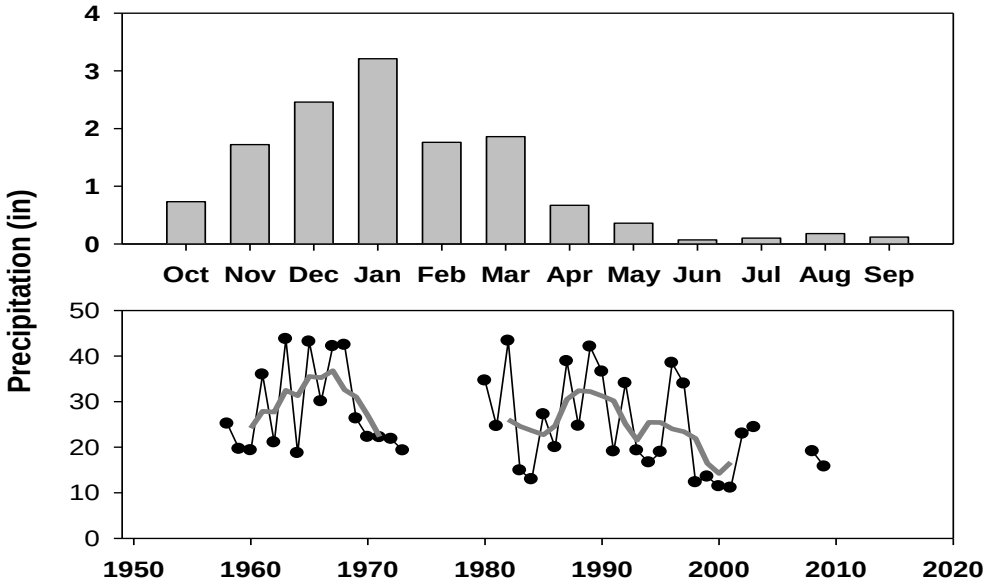
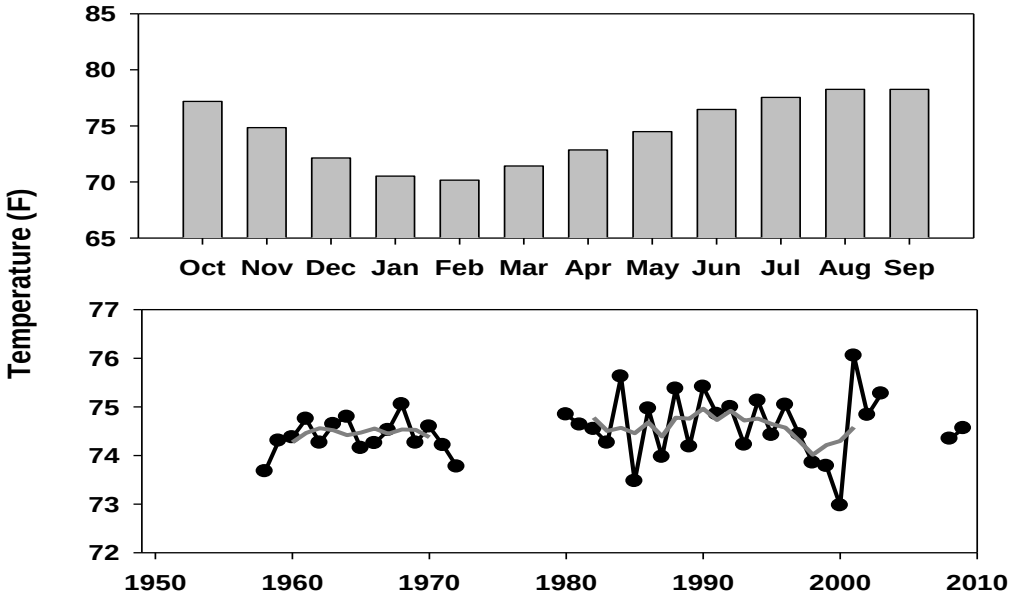


Figure 3.2. Annual cycle of average monthly temperature (top) and average annual temperature with 5-year moving average (bottom) at Moloka‘i Airport, HI 1958-2009.



Average monthly temperatures for 1958-2009 (Figure 3.2) were fairly constant throughout each month of the year at 75 degrees F. Maximum monthly temperatures occured July-September and average 77-79 degrees F and minimum monthly temperatures occured January-March and average 70-72 degrees F.

Both short-term interannual climate variability and long-term decadal variability affect water resources and streamflows on Moloka‘i. Many of the droughts in Hawai‘i are related to El Niño events, which are associated with drier than normal winters (Oki 2004). The Pacific Decadal Oscillation (PDO) also influences Hawaiian climate. The pattern of ocean-atmosphere variability associated with El Niño-Southern Oscillation phenomenon occurs on a relatively short time scale of one to several years while the PDO is a longer term phenomenon occurring over one to several decades. Rainfall and streamflow tends to be low in winter during El Niño periods and high during La Niña periods, especially during positive (warm) phases of the PDO. Temperature may be affected by PDO phases, too.

3.2.1 Global Climate Change

The future climate change impacts expected for Hawai‘i are warmer temperatures (air and ocean), more severe droughts and floods, and a rise in sea levels (Mimura et al. 2007). More recent observations and re-analyses of temperatures averaged over land and ocean surfaces show consistent warming trends in all small-island regions over the 1901-2004 period (Mimura et al. 2007). Giambelluca et al. (2008) reported that air temperatures at 21 weather stations in Hawai‘i have increased at a rate of 0.3 degrees F/decade since 1975, which is comparable to the rate of increase in global temperatures. Rainfall intensity has reportedly increased 12 percent in Hawai‘i between 1958-2006 (Fletcher 2010) but total rainfall has decreased about 15 percent over the last 20 years (Chu

and Chen, 2005). These changes have and will continue to affect biologic and water resources on Molokaʻi and the other islands (Oki 2004).

The low resolution of many global circulation models is problematic for representing Hawaiʻi which is strongly influenced by steep topography, aspect, and location. This information is not included in global climate models. Typically, the models represent the islands as a single grid cell or ignore the islands completely. Higher resolution regional climate models project increasing temperature and precipitation for the islands in the future, with an increase in extreme events such as floods and droughts. Temperatures for the North Pacific region are forecast to increase 0.9-1.1 degrees F from 2010-2039 relative to the 1961-1990 period (Mimura et al. 2007).

Precipitation is forecast to change by -6.3 to +9.1 percent for the same region relative to the same period. Timm and Diaz (2009) were the first authors to evaluate global climate model performance for Hawaiʻi and downscale climate scenarios for Hawaiian rainfall. Based on statistical downscaling of climate model output, they concluded that the most likely scenario is a 5-10 percent reduction of wet-season precipitation and a 5 percent increase during the dry season, as a result of changes in the wind field. Future changes in precipitation are less certain because they depend on how El Niño might change which is unknown. Warmer air temperatures will increase water use and demand (evaporation and consumptive use), which will exacerbate water supply concerns and environmental stresses. A number of studies suggest that climate change could be a major factor in accentuating the current climate regimes and the changes that come with ENSO events (Mimura et al. 2007).

The Service is supporting the development of regional Landscape Conservation Cooperatives (LCC) that will integrate local climate models with models of climate-change responses by species, habitats, and ecosystems. The regional version of these LCC is the Pacific Islands Climate Change Cooperative (PICCC), headquartered in Honolulu, Hawaiʻi, but working across the Pacific. The PICCC was established in 2010 to assist those who manage native species, island ecosystems, and key cultural resources in adapting their management to climate change for the continuing benefit of the people of the Pacific Islands. The PICCC steering committee consists of more than 25 Federal, State, private, indigenous, and non-governmental conservation organizations and academic institutions, forming a cooperative partnership.

3.2.2 Ecological Responses to Climate Change

Evidence suggests that recent climatic changes have affected a broad range of individual species and populations in both the marine and terrestrial environment. Organisms have responded by changes in phenology (timing of seasonal activities) and physiology; range and distribution; community composition and interaction; and ecosystem structure and dynamics. The reproductive physiology and population dynamics of amphibians and reptiles are highly influenced by environmental conditions such as temperature and humidity. For example, sea turtle sex is determined by the temperature of the nest environment; thus, higher temperatures could result in a higher female to male ratio. In addition, increases in atmospheric temperatures during seabird nesting seasons will also have an effect on seabirds and waterbirds (Duffy 1993, Walther et al. 2002, Baker et al. 2006). Changes in ocean temperature, circulation, and storm surge due to climate change will impact seabird breeding and foraging. The ENSO has been shown to cause seabirds to abandon habitats, nest sites, and foraging areas for colder/warmer waters. Studies have found that nesting success is reduced for some species during this climatic event. Oceanographic changes associated with ENSO may also

increase or decrease food supply for seabirds and subsequently impact populations that forage offshore. Shifts in marine temperature, salinity, turbidity, currents, depth, and nutrients will have an impact on seabird and water bird prey composition and availability. Although these potential changes may impact seabirds throughout the Hawaiian Islands, contrary evidence suggests that seabirds may have coped with and evolved around climatic changes in the past (Duffy 1993).

Warming has also caused species to shift toward the poles or higher altitudes and changes in climatic conditions can alter community composition. For example, increases in nitrogen availability can favor those plant species that respond to nitrogen rises. Similarly, increases in CO_2 levels can impact plant photosynthetic rates, decrease nutrient levels, and lower herbivore weights. Although there is uncertainty regarding these trajectories, it is probable that there will be ecological consequences (Vitousek 1994, Walther et al. 2002, Ehleringer et al. 2002).

Climate change has the potential to influence two important ecological issues in the State of Hawaiʻi: endangered species and pest species. The majority of U.S. endangered species are found in the State of Hawaiʻi. Species declines have resulted from habitat loss, introduced diseases, and impacts from pest species. Changes in climate will add an additional threat to the survival of these species. For example, warmer night temperatures can increase the rate of respiration for native vegetation, resulting in greater competition from pest plants. Furthermore, climate change may enhance existing pest species issues because alterations in the environment may increase the dispersal ability of flora or fauna. Species response to climate change will depend on the life history, distribution, dispersal ability, and reproduction requirements of the species (DBEDT and DOH 1998, Middleton 2006, Giambelluca 2008).

3.3 Geology and Soils

The Hawaiian Islands were created by a geologic hot spot underneath the surface of the earth. As the earth's crust has moved over this spot, magma has created new islands in the form of volcanoes. Iron-rich, quartz-poor rock flowed out of thousands of vents as highly fluid lava. The Island of Molokaʻi is the fifth largest of the Hawaiian Islands. The island was formed by volcanic activity at Wailau (elev. 4970 ft) and Maunaloa (elev. 1430 ft). The two volcanoes are connected by the Hoolehua Plain, created by lava flows from Wailau. Most of the island's population and development occurs in this area and along the south shore of the island. No perennial streams exist in the Hoolehua Plain, water is supplied from diverted streamflow from East Molokaʻi and from groundwater development.

The exposed rocks of East Molokaʻi are classified as East Molokaʻi volcanics and Kalaupapa volcanics. Kaunakakai Stream flows over the East Molokaʻi volcanics, which is divided into two informal members—a lower member consisting of shield-stage tholeiitic, olivine-tholeiitic, and picritic-tholeiitic basalts and postshield-stage alkalic basalt; and an upper member consisting of postshield-stage mugearite and lesser amounts of hawaiite and trachyte (Langenheim and Clague 1987). The upper member forms a relatively thin (50-500ft thick) veneer over the lower member (Stearns and Macdonald 1947). The northeastern part of Wailau contains numerous intrusive volcanic dikes, which form a dike complex and reduce bulk permeability of the rocks in the area. The volcanic rocks of West Molokaʻi are separated from the East Molokaʻi volcanics by an erosional

surface that forms a hydrologic confining unit over the West Molokaʻi volcanics (Langenheim and Clague 1987).

3.4 Hydrology

Precipitation is the source of all freshwater on Molokaʻi. The windward (northeast) side is wettest, due to the orographic lifting of moisture-laden northeasterly trade winds along the windward slope of Wailau. Maunaloa is considerably drier because it does not extend upward into the cloud-forming zone at higher altitudes. Most of the fresh groundwater on the island is in East Molokaʻi because of the higher precipitation in this area. Groundwater levels are highest in the mountainous interior parts of the island, particularly in the northeast, and lowest near the coast. Freshwater floats on top of saltwater near sea level within the more permeable lava flows on the flanks of the volcanoes (Shade 1997).

The State Commission on Water Resource Management (CWRM) designated the Island of Molokaʻi as a Groundwater Management Area in 1992. With this designation, the State was authorized to protect the groundwater resources of Moloka'i by managing groundwater withdrawals from the aquifer through a permitting process. Most of the groundwater withdrawn on Molokaʻi is from Kualapuʻu in the southeast coastal area and the dike complex in the northeastern part of the island (Oki 2007). Several existing production wells have experienced rising salinity as a result of the declining water levels and a rising brackish-water transition zone caused by the cumulative effect of withdrawals. Any new groundwater development must be approved by the CWRM, and the State manages groundwater withdrawals from the aquifer through a permitting process. There are several existing groundwater wells in the vicinity of Kakahaiʻa NWR (Oki 2007).

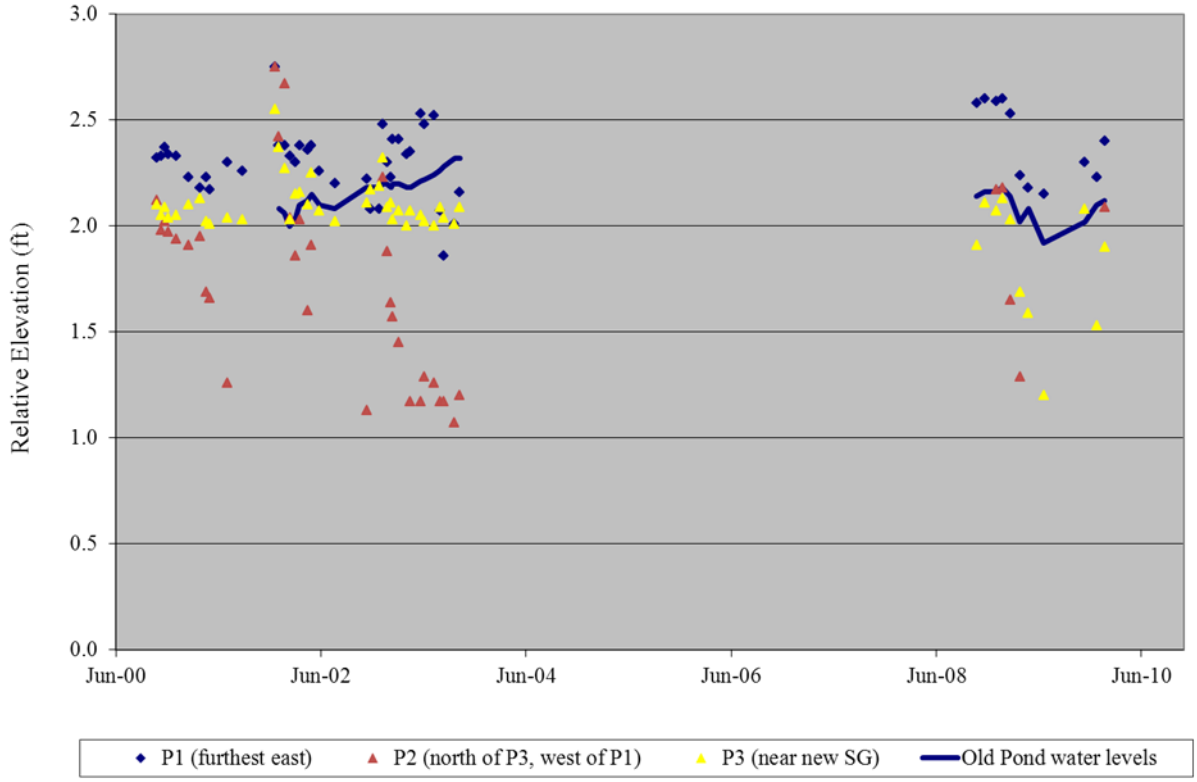
Stearns and Macdonald (1974) indicated that several streams on the southern slope of Wailau are perennial in their upper reaches but do not flow continuously to the coast because of seepage loss and evaporation. These streams are generally perennial where they flow over lavas of the upper member of the East Molokaʻi Volcanics and where water discharges from springs or drains swamps. Where streams flow over the more permeable lower member, surface water is more readily lost to infiltration.

Kakahaiʻa NWR is in the driest part of the island and is underlain by the Kawela groundwater aquifer (Shade 1997). The Refuge consists of two wetlands: Old Pond is a natural wetland and New Pond is a constructed wetland. For some years, New Pond was supplied with water by a pump from Old Pond. However, thick vegetation growth in Old Pond began to impede the movement of water, drying out the area around the supply pump, so this was discontinued. For most of the year, New Pond is now dry.

Old Pond depends on groundwater in the form of natural spring discharge for its water supply. Occasional runoff from the surrounding hills is secondary source of water. Spring discharge into the pond is diffuse and cannot be measured directly but we have regularly recorded groundwater levels in three piezometers on the Refuge since 2002. This is an indirect measurement of hydrologic conditions and spring discharge at the Refuge. The record of measurements is shown below (Figure 3.3). Gaps represent years with missing data. The less frequent measurements in P2 shown in recent years are because that piezometer has been dry more frequently recently.

The record shows seasonal and annual variability but little long-term change in water levels. However, there has been an increasing frequency of “dry” measurements in one of the piezometers, P2, in recent years. These water level measurements are useful in terms of detecting changes and impacts to Refuge hydrology.

Figure 3.3 Old Pond water levels and groundwater levels, 2000-2010.



The closest streamflow gage is the USGS gage at Kawela Gulch (Site No. 16415600), located about 1,500 feet west of the Refuge at the mouth of Kawela Stream. The site elevation is 40 feet above sea level, the drainage area above the gage is 5.3 square miles, and the period of record is 2004-present. The stream has been dry 60 percent of the time, based on daily flow records. The monthly flows are shown in Table 3.1. Flow is greater during the winter months in response to greater rainfall.

Another USGS streamflow gage close to the Refuge is at Kaunakakai Gulch (Site No. 16414200), located about 6 miles west of the Refuge and just north of the town of Kaunakakai at an elevation of 75 feet. Hydrologic conditions at this site are likely very similar to the Refuge, although the area is underlain by a different aquifer system (Shade 1997). The period of record for this site is from 2003 to the present (Figure 3.2). Streamflow is sporadic and seasonal and most common during the wetter winter months in response to rainfall. The stream was estimated to be dry 91 percent of the time during water years 2004-2006 (Oki 2007). No known diversions exist upstream from the gauging station. Oki (2007) reports that the stream becomes perennial further downstream near the coast, where it is hydraulically connected to the groundwater system.

Table 3.1. Monthly streamflow data for Kawela Gulch(USGS Site No. 16415600), located just west of Kakahai'a NWR. .

YEAR	Monthly mean in cfs (Calculation Period: 2004- 2009)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004										0.12	2.94	3.6
2005	12.7	1.82	6.85	3.67	0.36	0.53	1.52	0.03	2.59	3.71	4.01	0
2006	2.69	3.16	11	10.6	2.66	0	0.83	0.1	0	1.77	7.37	1.4
2007	1.99	1.38	4.95	1.73	0.13	0.25	3.79	0.93	0.2			
2008										0.13	1.76	7.6
2009	4.31	2.48	2.29	0.22	0	0.6	0.08	2.07	0.01			
Mean of Monthly Discharge	5.4	2.2	6.3	4.1	0.79	0.34	1.6	0.78	0.7	1.4	4	3.1

Blank boxes indicate missing data due to malfunctioning equipment.

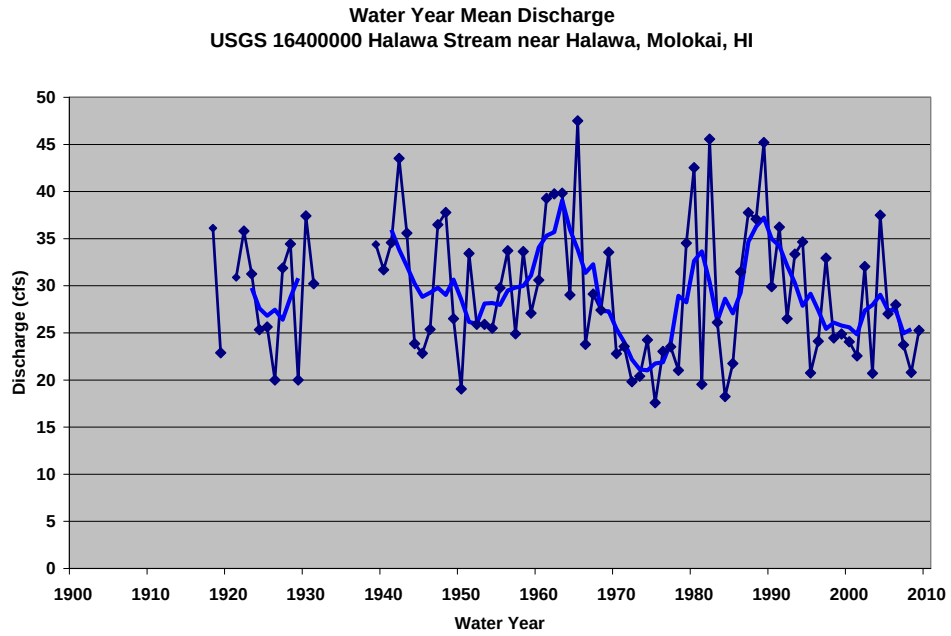
Table 3.2 Monthly streamflow data for Kaunakakai Gulch (USGS Site No. 16414200)..

YEAR	Monthly mean in cfs (Calculation Period: 2003- 2009) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003			0.392					0	0	0	1.54	2.61
2004	12.3	1.7	8.3	3.4	0.9	0.0	0.0	0.0	0.0	0.0	1.1	0.6
2005	6.2	0.1	4.4	0.4	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
2006	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
2007	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	13.3
2008	1.7	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.6
2009	0.5	0.3	0.3	0.0	0.0	0.0	0.0	0.4	0.0			
Mean of Monthly Discharge	3.5	0.72	2.1	0.63	0.16	0	0.01	0.06	0	0.17	0.83	3

Near the coast in this area, the main groundwater-flow system consists of a freshwater lens system (Gingerich and Oki 2000) within dike-free rocks. In general, a freshwater-lens system includes a lens-shaped freshwater body, an intermediate transition zone of brackish water, and underlying salt water. In the Kaunakakai Stream area, the freshwater-lens system exists in the volcanic rocks and sedimentary deposits near the coast. Alluvium overlies the volcanic rocks near the mouth of Kaunakakai Stream, where groundwater levels probably range from near sea level to about 2 feet above mean sea level. Both groundwater levels and stream stage are expected to be affected by ocean tides and longer-term variations in sea level. On the basis of water quality information from nearby wells, the salinity of groundwater near the mouth of Kaunakakai Stream is likely brackish because of mixing with saltwater from the ocean. Hydrologic conditions at Kakahai‘a NWR are likely very similar to this location.

The only long-term streamflow gage on the Island of Moloka‘i is at Halawa Stream, located on the northeastern tip of the island at an elevation of 210 feet above sea level. The drainage area above the stream is 4.62 square miles and the period of record is 1918- present. It is useful to look at the annual flows for any long-term trends or changes, since this gage reflects the response to climate rather than anthropogenic activities (Figure 3.4). The streamflow data confirms the drying trend since 1990 that can be observed in the precipitation data from the airport. The 1970s were also quite dry, according to the streamflow data. Precipitation data from these years was missing at the airport. Oki (2004) reported a statistically significant decrease in annual median flow and annual baseflow for this site for the period of record.

Figure 3.4 Annual stream discharge at USGS streamflow gage Halawa Stream, 1918-2009. The line is a 5-year centered moving average.



Mass erosion caused by large goat populations in the uplands allow for flash flooding to occur on the Refuge during heavy rains. Poor drainage due to residential retaining walls and recurring blockages along the Kawela Stream and bridge has compounded the problem.

3.5 Topography/Bathymetry

We have no data on the current bathymetry of the ponds. The upper watershed has undergone changes in land use over the decade resulting in flood waters with a high volume of suspended sediments that enter the north side of the Refuge during winter months. Surface water drainage from the Kawela watershed is not a major factor in water levels in Old and New Ponds because the ponds are disconnected from surface flows; however, large amounts of water flow into other areas of the Refuge and have damaged the levees. We have identified the need for a comprehensive hydrological assessment to evaluate wetland needs in relation to upper watershed land-use changes. An evaluation of the groundwater source is essential as Old Pond receives its water from this source.

3.6 Environmental Contaminants

The Maui Department of Water Supply (DWS) conducts annual testing of groundwater wells in the Kawela watershed. The most recent report is a review of testing conducted and compiled in 2009 for reporting in July 2010. The DWS tested for more than 100 substances in the water, including bacteria, pesticides and herbicides, asbestos, lead, copper, and petroleum products. The only measurable contaminant found was nitrate (as N) with the highest detection level of 0.31 ppm, well below the EPA allowable limit of 10.0 ppm. The typical source of this trace contaminant is from erosion of natural deposits. In summary, no sources of environmental contamination have been detected or are suspected of adversely affecting the Refuge (DWS 2010).

3.7 Land Use

Immediately above and adjacent to Kakahaiʻa NWR is the residential development of Kawela Plantations, which spans 6000 acres of former Molokaʻi Ranch agricultural land with 210 1-acre residential/agricultural lots. Kamehameha V Highway bisects the wetland area from the makai (ocean-side) section of the Refuge. This shoreline area is operated as Kakahaiʻa Park through a cooperative agreement with Maui County. Located just 5.5 miles east of the main city of Kaunakakai, the park is used primarily for picnicking and shoreline fishing.

3.7.1 Previous Land Uses

Molokaʻi was first settled 450-650 CE. As agriculture developed, the landscape began to transform and has undergone alterations throughout its history of human settlement. Polynesian voyagers stocked their canoes with pigs, chickens, and dogs as well as crops needed for colonization. The native lowland forests were cleared and replaced with taro, sweet potato, yam, banana, sugarcane, breadfruit, and coconut. The land was modified with advanced farming practices that included irrigation from streams, terracing, mulching, and use of green manure. Slash and burn techniques were used to clear land for crops and to encourage the growth of pili grass used in house thatching (Roberts 2000, Ross 2011).

Significant sections of the coastline were modified between 1000-1400 CE with the creation of over 50 coastal fishponds ranging in size from a few acres to several hundreds of acres across and 1-30 feet deep. Native Hawaiians used lava boulders and coral to build the semi-circular walls of the ponds which would keep the fish inside while allowing the sea water to ebb in and out. The fish from these ponds were only eaten by the aliʻi (chiefs and royalty). Both down-slope and along-shore sediment transport patterns were altered. Many of these fishponds formed catchment basins for sediments coming off the expanded terraces and agricultural lands (Roberts 2000, Hawaiianweb 2006).

Prior to the fishpond construction, it is likely that the marsh was located closer to the springs along the present inland margin of the pond. The fishpond was created by removing vegetation, excavating the pond, and using the mud to form an earthen berm. A rock wall was constructed in areas where the earthen berm was not a sufficient barrier (Weisler 1983). A ditch was built between the pond and the sea in order to permit the flow of seawater and young fish. This flow was regulated by a gate, or

makaha (Summers 1964). Small fry were introduced to the pond including awa (milkfish), ʻamaʻama (mullet), aholehole, and ʻoʻopu (gobies). Similar to other Hawaiian fishponds, the perimeter may have been planted with taro, sweet potato, sugarcane, or ti (Weisler 1983).

The thin sandy strip of land separating the pond from the sea suggests that the area was formerly a bay open to the sea (Estioko-Griffin 1987). Numerous rounded basalt boulders located along the strip of land, which are facilitating beach erosion, resemble boulders found in the Kawela Gulch stream course. Weisler (1983) suggests that due to the historic and current location of Kawela Stream, these boulders were intentionally brought from the gulch to construct a seaward boundary for the pond. Thus, Kakahaiʻa may have initially been a loko kuapa, a fishpond composed of a continuous stone wall connecting two protruding points along the shoreline, which has subsequently been buried due to sand accretion (Weisler 1983).

The arrival of Europeans in the 1770s brought the the introduction of goats, horses, cattle, and sheep. Ellis (1827) was the first to provide a written description of the island and estimated the population not to exceed 3,000. In 1828, Reverends Green and Andrews, while on a tour of Molokaʻi, estimated that the population was 5,000 and that there were 1,000 houses, although only 700 houses were actually counted (Missionary Herald 1829).

The Kawela ahupuaʻa became part of King Kamehameha V's ranch in the 1850s and was used as grazing land for cattle. The Duke of Edinburgh had deer transported from Japan to Molokaʻi as a gift to Kamehameha V in 1870. The growing herds quickly increased and endemic plants quickly declined, leaving vast areas barren due to soil compaction that increased runoff and accelerated erosion (Roberts 2000).

The Hawaiian Sugar Planters' Association leased the Kawela lands in 1928, constructed a quarantine station for imported experimental varieties of sugarcane, and planted cane on the alluvial flats which was immediately flooded by heavy rains. To mitigate future flooding, the Planters' relocated the stream to its present location by dozing boulders and river rocks in a straight line to the ocean. In 1935, the sugarcane fields were tilled-under and planted in mango trees, which remain today.

Weisler and Kirch (1982) estimated that since 1880, the Kawela shoreline increased by 1 foot per year. Although some farmers remained on ancestral land east and west of Kawela Stream, upland residences gave way to Western-style habitation along the coast. In 1901, Kakahaiʻa Pond was used to produce rice and several residences were established along the pond edges to facilitate cultivation (Weisler 1983, Shallenberger 1977). During this time, the pond was much larger, with surface water areas estimated at 31 acres. A 1940, USGS aerial (page 3-12) shows much of the pond in rice production, which continued until 1950, at which time the Yuen family leased the pond from the McCorriston Trust and excavated the area to cultivate catfish and seabass. The surrounding area was used to raise pigs and produce kiawe charcoal until 1975. Five years later, the Kawela Plantation Development began construction on the upland ridges above the pond, further increasing siltation to the pond.

Kakahai‘a aerial view, 1940 USGS

Kakahai‘a aerial view, 1975 Air Survey Hawai‘i

Chapter 4. Refuge Biology and Habitat

4.1 Biological Integrity Analysis

Kakahaiʻa NWR is located within the Kawela watershed. The drainage basin has changed considerably due to agricultural activities. Cattle, deer, and goats have denuded much of Kawela and accelerated soil erosion along the lower elevations. Old Pond was once an inland freshwater fish pond and New Pond was created in 1983 to provide shallow water habitat for aeʻo. Adjacent lands include both agricultural and residential properties.

Little is known about the historic pristine coastal wetland vegetation due to its conversion by early Hawaiians into fishponds and irrigated farmlands. A small number of native plants still occur at the Refuge, but their distribution before introduction of nonnative species is difficult to reconstruct. Recent vegetation changes followed the creation of New Pond. Although wetland plant species initially thrived in the 1980s and 1990s, these plants died out as the pond lost water. Due to its dewatered condition since the early 2000s, the New Pond acreage is now dominated by dry upland pest species. The remaining vegetated wetlands of Old Pond are dominated by California bulrush with small stands of kaluha (alkali bulrush) and patches of ʻākulikuli (sea purslane). The latter two species and kīpūkai (seaside heliotrope) are the only common native plants on the Refuge.

4.2 Conservation Target Selection and Analysis

Endangered Hawaiian waterbirds, migratory birds, and their associated wetland habitat are the conservation targets of this plan (Table 4.1). They are consistent with the purpose of the Refuge, the Hawaiian waterbird recovery plan and the shorebird conservation plan. The objectives as described in Chapter 2 were developed based on desired outcomes, biological and abiotic factors as well as feasibility to meet those objectives (USFWS 2005, Engilis and Naughton 2004).

Table 4.1. Conservation targets for the CCP.

System targets	**Benefiting Resources**
Wetland habitat	All wetland habitat species
Grassland habitat	Native plants and birds that graze on grasses
Dry forest habitat	Native plants
Coastal strand habitat	Migratory shorebirds and native plants
Species Group Targets	**Benefiting Resources**
Endangered Hawaiian Waterbirds	All listed waterbird species
Migratory birds	All migratory waterfowl and shorebirds

4.3 Wetland Habitat

Palustrine wetlands (non-tidal and dominated by trees, shrubs, and emergent vegetation) cover 20.5 acres at Kakahaiʻa NWR as delineated by the National Wetlands Inventory program (Cowardin et al. 1979). A spring provides water for Old Pond, which is dominated by California bulrush with small stands of great bulrush. When the Refuge was acquired in 1976, Old Pond had 15 acres of open water. By 1991, open water was reduced to 4 acres and by 2010 it had diminished to less than an acre.

Water pumped from Old Pond was the primary water source for New Pond, created in 1983 to provide shallow water habitat. The wetland was heavily impacted by residential development and overgrazing higher in the watershed. Associated water withdrawals from the aquifer and soil erosion amplified sediment buildup in Old Pond which reduced our ability to pump water. Old Pond vegetation could not be controlled without heavy equipment. By 1997, New Pond was overgrown with vegetation. In 1999, an attempt was made to clear the dikes and margins, but vegetation quickly returned. In 2000, the intake area began to dry out after just a few hours of pumping. By 2002, the intake area dried out completely except after periods of heavy rainfall.

Kiawe has spread across dried-out New Pond USFWS

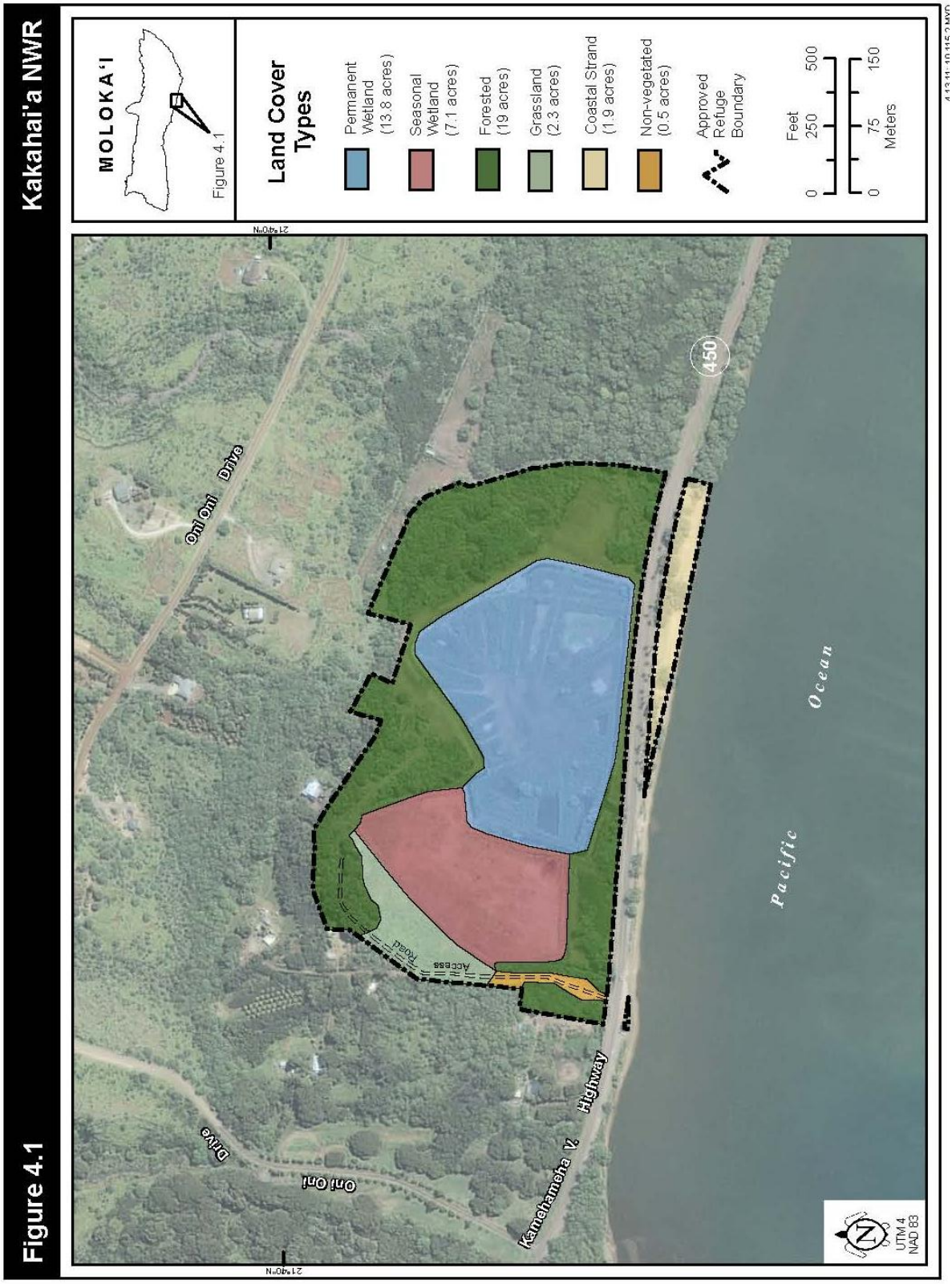
As a result, New Pond remains dry for most of the year. Nearly all of the vegetation is comprised of pest species (Indian marsh fleabane, kiawe, swollen finger grass, and Australian saltbush). Kīpūkai is the only native species currently present. In the past, the Refuge provided year-round habitat for the endangered ʻalae keʻokeʻo and aeʻo. A few migratory waterfowl and shorebirds also used the wetland. Currently, waterbirds occur only when heavy rainstorms replenish New Pond. ʻAmaʻama (mullet), *Oreochromis*, *Poecilia*, and mosquitofish are found in Old Pond.

4.4 Grassland Habitat

Over 90 percent of this ecoregion in Hawaiʻi has been lost due to human development and pest vegetation. The dominant grass in Hawaiʻi prior to nonnative grasses was probably pili. ʻAkiʻaki is another native grass that is salt-tolerant and can be grown adjacent to the coastline. Restoration of native grassland plants such as these within the fenced area of the Refuge will benefit native birds that graze on grass.

Grassland adjacent to entry road Mike Nishimoto/USFWS

Figure 4.1. Land Cover Types.



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4.5 Coastal Dry Forest

Kiawe dominates the forest USFWS

Dry forest covers 22.1 acres along the upland areas of the Refuge, mostly occurring to the north and east of the wetlands. Trees are 30-40 feet tall. The forest is species poor with most plants introduced since the 19th century. This habitat is dominated by nonnative kiawe and monkey pod with an understory of Indian marsh fleabane. The inland kiawe subtype occurs especially in dry areas on all of the main Hawaiian Islands usually below the 1,000 foot elevation.

Much of this habitat had been cleared in 1999, but 70 percent has since grown back. A portion of the area north of New Pond is relatively open and typically with scattered trees about 10-15 feet tall. Floods that result in pools of standing water may kill upland vegetation that reduces water velocity allowing sediments and vegetative debris to settle out.

A variety of nonnative birds inhabit the dry coastal forest. Gray francolins commonly occur at the forest edge while passerines such as the white-rumped shama, northern cardinal, red-crested cardinal, and house finch are found in amongst the kiawe trees. Terrestrial pest mammals commonly observed include house mouse, Norway rat, black rat, dog, mongoose, cat, and axis deer.

4.6 Coastal Beach Strand

Coastal beach strand covers 2.0 acres of the Refuge on the south side of Kamehameha V Highway. This habitat is dominated by nonnative grasses, coconut trees, and kiawe. Indian fleabane and milo also occur in this habitat. The entire shoreline has been affected by beach erosion with the west side more severely impacted. Few migratory birds inhabit the coastal strand. The beach does provide some foraging habitat for hunakai (sanderling), while the grassy area is used by kōlea (Pacific golden-plovers) and 'akekeke (ruddy turnstone).

Kakahai'a coastal beach strand USFWS

Pest mammals present in this habitat include house mice, Norway rats, black rats, dogs, small Indian mongooses, and cats. Shoreline erosion that converts uplands to submerged lands with the associated sedimentation of adjacent reefs is a recognized threat to the coastal beach strand.

4.7 Endangered Hawaiian Waterbirds

Kakahaiʻa NWR was established to provide protected habitat for two of Hawaiʻi's endangered waterbirds, the aeʻo and ʻalae keʻokeʻo. Statewide, the primary causes of their population decline include loss of wetland habitat, predation by introduced animals, altered hydrology, habitat alteration by pest plants, and disease. In addition, environmental contaminants may also potentially threaten populations in certain areas. No critical habitat has been designated for any of Hawaiʻi's endangered waterbirds.

Aeʻo pair © Brian Barker

4.7.1 Aeʻo (*Himantopus mexicanus knudseni*) or Hawaiian Stilt

The aeʻo is an endangered subspecies endemic to the Hawaiian Islands, which is part of a superspecies complex of stilts found in various parts of the world. The State population of this non-migratory shorebird fluctuates between 1,200-1,500 birds with a 5-year average of 1,350 birds. Refuge counts of up to 40 birds were observed in the early 1990s at New Pond. These counts were down to 20 in the late 1990s and now a few aeʻo are seen around the Refuge only after heavy rains (FWS 2005, Robinson et al. 1999).

Aeʻo favor open wetland habitats with minimal vegetative cover and water depths less than 9.4 inches, as well as tidal mudflats. Due to the deeper water, they did not use Old Pond. Aeʻo nest April-August with nesting sites consisting of simple scrapes on low relief islands within or adjacent to ponds. They tend to be opportunistic users of ephemeral wetlands to exploit seasonal abundance of food, feeding on small fish, crabs, polychaete worms, and insects. Ongoing threats to foraging and breeding birds on Refuge lands include predation by owls, mongooses, cats, rats, dogs, ʻaukuʻu (black-crowned night-heron), cattle egrets, common mynas, ʻakekeke, and laughing gulls (Robinson et al. 1999, Rauzon and Drigot 2002).

4.7.2 ʻAlae keʻokeʻo (*Fulica alai*) or Hawaiian Coot

The ʻalae keʻokeʻo is an endangered species endemic to all the main Hawaiian Islands except Kahoʻolawe. The State population has fluctuated between 2,000-4,000 birds. Nesting occurred around Old Pond in the late-1970s through the 1980s when there was open-water habitat. New Pond provided nesting and feeding habitat for a small number in the late 1990s with counts up to 50 birds. Only 2 ʻalae keʻokeʻo are currently occasionally present at the Refuge (Brisbin et al 2002, USFWS 2005).

ʻAlae keʻokeʻo Laura Beauregard/USFWS

ʻAlae keʻokeʻo are usually found on island coastal plains and prefer freshwater ponds or wetlands, brackish wetlands, and manmade impoundments. They prefer open water that is less than 12 inches deep for foraging and nesting habitat that has open water with emergent aquatic vegetation or heavy stands of grass. ʻAlae keʻokeʻo feed on seeds and leaves of aquatic and terrestrial plants, freshwater snails, crustaceans, tadpoles of marine toads, small fish, and aquatic and terrestrial insects (Schwartz and Schwartz 1949, Brisbin et al. 2002).

Nesting occurred November-April during the late 1990s, with opportunistic nesting occurring year-round depending on rainfall. ʻAlae keʻokeʻo will construct floating nests of aquatic vegetation, semi-floating nests attached to emergent vegetation, or in clumps of wetland vegetation. Cats, dogs, and mongooses are the main predators of ʻalae keʻokeʻo. Other predators include ʻaukuʻu, cattle egrets, and large fish. ʻAlae keʻokeʻo are also susceptible to avian botulism outbreaks (Brisbin et al. 2002).

4.8 Migratory Waterfowl

Koloa māpu © Tom Dove

Migratory waterfowl winter over in the Hawaiian Islands from September-May. They used the open waters of New Pond until it began to dry out in the late 1990s. Species recorded at the Refuge included koloa māpu (northern pintail), koloa mohā (Northern shoveler), green-winged teal, and koloa-mallard hybrids. Our observations through the 1990s noted migratory waterfowl were more prevalent during the winter months, with numbers exceeding 15 birds comprised of a few different species.

4.9 Migratory Shorebirds

Shorebirds use mudflats and dikes in the wetlands and along the coastal strand area of Refuge during the winter months. Although their numbers have declined significantly due to lack of water, they are still seen after heavy rains at New Pond. Occasional sightings include the kōlea, ʻakekeke, hunakai, and ʻūlili (wandering tattler). The only resident shorebird is the aeʻo.

ʻŪlili © Michael Walther

4.10 Pest Species

A pest species is defined as a species whose migration and growth within a new range is causing detrimental effects on the native biota in that range. These species become pests because their population and growth are no longer balanced by natural predators or biological processes that kept them in balance in their native ecosystems. In the absence of these restraints, they have the potential to compete with native species for limited resources, alter or destroy habitats, shift ecological relationships, and transmit diseases. Native species as well as nonnative species can become pests when their natural ecosystem is out of balance.

Pest species are one of the most serious problems in conserving and managing natural resources. In particular, the ecological integrity of Pacific Island environments is greatly threatened by pest species. Hawaiʻi, which existed in isolation for millions of years, is an exceptionally ideal environment for these species. Most native species lost their natural defense mechanisms and are more vulnerable to introduced species (Pattison et al. 1998, Ikuma et al. 2002, Middleton 2006).

4.10.1 Mammals

Rat (*Rattus* spp.)
Three pest rat species are found throughout the Hawaiian Islands. Polynesian rats arrived from the central Pacific 1,500 years ago with the Polynesians; Norway rats reached the Hawaiian Islands after the arrival of Captain Cook in the 1770s; and black rats most likely arrived in the 1870s.


Black rat © Jack Jeffrey

All three species in Hawaiʻi are known predators of eggs, nestlings, young, and occasionally adults of endangered waterbirds, seabirds, migratory shorebirds, and forest birds. Ground- and burrow-nesting seabirds are particularly vulnerable to rat predation, even by the arboreal black rat. Rats also consume plants, insects, mollusks, and other invertebrates. Because these species are also eaten by birds, a reduction in these populations may indirectly affect avian populations (Olson and James 1982, Harrison et al. 1984, Brisbin et al. 2002, Engilis et al. 2002, Mitchell et al. 2005).

The use of snap traps and ground-based application of diphacinone rodenticide to control rats in the main Hawaiian Islands has shown a positive effect in native bird survival. After wetland restoration, rat control will be conducted at the Refuge with various methods including the use of rodenticide placed in tamper-resistant bait stations, live traps, and snap traps.

Small Indian mongoose
(*Herpestes javanicus*)

Small Indian mongoose USFWS

The small Indian mongoose was introduced to the main Hawaiian Islands in 1883 as a bio-control agent against rats in sugarcane fields. The mongoose inhabits all habitat types from 0-10,000 feet on the islands of Hawaiʻi, Maui, Oʻahu, and Molokaʻi. In other areas of the world, mongooses appear to avoid wet areas; however, in Hawaiʻi, dense populations of mongooses are concentrated in wet habitats.

The home range of a female in Hawaiʻi is about 3.5 acres, and the main reproductive period occurs February-August. The high density of mongooses is due to abundant food and the lack of natural predators. They are voracious omnivores, consuming insects, reptiles, mammals, amphibians, crabs, plants, and birds. They are a major threat to any ground dwelling and nesting species in Hawaiʻi, known to eat eggs, young, and adults of endangered waterbirds, seabirds, and shorebirds. After wetland restoration, the mongoose population will be managed using traps and diphacinone rodenticide (Staples and Cowie 2001, Mitchell et al. 2005, Hays and Conant 2007).

Cat (*Felis catus*)

Neutered & released cat w/ waterbird © Michael Walther

Cats arrived in Hawaiʻi in the early 1800s on European ships and are now found on all the main Hawaiian Islands from 0-10,000 feet. Cats are natural hunters with their sharp teeth; the upper teeth overlap the lower, giving them a firm grasp to shake or tear prey to death. Food habits of cats in Hawaiʻi include insects, centipedes, crustaceans, lizards, mice, rats, bird eggs, and birds (Scott and Thomas 2000, Mitchell et al. 2005).

Dog (*Canis lupus familiaris*)

The dog is a domesticated form of the gray wolf, a member of the Canidae family of the order Carnivora. Abandoned, escaped, or pet dogs allowed to run loose can cause great harm to native species and ecosystems. Dogs have caused terrible damage to native ground-nesting birds. Dogs can attack a large number of birds in a single incident by grabbing and shaking the birds around with their mouths and leaving them for dead before heading to another nest or burrow.

Axis Deer (*Axis axis*)

Eight axis deer were brought to the Hawaiian Islands in December 1867 and released on Molokaʻi in January 1868. That number has risen to over 8,000 today. Axis deer originate from India and are also known as cheetal deer. They stand about 3 feet tall at the shoulder and weigh about 185 lb. with a lifespan of 20-30 years. Axis deer have a protracted breeding season in our tropical climate, and births can occur throughout the year. Males do not have their antler cycles in synchrony and there are some fertile females at all times of the year. The growing population of axis deer has created a number of concerns ranging from vehicle accidents and poaching to crop and ecosystem damage (Waring 1996, Maui Axis Deer Group 2002, Stephenson 2010).

4.10.2 Birds

There are a number of nonnative species that have been introduced through human activity. Molokaʻi's native birds coevolved in isolation and developed specialized life history requirements in order to minimize competition. Most of the nonnative birds have been introduced just within the last 100 years and use the same habitats, eat the same foods, and use similar foraging strategies as our native birds. Direct competition for limited food and habitat may be a serious issue. These species are resistant to avian pox and malaria and may serve as carriers for transmitting these devastating diseases. Nonnative bird species are fairly common to abundant, and also play a role in spreading the seeds of pest plants into native habitats.

Cattle egret Laura Beauregard/USFWS

Cattle egret (*Bubulcus ibis*)
The cattle egret was introduced to Hawaiʻi in 1959 from Florida for insect control on cattle and has become widespread. Rookeries were documented on Niʻihau, Kauaʻi, Oʻahu, Hawaiʻi Island, Molokaʻi, Lanaʻi, and Maui by the mid-1980s.

Its diet primarily consists of grasshoppers, crickets, spiders, flies, frogs, and nocturnal moths, but the bird will also consume prawns, mice, crayfish, and the young of native waterbirds. Cattle egrets have been documented taking chicks of all endangered waterbird species occurring on the Refuge. After wetland restoration and if predation on endangered waterbirds exceeds our target limit, population control measures as identified in the IPM would be implemented (Engilis et al. 2002, Hawaii Audubon Society 2005).

4.10.3 Amphibians

Cane toad *(Bufo marinus)*
Cane toads or Pacific giant toads are native to Latin America and were brought to the Hawaiian Islands in 1932 to control insect pests. The adults only require water for breeding, an event which results in thousands of eggs per mating occurrence. Cane toads are active at night and primarily feed on cockroaches, crickets, grasshoppers, grubs, earthworms, slugs, spiders, centipedes, and snails. In addition, these highly invasive amphibians are potential predators of endangered waterbird eggs and young (Yamamoto & Tagawa 2000, Staples & Cowie 2001).

Cane toad Laura Beauregard/USFWS

4.10.4 Invertebrates

Ants
Hawaiʻi is one of the few places on Earth believed to harbor no native ant species. Today, at least 47 ant species in 7 subfamilies and 24 genera have become established. Ants are a growing concern since they can have negative effects on native and endangered plants and animals. Ants are known to attack, injure, or kill young birds. Ants are also implicated in having negative effects on native and endangered plants. Control of ants has potential on the Refuge to protect trust resources. The Service is currently studying the efficacy of various baits and approved toxins on pest ants on Oʻahu and Johnston Atoll. After wetland restoration, it is anticipated that the Refuge will adopt IPM methods to control ants based on the results of these studies.

4.10.5 Plants

At the ecosystem level, pest plants have been shown to be capable of changing fire regimes, altering nutrient cycling patterns, and modifying the surface runoff of water. Nonnative plants can physically displace native species, and/or supersede them in competition for water, nutrients, or other limited resources. They can also be vectors and hosts for introduced pests and diseases to which the native species lack natural defenses (Jui Min et al. 2007).

Almost half the flora of the Hawaiian Islands is comprised of naturalized nonnative plants, approximately 1,100 species. According to Staples et al. (2000), pest plants in Hawaiʻi share the following biological and reproductive characteristics:

- Adaptable to and capable of thriving in different habitats;
- Tolerant of variable conditions (such as light, temperature, moisture);
- Fast growing;
- Tolerant of disturbance;
- Easily dispersible to new localities by seeds, fruits, spores, or vegetative parts;
- Produce small seeds/spores early in life;
- Long reproductive periods; and
- Dispersed by animals and with no special germination requirements.

The control and eradication of pest plants has been the top priority of natural resource managers in Hawaiʻi. Pest species out-compete more desirable plant species here, as well as invade open water and mudflat habitats. In addition, the high biomass characteristic of pest grasses produces a high amount of fuel for fire. Pest plants on the Refuge include California grass, California bulrush, Indian marsh fleabane, kiawe, and long thorn kiawe.

California grass (*Brachiaria mutica*)

California grass Mike Silbernagle/USFWS

California grass is a sprawling perennial with culms up to 19 feet long. Stolons and leaf sheaths are densely hairy. It is suspected to have originated in Africa and occurs pantropically as a pasture grass, well adapted to a wide range of soil conditions (sandy to clay). It tolerates moderate shade but prefers full sun (Cook et al. 2005).

It grows prolifically in wetland habitats, but it can also withstand severe drought. In addition to displacing native plants, California grass alters and destroys wetlands, causing a reduction in bird habitat. The Hawaiʻi-Pacific Weed Risk Assessment, conducted by the University of Hawaiʻi and the U.S. Forest Service, identifies California grass as "documented to cause significant ecological or economic harm in Hawaiʻi" (Stone et al. 1999, Motooka et al. 2003).

Indian marsh fleabane (*Pluchea indica*)

Indian marsh fleabane Mike Silbernagle/USFWS

Indian fleabane is an erect shrub that grows up to 6.6 feet tall. It is native to temperate and tropical Asia, northern Australia, and is naturalized elsewhere. In Hawaiʻi, it occurs in lowland, coastal habitats such as wetlands and fishponds (GRIN Online Database).

Indian fleabane out-competes native sedges on the Refuge, reducing forage and nesting habitats for native birds. The understory and open areas of the coastal dry forest habitat are dominated by this pest species. It tends to harbor huge nests of paper wasps, which are a hazard to Refuge staff. The Refuge uses mechanical, chemical, and prescribed burning IPM techniques to control this pest species.

California bulrush (*Schoenoplectus californicus*)

California bulrush Mike Silbernagle/USFWS

California bulrush is a perennial sedge native to marshes of the tropical and subtropical Americas. It was first found on Molokaʻi in 1912. It has tall, thin, dark green stems which are usually triangular in cross-section and woolly, bristly tan or brown flowers in panicle inflorescences. It has characteristics common in the sedge family, such as creeping. It is intolerant of shade, but can spread rapidly by vegetative means (Wagner et al. 1999, Erickson and Puttock 2006).

Kiawe thorns & seed pods
© F & K Starr

Kiawe *(Prosopis pallida)*
Kiawe is native to Peru, Colombia, and Ecuador. More than 150,000 acres of kiawe forests in Hawaiʻi are descended from a single tree planted in 1828 by Father Bachelot, the first Catholic priest in the Hawaiian Islands. By 1840, progeny of the tree were already spreading to dry, leeward plains on all of the islands (Nelson and Wheeler 1963).

Most kiawe have thorns with strong, 1 inch-long spines. It usually flowers January-March, but in years with wet summers it also flowers September-October. Kiawe overshadows native plants and deep taproots use all available water. Dense kiawe thickets have replaced native plants in the coastal dry forest at the Refuge.

Long thorn kiawe (*Prosopis juliflora*)
Related to the common kiawe, long thorn kiawe differs in that it is sprawling in nature (rather than an upright tree), has a larger leaf structure and, most notably, thorns up to several inches long which are sharp enough to pierce vehicle tires. Long thorn kiawe has been known to hybridize with common kiawe. It has many seeds and grows rapidly, impeding access in New Pond with its sprawling branches and long sharp thorns. The Molokaʻi/Maui Invasive Species Committee has identified long thorn kiawe as a target pest species for removal. Our control options include hand pulling new shoots as soon as they have emerged and are large enough to grip. Cutting the plant at the base and treating with herbicide will effectively stop it from re-sprouting. Constant monitoring is needed to watch for new growth (MoMISC 2010).

Long thorn kiawe © F & K Starr

4.11 Wildlife and Habitat Research and Monitoring Efforts

A research project on wetland ecology has been conducted at Kakahaiʻa NWR for the past several years. It included a study on nitrogen source tracking through wetland plants. It showed low values from wetlands on Molokaʻi and higher values at wetlands on Oʻahu and Maui. The higher values were attributed to more developed and densely populated watersheds (Bruland and MacKenzie 2010).

Chapter 5. Refuge Facilities and Public Use Programs

5.1 Refuge Infrastructure and Operational Facilities

There are few facilities at Kakahaiʻa NWR due to the limited space available and the need to only secure equipment and supplies at this unstaffed Refuge. The Refuge is provided with electrical service from Maui Electric Company, Inc. Water and septic services are not available.

5.1.1 Refuge Operations

The administrative functions and staff for Kakahaiʻa NWR are located at the Maui NWR Complex office located at Kealia Pond NWR on the island of Maui. All staff have dual responsibilities for the oversight of both Refuges. Trips to Kakahaiʻa NWR are regularly scheduled for every other week and is typically made by the maintenance worker to inspect the Refuge condition and perform maintenance and habitat improvement tasks. Periodically, volunteers or other Refuge staff is sent to assist with projects. The maintenance worker makes 26 trips per year on average; however, overnight trips are made to complete priority and time-sensitive projects (fence repairs, road work).

5.1.2 Maintenance Facilities

The primary maintenance facilities include a metal container and shed to secure equipment and supplies. This minimal storage is sufficient given the amount of non-wetland area available and the unstaffed Refuge status.

Kakahaiʻa storage units USFWS

5.1.3 Dempster Windmill

The metal Dempster windmill located between Old and New Ponds was erected when Molokaʻi Ranch was using the wetland for rice production from the late 1800s-1950. When the Refuge was acquired by the Service, the windmill was being used for fish production by the Yuen family. After acquisition, the windmill pump was used to deliver water from Old Pond to New Pond and was still in operation in 1988. At that time, Refuge staff reported considerable savings in electric pumping cost; however, the seasons when winds along the Molokaʻi shoreline were fairly constant (10-15 mph spring-summer) were not when water was needed most (fall).

Today, the windmill frame is still in place but the blades have long been removed because of disrepair. This structure has become a local landmark and a signature feature of the Refuge. Molokaʻi residents have requested the Service retain and repair the windmill even if it no longer operates as source of electricity.

5.1.4 Roads

The Refuge has one access road located off Kamehameha V Highway approximately 5.4 miles from the main town of Kaunakakai. The entrance road also serves as a right-of-way for five (5) residents north of the boundary. Through the years, the original dirt road had become eroded and susceptible to flooding from upper watershed draining and Kawela Stream overflow. From 2000-2009, flooding of the road increased dramatically and prompted efforts to secure funding, reconfigure and repair the road, and evaluate the flooding issue. In June 2010, the road was elevated and paved to allow safe, reliable access for staff and the adjacent neighbors. A slight modification to the road alignment allows for minimal parking for future wildlife observation from outside the fence.

5.1.5. Constructed Ponds and Levees

Old Pond covers about 15 acres. The levees around the perimeter are currently eroded and impacted by invasive woody and annual plants making it impenetrable for access by foot. When this levee is reconstructed it will provide access for staff, visitors, and Refuge vehicles. In 1984, radial levees were constructed inside the pond; these levees will be removed to allow natural flooding and eliminate the high elevation inside the pond where invasive plant growth is an existing problem.

The 5.5-acre New Pond was constructed in 1984 for shallow water habitat; however, the lack of water has greatly decreased its value to endangered waterbirds. The inner pond and perimeter levees are currently covered with pest plants, a majority of which is woody vegetation that impairs the integrity of the pond. The levees around this pond were accessible in the past and will continue to be used for EE and interpretation when restored. This pond is visible from the Refuge entrance road and would be a key area for wildlife observation and photography in the future.

5.1.6 Wells, Pumps, Water Distribution Lines, and Water Control Structures

In 1984 (when New Pond was constructed), a water control structure was installed to connect both ponds and a pump located at the windmill was used to pump water from Old Pond into New Pond. This pump was in use until 2003; however, it is no longer functional because there is not enough water on the west side of Old Pond to pump into New Pond. At one time, the wind-driven pump was operational at all times of the year. Once the wetlands are restored, the Refuge would replace the pump to take advantage of the natural flooding from groundwater springs in Old Pond. Previous owners of the property had drilled modest wells, one of which has a coral lining above ground that is still visible. The Refuge will evaluate the feasibility of using these borings to install a casing and outfit it with a pump before drilling a new well. A new water supply is needed for New Pond to create and maintain shallow water habitat for endangered aeʻo and to help control pest plants.

Old Pond has an old water control structure with a connection to the makai side via a culvert under Kamehameha V Highway. This structure is degraded and is intended to be removed and closed because the culvert is lower than the shoreline and covered with sand, preventing natural flow of water to the ocean. Both Old and New Ponds should have separate water control structures located at the lower elevation of each pond and connected to a ditch running along the south side of New Pond. This ditch intersects with the drainage ditch and culvert under the highway and exiting to the ocean.

Currently, there are no water distribution lines dedicated to habitat management. The Refuge has initiated preliminary investigation into the re-establishment of an existing well or construction of a new well to provide an alternative water source for New Pond. The pump outfitted on this well would have water distribution lines, primarily to feed into New Pond but a valve to Old Pond would also be constructed to provide alternative flooding capabilities.

5.1.7. Kamehameha V Highway Culvert

A concrete culvert under Kamehameha V Highway is located on the east side of the entrance road and provided drainage to the ocean. At the time of construction, the culvert may have been appropriate for drainage and situated at an elevation that allowed unimpeded flow to the ocean; however, that is no longer the case. The existing elevation of the culvert is below the mean tide resulting in sand buildup in front of the opening and prevention of appropriate drainage. This condition is similar to other culverts along the southeastern shore of Molokaʻi causing occasional flooding of the highway and private property. During and after winter rains, HDOT uses heavy equipment to remove sand from culvert openings and plows sediment runoff from the highway. Unfortunately, once most water is drained, the culvert openings become plugged with sand with the next high tides.

The flooding along the highway and entrance road at Kakahaiʻa NWR has been an issue not only because of the culvert but also due to drainage problems at Kawela Bridge, approximately 0.3 miles west of the entrance road. Debris and sediment blocking water flow under the bridge results in overflow along the highway that eventually reaches the Refuge entrance road, adding water to an already flooded area. Although, the culverts are the responsibility of the State, the flooding is a Refuge issue that not only impacts staff access onto the Refuge but also impacts the five property owners who have a right of access along the Refuge road to their property.

In 2004, the Service collaborated with the Federal Highway Administration to address flooding at the culvert with the intention of developing a design to resolve the sand blockage problem. The options were limited due to feasibility, collaboration with other agencies, and the potential impacts to areas further down the shoreline. The flooding issue is prevalent along the entire southeastern shoreline of Molokaʻi and is an issue that the Refuge will continue to investigate to develop solutions that are agreeable with all agencies and adjacent landowners.

5.1.8 Fences and Gates

There are two fences at Kakahaiʻa NWR. One fence encompasses both Old and New Ponds, coastal forest habitat, open grassland areas, and the maintenance area. Although in fairly good condition along the highway, along the eastern boundary it is susceptible to sediment buildup from runoff and erosion. It is also heavily impacted by axis deer and it requires periodic repairs. The portion of this fence that is parallel with the entrance road was replaced in 2010-11 when the Refuge entrance road

Damaged fence along the northern boundary USFWS

was paved. The north side of the fence, along its entire length, is in need of replacement.

A second fence used to be on the west and north sides of the Refuge road and provided a physical boundary with the neighboring private lands. Through the years, portions of this fence were removed due to disrepair and lack of funds to replace. Only small sections are remaining. The Refuge intends to replace this fence in its entirety throughout the length of the entrance road.

5.2 Public Use

5.2.1 Special Use Permits

The wetland areas of the Refuge are closed to the general public. Specific proposed public activities on the Refuge are evaluated to ensure they are compatible with the Refuge's purposes and permitted on a case-by-case basis. Special Use Permits for EE and interpretation are provided to qualified organizations.

5.2.2 Kakahai‘a Park

Kakahai‘a Park, a day-use picnic area, was developed in 1978 makai of the highway bisecting the Refuge and continues to be maintained by the County of Maui. Concrete tables and metal barbeque grills are used on a limited basis by local residents and tourists. As the Refuge is currently unstaffed, we only have anecdotal information on the uses going on in the park. Park use will be evaluated as part of a step-down VSP (to include a new CD if needed).

County park sign USFWS

Picnic area and shoreline USFWS

5.2.3 Wildlife Observation and Photography

From 1976-2003, when the wetlands were habitable for endangered and migratory waterbirds, wildlife observation and photography opportunities were also available. Prior to the encroachment of California bulrush in Old Pond, the number and diversity of endangered and migratory waterbirds made for quality viewing experiences and is still remembered by the older generation of Moloka‘i residents. The Complex office receives an average of 30 e-mails and telephone inquiries each year for access to view wildlife and for classroom visits. The quality of wildlife observation has declined

significantly with the loss of water and open habitat leading to absence of waterbirds, except for the 2-4 days after a rainstorm.

When wetlands are restored and the endangered and migratory birds are once again using the Refuge for foraging, nesting, and resting, there will be an increased opportunities for wildlife observation and photography. A component of the VSP will include plans for an elevated area and kiosk along the entrance road that would provide viewing when the Refuge is closed and when staff is not present.

5.2.4 Environmental Education

In past years, the Refuge hosted EE groups, primarily from the local community and schools, as a supplement to the teacher/leader's in-class curriculum. The hands-on experiences were valuable for students with such limited access to wetland areas. Nēnē O Molokaʻi is a non-profit corporation created to establish and preserve wild nēnē on the island of Molokaʻi, while emphasizing education through community involvement. They currently have a SUP to access the Refuge and host school and other EE groups. The organization provides educational and volunteer opportunities to groups that include a well-rounded overview of the different types of wetland habitats on Molokaʻi with emphasis on the endangered waterbirds.

Refuge-specific EE programs will be developed for local school groups of varying age levels as part of the VSP. Volunteers would be recruited and trained to assist with the program. All EE programs will have a stewardship component where students would participate in a wetland restoration project.

5.2.5 Volunteers

After the Refuge was established in 1976, residents on Molokaʻi formed the group Kokua Kakahaiʻa to provide support for the Refuge and help define and develop goals for wetland restoration, bringing back the diversity of waterbirds at the Refuge, and develop a conceptual design that would include restoration by staff and community involvement. From 1998-2009, annual Kokua Kakahaiʻa luncheons at the Molokaʻi Historical Museum were coordinated and funded by group leader Kenneth Fiske. These meetings were an opportunity for the Refuge Project Leader and group to gather and discuss Refuge issues and updates.

Chapter 6. Cultural Resources, Social, and Economic Environment

6.1 Refuge Cultural Resources

The Service defines cultural resources as archaeological sites, historic places, objects of antiquity, cultural items, or traditional/religious values. This section provides a summary of the cultural and historic resources at Kakahaiʻa NWR and the surrounding Kawela ahupuaʻa. A discussion of the Native Hawaiian and Euro-American cultural history of the area is provided within the context of the broader history of Molokaʻi and the State of Hawaiʻi.

6.1.1 Native Hawaiian Cultural History

The early settlement history of the island is a subject of some debate. Some believe that the first Polynesians arrived in Hawaiʻi around 100-300 BCE from the Marquesas and were followed by Tahitian settlers around 1100-1300 CE who conquered the original inhabitants. Others believe that there was only a single, extended period of settlement. Polynesians developed a new Hawaiian culture while maintaining much of the social and political structure of their homeland.

Molokaʻi was first settled around 450-650 CE and was divided into two main districts – Koʻolau, which comprised the northeastern side, and Kona, which made up the remainder of the island. These districts were further divided into ahupuaʻa, a wedge-shaped Hawaiian land unit that traditionally subdivided resources from the uplands to the shore. Summers (1971) states that the "surviving traditional history of Molokaʻi is fragmentary" since the island's smaller size rendered it "not of major political importance." In ancient times, Molokaʻi was also referred to as Pule-oʻo (effective prayer). This name was acquired because the small population could not compete with larger islands during war periods and therefore the aliʻi of Molokaʻi largely relied on prayer for safety (Handy and Handy 1972).

The Kawela ahupuaʻa, which means "the heat," is an arid region on the southeastern portion of the island. Prehistoric use of Kawela is dated to approximately 1500 CE. During the 16th and 17th centuries, people used the coastal area for fishing and aquaculture (Weisler 1983). The broad fringing reef offshore contained abundant shellfish, seaweed, and fish. A low sand dune midden located west of Kakahaiʻa Pond contains cultural remains of these groups including small scoop hearths with associated fishbone, marine and brackish-water mollusks, and crustaceans (Weisler 1983). In addition, Weisler and Kirch (1982) observed bone in the stratified layer from several bird species, including nēnē (Hawaiian goose), koloa mapū, pueo (Hawaiian short-eared owl), and ʻalae keʻokeʻo. The presence of these particular species implies that marshlands were present in the area at that time.

Permanent, large-scale occupation of the Kawela area began in the 18th century. Residences were mostly concentrated along the ridgelines below the 115-foot contour. This elevation offered safety from flooding, exposure to the tradewinds, and allowed for high agricultural productivity along the Kawela Gulch and on the adjacent coastal flats (Weisler and Kirch 1982). Individual kauhale (housing complexes) within the community contained from 6-35 architectural features constructed of

stacked, dry-laid unmodified stone. A residential complex consisted of several structures ranging from pole-and-thatch houses to cooking shelters and craft areas. Despite limited water supply, Hawaiians used the well-drained soil of the Kawela Stream delta to cultivate sweet potatoes. Weisler and Kirch (1985) suggest that the two water ditches in the Kawela floodplain did not have continuous discharge and therefore the irrigation system probably only intermittently supported sweet potato plantings, but not wetland taro. Slash-and-burn agriculture for sweet potato cultivation was also conducted on land above the residences (Weisler 1983).

Early Hawaiians constructed one inland fishpond (Kakahaiʻa) as well as four coastal fishponds (Kanoa, Kaoaini, and two unnamed ponds) in the Kawela region (Weisler and Kirch 1985). Fishponds, which were considered sacred due to their spiritual power, were an important element of Hawaiian social and cultural life (Farber 1997). The Kakahaiʻa fishpond is located in the southeastern corner of the Kawela ahupuaʻa. This small inland fishpond, or loko puʼuone, is a brackish pond connected to the sea by a ditch and fed by several flowing inland streams (Weisler 1983, Estioko-Griffin 1987). Radiocarbon dating suggests that the pond area was initially used by Hawaiians as early as 1500 CE; however, stata analysis shows that the area was probably not utilized as a fishpond until the early 1700s when more permanent settlement occurred in the adjacent uplands (Weisler 1983).

In 1736, the final battle of a failed takeover by Kapiʻioho o Kalani, son of Kualiʻi, the chief of Oʻahu, and Alapainui from Hawaiʻi Island, was fought on the plains of Kawela. Fornander (1880) wrote:

> ʻThis famous battlefield may still be seen in the place described, where the bones of the slain are the sports of the winds that sweep over the sandy plain, and cover or uncover them, as the case may be. The numerical strength of the two opposing armies is not mentioned in the legends; but to judge from the multitude of bones and the number of skulls that are bleaching in the sun when a strong north wind has removed their sand covering, the numbers engaged on each side must have been reckoned by thousands.ʼ

Weisler (1983) theorizes that use of the fishpond ceased in the early 1800s. This idea is supported by the presence of nonmarine mollusks in the upper stratigraphic layer. Although the species were not positively identified, two species (*Thiara granifera* and *T. tuberculata*) "not proven to be native in Hawaiʻi" are present at Kakahaiʻa and also found in other southern fishponds along the coast of Molokaʻi (Weisler 1983). By 1851, the traditional system of fishponds throughout the Hawaiian Islands was largely abandoned (Farber 1997).

6.1.2 Euro-American Cultural History

British explorer Captain James Cook is credited with being the first European to visit Hawaiʻi in 1778 on the *H.M.S. Resolution*. There is some evidence that Spaniards, who first crossed the Pacific Ocean in 1522, also made landfall in Hawaiʻi but they never correctly mapped or claimed credit for their accomplishment. The first interaction between residents of Molokaʻi and Europeans occurred in 1786 when Captain George Dixon anchored off the coast.The island was rarely visited by foreigners until the establishment of a Protestant mission in 1832 (Spalding 1983).

Contact with Europeans irrevocably changed the lives of Native Hawaiians. These contacts began a series of serious plagues for which they had no immunities. In time, the Native Hawaiian population would plummet from 300-500,000 in 1778 to only 30,000 by 1900. Molokaʻi experienced a smaller population decline after western contact compared to other Hawaiian islands which can be attributed to the minimal interaction with westerners and subsequent smaller percentage of disease transferral. Summers (1964) argued that the population decrease may have been attributed to natives leaving to larger islands in the archipelago.

As trade and shipping brought Hawaiʻi into contact with a wider world, it also enabled the acquisition of Western goods, including arms and ammunition. In 1795, Kamehameha I from the Island of Hawaiʻi assembled the largest army the Hawaiian Islands had ever seen, with over 10,000 men and 1,200 war canoes, equipping them with European muskets and cannon. He established the Kingdom of Hawaiʻi with the subjugation of the smaller independent chiefdoms of Oʻahu, Maui, Molokaʻi, Lānaʻi, Kauaʻi, and Niʻihau into one unified government over the period 1795-1810. On Molokaʻi, Kamehameha I landed his invading force near Kawela. It is estimated that his canoes stretched for over four miles. Local legends tell of ghost warriors (known as night marchers) still walking the ancient paths with their torches, talking and making noises on their way to battle (Crowe 2002). The defeated warriors took refuge at the puʻuhonua (place of refuge) in Kawela. A burial mound of the warriors killed in this battle is located in the eastern portion of the Kawela ahupuaʻa (Summer 1971).

Kamehameha made Lahaina, Maui, the new capital of the Kingdom of Hawaiʻi. For nearly 5 decades, Lahaina served as the center of government. Although salt was an early island export, ʻiliahi (sandalwood) was the first major item of external trade. By 1805, ʻiliahi had begun to reach China, and by 1809 it was a regular trade commodity. In 1810 American merchants reached an agreement with Kamehameha for a monopoly on the ʻiliahi trade in exchange for a quarter of the profits. These merchants took a convoy of ʻiliahi ships to China in 1812, making a good profit on their sales. This agreement stood for only one shipment, though, and shortly thereafter the War of 1812 resulted in a British blockade of Hawaiʻi for 2 years (Daws 1989).

When trade resumed in 1814, King Kamehameha claimed the trees as his own in a near-monopoly and organized the cutting and transport of ʻiliahi under his public works program. A 75-foot long boat-shaped “lua na moku ʻiliahi” (sandalwood measuring pit) still remains in central Molokaʻi. A boat of foreign goods was bought by exchanging the amount of ʻiliahi that would fill the pit. The ʻiliahi trade had serious consequences on Hawaiian culture. The income encouraged the transition to a cash economy, the purchase of luxury goods, and became the main source of revenue for the aliʻi. (Gast and Conrad 1973).

Kamehameha I's death in 1819 triggered a dramatic change in the social, political, and religious systems of the country. Members of the aliʻi had acquired many of the outward manners and dress of European civilization during the final years of Kamehameha's reign. His successor Liholiho (Kamehameha II) ended the kapu system and ordered the destruction of images and heiau throughout the Kingdom (Gast and Conrad 1973, Judd 1966).

Kamehameha II fell into debt with ʻiliahi traders and by 1826, a general tax on the Hawaiian people was imposed to pay off some of the collective debt of the king and aliʻi. As logging continued, stands of ʻiliahi were harder to find. Fires were set in forested areas to detect the ʻiliahi trees by their sweet

scent. While mature trees could withstand the fire, the flames wiped out new seedlings. By 1830, the ʻiliahi trade had completely collapsed (Judd 1966).

6.1.3 The Mahele, 1848-1851

Among other things, foreigners speculating in Hawaiian commodities demanded private ownership of land to insure their investments. Influenced by these foreign investors, King Kamehameha III instigated the Great Mahele of 1848 and drastically altered the Hawaiian land system by redistributing land ownership between the kings, aliʻi, foreigners, and makaʻainana (common people who were fishermen, craftsmen, and farmers). Once lands were made available and private ownership was instituted, the makaʻainana were able to claim the plots on which they had been cultivating and living, if they had been made aware of the foreign procedures for Land Commission Awards (LCA). These claims could not include any previously cultivated or presently fallow land, stream fisheries or many other resources necessary for traditional survival (Kelly 1983, Kameʻeleihiwa 1992, Kirch and Sahlins 1992).

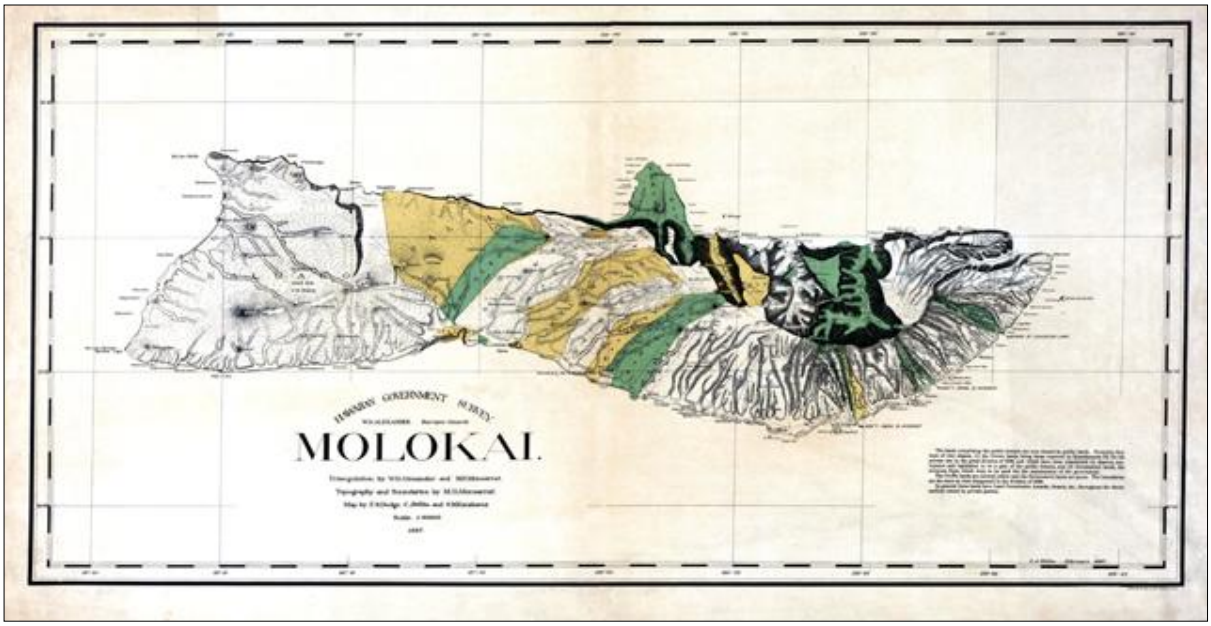
This division transformed a vast majority of Molokaʻi into pastureland grazed by sheep and cattle (Spalding 1983). Furthermore, the division affected the social and cultural environment since individuals were allowed to own private property for the first time (Weisler and Kirch 1985, Farber 1997). Land claims to the Board of Commissioners in the Kawela ahupuaʻa offer written records and insight into the historic land use during the mid-1800s. Claims were concentrated on the immediate area of the floodplain and delta (Weisler and Kirch 1985). In 1859, the two districts were abolished and the entire island was classified as the Molokaʻi district (Greene 1985).

6.1.4 Post-1850s History

Molokaʻi achieved notoriety in 1865 when King Kamehameha V approved *An Act to Prevent the Spread of Leprosy*, instituting a century-long policy of forced segregation of persons afflicted with Hansen's disease to a remote, fairly inaccessible finger of land on the north side of the Island. To the south, the Kalaupapa Peninsula was cut off from the rest of Molokaʻi by a sheer cliff about 2,000 feet high. Once the law passed, the government proceeded to purchase lands in the isolated Kalaupapa area and move the residents to other homes. The village of Kalawao became home to thousands of Hansen's disease victims forcibly moved there from throughout the Kingdom. Father Damien deVeuster, a Catholic missionary priest from Belgium, arrived at Kalaupapa in 1873 and served the patients until his death in 1889 (he was canonized as a saint in 2009). The forced segregation policy continued until 1969 (NPS 2010).

In the 1880s, George Trimble owned a parcel adjacent to Kakahaiʻa Pond, and leased 50 acres nearby in the alluvial plain for the cultivation of sugarcane (Cooke 1949) for the Kamalo Sugar Mill (Judd 1936:10). Trimble would load his sugarcane onto a small flatbed barge and tow the cargo by draft animals along the shallow shoreline to the mill 5 miles east at Kamalo (Cooke 1949). In 1897, the remaining Molokaʻi holdings of the Bernice P. Bishop Estate were purchased by the newly formed Molokaʻi Ranch and immediately its headquarters were built on the Kawela flats. A year later, the ranch formed the American Sugar Company, and leased all of its lands to the new corporation with the intent to establish a sugar plantation. The venture failed within a year, and efforts shifted towards the raising of cattle and sheep.

The Kingdom of Hawaiʻi lasted throughout most of the 19th century, when the expansion of the sugar industry meant increasing U.S. business and political involvement. Through the *Reciprocity Treaty between the United States of America and the Hawaiian Kingdom of 1875*, the United States obtained exclusive rights to Pearl Harbor in exchange for allowing Hawaiian sugar to enter the United States duty-free. In 1893, Queen Liliʻuokalani was deposed in a coup d'état led by American citizens supported by U.S. Marines. The sovereignty of the Kingdom of Hawaiʻi was lost to a Provisional Government led by the conspirators, later briefly becoming the Republic of Hawaii [sic], before eventual annexation in 1898 as a U.S. territory (Greene 1985).



Molokaʻi 1897, surveyed by W.D. Alexander and M.D. Monsarrat

The introduction of horses and cattle at the end of the 19th century spurred new ranching operations. Cattle hides, tallow, and meat became important commodities of local and international trade. In 1897, a group of businessmen purchased 70,000 acres on the western half of Molokaʻi and leased another 30,000 acres from the government to raise cattle, horses, mules, and sheep. They leased some of their property to Libby and Del Monte for pineapple cultivation between 1923 and 1985 (Cowan-Smith and Stone 1988).

Beginning in the mid to late 1800s, changing land uses in the region resulted in significant landscape alterations. Vegetation removal by cattle, sheep, goats, and deer caused extensive erosion from upland areas, shoreline accretion, extension of the alluvial plain, and infilling the pond. Weisler and Kirch (1982) estimated that since 1880, the Kawela shoreline increased by 1 foot per year. Although some farmers remained on traditional land east and west of Kawela Stream, upland residences gave way to Western-style habitation along the coast. In 1901, Kakahaiʻa pond was utilized to produce rice and several residences were established along the pond edges to facilitate cultivation (Shallenberger 1977). During this time, the pond was much larger, with surface water areas estimated at 31 acres. Rice production in Kawela ceased in the late 1940s, although the pond is still referred to as "rice patch" by local island residents (Weisler 1983).

The Molokaʻi District was incorporated into the County of Maui in 1909 (with the exception of the Kalaupapa Penisula which became the Kalawao District). Inter-island steamers began carrying freight, produce and passengers to and from Molokaʻi in the early 1900s. Ship travel became less popular with the opening of Hoʻolehua airport in 1928; and in 1929, the Inter-Island Airways inaugurated their first regular air service to other islands (Maui County Planning Department (MCPD) 2001). In 1959, Hawaiʻi became the 50th state of the United States.

The Kawela area was used to raise pigs and produce kiawe charcoal until 1975. In 1980, the Kawela Plantation Development Associates began construction of a 6,000-acre farming community on the upland ridges of the watershed, further increasing siltation to the pond (Shallenberger 1977, Greene 1985).

6.1.5 Archaeological/ Cultural Surveys

Few archaeological and cultural investigations had been conducted on the southeastern portion of Molokaʻi and throughout the entire island prior to the 1980s (Weisler and Kirch 1982). An early study by Stokes (1909) surveyed the heiau and koʻa of Molokaʻi. Phelps (1937) conducted a study of regional settlement patterns on the island during the early 1800s. This study noted the remains of Kawela Puʻuhonua, which was used by defeated warriors from the nearby battlegrounds. Summers (1971) recorded many cultural sites throughout Molokaʻi, including nine sites in the Kawela ahupuaʻa. Among those listed were the Kawela battlefield, a heiau, petroglyphs, a family residence and shrine, a burial mound, a puʻuhonua and/or puʻukaua (a fortification), three coastal fishponds, and Kakahaiʻa fishpond.

Residence site near Kakahaiʻa Pond © Arleone Dibben-Young

Six archaeological studies have been conducted in the Kawela area. Environmental Impact Study Corp. (1979) conducted both surface and subsurface testing near the Kanoa fishpond for the development of the Kanoa Beach lots. No cultural material was encountered during this study, besides the known fishpond.

Weisler and Kirch (1982, 1980) conducted an extensive survey of the Kawela and Makakupaʻia Iki ahupuaʻa for the Kawela Plantation Development Associates. Identifying 499 late prehistoric Hawaiian features and recording 182 sites, the "Kawela Archaeological Project" documents an exceptionally high density of archaeological remains in the dry upland ridge environment. Archaeological features in the immediate vicinity of Kakahaiʻa Pond NWR include petroglyphs, stone platforms (structures and burials), shelters for temporary and permanent habitation, natural cave shelters, agriculture terraces, a holua slide, and numerous religious shrines. The Kawela Complex is listed on both the National and Hawaiʻi State Register of Historic Places (MCPD 1984).

Weisler (1983, 1981a) also conducted a pedestrian surface survey and excavated 11 subsurface auger holes in two transects specifically for Kakahaiʻa NWR. Besides the fishpond, no prehistoric sites were documented within the Refuge boundaries. Sedimentation from upland habitats and seasonal flooding of the pond area is suspected to have buried any potential resources (Weisler 1983).

However, archaeologists at the State Historical Preservation Division stated that because Weisler's (1983) report was drafted prior to current State standards, restoration work conducted on the Refuge property may require an additional archaeological inventory survey (Kirckendall pers. com.).

Estioko-Griffin (1987) conducted an islandwide inventory of fishponds, listing Kakahaiʻa as a loko puʻuone (fishpond isolated from the ocean by a mound of sand). DHM Planning Inc. et al. (1990) conducted an extensive Hawaiian fishpond study for the DLNR Historic Preservation Division. While this inventory also listed Kakahaiʻa as a loko puʻuone, it did not provide an in-depth study of the fishpond.

Three recent sites, dated post-1940, were recorded during a Refuge boundary survey in 1975 and 1976 by R.M. Towill Corporation. Weisler (1983) revisited these locations and suggested they be avoided during any land modification on the Refuge. The historical sites include the following:

> **Abandoned Residence**: An abandoned residence was found immediately east of the pond. The site includes a small, wood-frame house, a separate cookhouse, and a small shack; however, because the structures were demolished around 1976, only the foundation of a barbeque remains.
>
> **Piggery and Charcoal Production**: North of the abandoned house and east of the pond, is a piggery and charcoal manufacturing site. The 10 portable ovens noted during the 1976 boundary survey were removed prior to the 1983 survey, leaving only piles of small kiawe charcoal fragments. The ovens mostly likely burned kiawe into charcoal for export to Honolulu markets. The site also includes a 40 foot by 20 foot concrete foundation that has a pair of parallel troughs for feeding and watering pigs.
>
> **Residence and Piggery**: In the northwest corner of Refuge, a residence, piggery, and well were documented. A narrow dirt road separates the well from the property and an earthen berm which probably created a pond for rice cultivation. The berm is bisected by a ditch from the well to the residence. Also observed at the site was a hand-carved wooden net float, as well as cans and bottles dated between 1943-1983.

6.1.6 Paleontological Resources

Unless found in an archaeological context, "nonfossilized and fossilized paleontological specimens, or any portion or piece thereof," are not considered archaeological resources (16 U.S.C. 470bb(1)). Paleontology resources include life forms that existed in prehistoric or geologic times, as represented by the fossils of plants, animals, and other organisms. Ziegler (2002) defines fossils as "biological remains, whether permineralized or not," that were "deposited in the islands before the time of European Contact (1778 CE) *and* are not definitely components of prehistoric archaeological midden (human food refuse and other cultural debris)." Paleontological fossils have been uncovered in a variety of sites throughout Hawaiʻi, including sand dunes, sinkholes, lava tubes, and pond deposits (Ziegler 2002).

Ziegler (2002) states that the only fossiliferous sites on the island of Molokaʻi are coastal sand dunes. The remains of several bird bone species dating back to 1500 CE were uncovered by Weisler (1983) at a low sand dune west of Kakahaiʻa pond. Avifaunal species identified from prehistoric deposits within the dune include the koloa mapū and ʻalae keʻokeʻo, which were probably confined to the

marsh habitat, as well as nēnē and pueo, which may have utilized the surrounding grassy area. Because Rallidae birds prefer marshes, ponds, and lakes, Weisler (1983) believed that the presence of these bones implied that the area contained marshlands during and prior to 1500 CE. Prehistoric deposits within the dune also contained evidence of other bird species; however, Weisler (1983) concluded that these birds were not associated with the pond area. Although Weisler (1983) does not provide a thorough analysis of whether the avifaunal remains uncovered in the Kawela were considered cultural debris, his later critical review (1989) stated that nēnē bones found in the dune "may have been culturally deposited."

Auger holes excavated by Weisler (1983) showed that the pond layer (Stratum II), although predominantly composed of sand and silt, also consisted of nonmarine mollusks and seeds of the genus *Spirpus*. The nonmarine mollusks identified include *Theodoxus neglectus, Tryonia protea, Thiara granifera,* and *Thiara tuberculata.* The thickness of the nonmarine mollusk layer increases toward the pond area. In addition, the marine layer (Stratum III) of the most inland auger hole contained two chunks of coral (*Porites* sp.) at 10 feet below the surface dating between 1560-1875 BCE (Weisler 1983).

6.2 Social and Economic Setting

This section discusses the social and economic environment surrounding the Kakahaiʻa NWR, within the context of the island of Molokaʻi, the County of Maui, and the State of Hawaiʻi. Kaunakakai, the island's major population and commercial center, is located about midway along the south coast. A major tourist destination area is located at Kaluakoi, on the western end of the island. There are small plantation communities of Maunaloa and Kualapuʻu in the central plain, as well as rural Hawaiian homestead settlements of Hoʻolehua and Kalamaula. There is also a settlement pattern along the southeast coast which becomes more rural and dispersed as it extends from Kaunakakai to Halawa Valley (MCPD 2001).

6.2.1 Population

The 2010 Census data shows the population of Molokaʻi has decreased over the past decade with a decline from 7,404 to 7,345 since 2000. Much of the decline is attributed to Kalaupapa, where only about 18 patients remain in the Hansen's disease settlement. Because Kalaupapa is located in Kalawao County, its census figures are not part of Maui County. Kaunakakai, which is located 5 miles east of the Refuge, is the main population and commercial center of Molokaʻi. Approximately 2,726 people resided in the 2.03 square miles of Kaunakakai in 2000. Data for 2010 shows a decrease to 2,603 (U.S. Census Bureau 2010).

Table 6.1. Population figures for selected areas.

Area	Population (1990)	Population (2000)	Population (2010)
Molokaʻi Island	6,587	7,404	7,345
Kaunakakai	2,658	2,726	2,603
Maui County	100,374	128,094	154,834
Hawaiʻi State	1,108,229	1,211,537	1,360,301

Source: U.S. Census Bureau 2010

6.2.2 Housing

In Kaunakakai, the estimated median house or condo value in 2009 was $298,765 (it was $148,500 in 2000). The median family income for the Island of Molokaʻi in 2009 was $41,528. At 12 percent in January of 2011, Molokaʻi has the highest unemployment rate of all the Hawaiian Islands. The most recent income figures around the region of the Refuge are shown below in Table 6.2 (DBEDT 2010, Census 2010).

Table 6.2. Census Bureau estimated median and per capita income figures, 2009.

Area	Median Family Income	Per Capita Income
Kaunakakai	$47,863	$20,112
Island of Molokaʻi	$41,528	$20,126
Maui County	$72,367	$29,121

Source: U.S. Census Bureau 2010

The Census Bureau estimated that Maui County residents paid an average of $24,204 per year in mortgage costs, consuming 42.04 percent of their income. The generally accepted definition of affordability is for a household to pay no more than 30 percent of its annual income on housing. Families who pay more than 30 percent of their income for housing are considered cost burdened and may have difficulty affording necessities such as food, clothing, transportation and medical care. The majority of Maui County residents are paying an unsustainably high percentage of their income toward housing (MCPD 2006, 2010).

6.2.3 Education

The following schools are located on the island of Molokaʻi: one preschool, four public elementary schools, one private school grades K-8, one public intermediate school, one public high school, and one private school with preschool to high school students (Maui County Office of Economic Development 2005).

In 2005, the Census Bureau estimated that 86.6 percent of County residents age 25 or older have graduated high school and 23.8 percent have a bachelor's degree or higher. While the high school graduation rate of Maui County is slightly higher than that of the remainder of the United States, the percentage of residents with higher-level degrees is lower.

The University of Hawaiʻi (UH) Maui College, Molokaʻi education center in Kaunakakai offers courses leading towards certificates and associate degrees in five primary majors: Liberal Arts, Agriculture and Natural Resources, Business Careers, Human Services, and Allied Health/Nurse Aide Training. It also serves as a receive site for selected bachelors and masters degree programs from UH Mānoa, UH West Oʻahu, and UH Hilo via interactive television classes. Of the 225 students, 75 percent are of Native Hawaiian ancestry – the highest percentage of any campus in the UH system.

6.2.4 Economics

Molokaʻi has Hawaiʻi's highest rate of residents – estimated at 30 percent – who rely at least in part on subsistence practices to feed themselves through farming, fishing, and hunting. Cattle ranching and farming, mostly on the central and western portions of the island, are currently the central components of the Island's economy. Small-scale agricultural patches growing coffee beans, papaya, macadamia nuts, vegetables, and melons can be found scattered throughout Molokaʻi (Molokaʻi Community 2008).

Since its collapse in the early 1980s, no large-scale agriculture has been able to replace the pineapple industry on Molokaʻi, which was historically the central element of the island's economy. More recently, the agricultural industry, especially vegetable and melon farms, has been have adversely impacted by farming developments on Oʻahu. However, the MCPD reported that some growth in the sector has occurred from seed corn farming, aquaculture, and forestry. The Molokaʻi Ranch closure in 2008 devastated the community when it laid off more than 120 people, representing nearly the entire labor force of the island's largest private employer at the time (MCPD 2010).

Tourism does not generate significant income to the Molokaʻi economy as it does on the other Hawaiian Islands, the Hawaiʻi Department of Business, Economic Development, and Tourism estimated that the number of visitors to the island in 2009, including domestic and international guests, was 48,339, down 29.8 percent compared to the previous year. The average daily census fell 22.2 percent to 647 visitors per day in 2009. Total visitor expenditures for the island in 2010 were estimated at only $2.5 million (DBEDT 2010).

Appendix A. Kakahaiʻa NWR Species List*

*Species currently present and/or historically recorded on the Refuge

Animal Species		
Common Name	**Scientific Name**	**Hawaiian Name**
Invertebrates, Aquatic		
Dragonfly	*Anax junius*	Pinao
Orange-black Hawaiian damselfly	*Megalagrion xanthomelas*	Pinapinao
Invertebrates, Terrestrial		
Paper wasp	*Polistes exclamans*	
Centipede	*Scolopendra subspinipes*	Kanapī
Cockroach	*Periplaneta americana*	
Scorpion	*Isometrus maculatus*	Kopiana
Fish		
Liberty/Mexican molly	*Poecilia ssp*	
Mosquito fish	*Gambusia affinis*	
Striped mullet	*Mugil cephalus*	ʻAma ʻama
Tilapia	*Oreochromis ssp*	
Reptiles and Amphibians		
American toad	*Bufo americanus*	
Common house gecko	*Hemidactylus frenatus*	Moʻo ʻalā
Green anole lizard	*Anolis carolinensis porcatus*	
Mammals		
Axis deer	*Axis axis*	Kia
Cat	*Felis catus*	Popoki
Dog	*Canis familiaris*	ʻĪlio
House mouse	*Mus musculus*	ʻIole
Rat, Polynesian	*Rattus exulans*	ʻIole
Rat, Norway	*Rattus norvegicus*	ʻIole
Rat, Black	*Rattus rattus*	ʻIole
Small Indian mongoose	*Herpestes auropunctatus*	Manakuke
Hawaiian Waterbirds		
Black-crowned night heron	*Nycticorax nycticorax hoactli*	ʻAukuʻu
Hawaiian coot	*Fulica alai*	ʻAlae keʻokeʻo
Hawaiian duck	*Anas wyvilliana*	Koloa maoli
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	ʻAlae ʻula
Hawaiian stilt	*Hemantopus mexicanus knudseni*	Aeʻo
Migratory Birds		
Herons		
Cattle egret	*Bubulcus ibis*	
Great blue heron	*Ardea herodias*	
Geese and Ducks		
American wigeon	*Anas americana*	
Blue-winged teal	*Anas discors*	
Brant	*Branta bernicla*	

Common Name	Scientific Name	Hawaiian Name
Bufflehead	*Bucephala albeola*	
Canada goose	*Branta canadensis*	
Canvasback	*Aythya valisineria*	
Eurasian wigeon	*Anas penelope*	
Fulvous whistling duck	*Dendrocygna bicolor*	
Gadwall	*Anas strepera*	
Greater white-fronted goose	*Anser albifrons*	
Green-winged teal	*Anas crecca*	
Lesser scaup	*Aythya affinis*	
Northern pintail	*Anas acuta*	Koloa māpu
Northern shoveler	*Anas clypeata*	Koloa mohā
Ring-necked duck	*Aythya collaris*	
Shorebirds		
Long-billed dowitcher	*Limnodromus scolopaceus*	
Pacific golden plover	*Pluvialis fulva*	Kōlea
Pectoral sandpiper	*Calidris melanotos*	
Ruddy turnstone	*Arenaria interpres*	ʻAkekeke
Sanderling	*Calidris alba*	Hunakai
Short-billed dowitcher	*Limnodromus griseus*	
Wandering tattler	*Heteroscelus incanus*	ʻŪlilī
Raptors		
Barn owl	*Tyto alba*	
Hawaiian short-eared owl	*Asio flammeus sandwichensis*	Pueo
Non-Native Passerine Birds		
Gallinaceous Birds		
Black francolin	*Francolinus francolinus*	
Gray francolin	*Francolinus pondicerianus*	
Mynas		
Common myna	*Acridotheres tristis*	
White-Eyes		
Japanese white-eye	*Zosterops japonicas*	
Northern mockingbird	*Mimus polyglottos*	
White-rumped shama	*Copsychus malabaricus*	
Cardinals and Sparrows		
House sparrow	*Passer domesticus*	
Northern cardinal	*Cardinalis cardinalis*	
Red-crested cardinal	*Paroaria coronate*	
Finches		
House finch	*Carpodacus mexicanus*	
Waxbills and Mannikins		
African silverbill	*Lonchura cantans*	
Nutmeg manikin	*Lonchura punctulata*	
Doves		
Rock dove	*Columba livia*	
Spotted dove	*Streptopelia chinensis*	
Zebra dove	*Geopelia striata*	

Plant Species		
Common Name	**Scientific Name**	**Hawaiian Name**
Australian saltbush	*Atriplex sp.*	
Bassia	*Bassia hyssopifolia*	
Bermuda grass	*Cynodon dactyron*	Manienie
Buffel grass	*Cenchrus ciliaris*	
California bulrush	*Schoenoplectus californicus*	ʻAkaʻakai
California grass	*Brachiaria mutica*	
Castor bean	*Ricinus communis*	
Coconut	*Cocos nucifera*	Niu
Coral vine	*Antigonon leptopus*	
Cuba jute	*Sida rhombifolia*	
Duckweed	*Azolla sp.*	
False daisy	*Eclipta alba (prostrate)*	
False kamani	*Calophyllum inophyllum*	
False mallow	*Malvastrum coromandelianum*	
Fingergrass	*Chloris sp.*	
Goosefoot	*Chenopodium murale*	
Grass	*Echinochloa sp.*	
Guinea grass	*Panicum maximum*	
Hibiscus	*Hibiscus tiliaceus*	Hau
Java plum	*Syzygium cumini*	
Khaki	*Alternanthera pungens*	
Leucaena	*Leucana leucocephala*	Koa haole
Long thorn kiawe	*Prosopis juliflora*	Kiawe
Marsh fleabane	*Pluchea indica*	
Marsh fleabane hybrid	*Pluchea x fosbergii*	
Mesquite	*Prosopis pallida*	Kiawe
Monkeypod	*Samanea saman*	
Native bulrush	*Schoenoplectus tabernaemontani*	Kaluhā
Pickleweed	*Batis maritima*	ʻAkulikuli kai
Portia tree	*Thespesia populnea*	Milo
Primrose willow	*Ludwigia octovalvis*	
Saltmarsh bulrush	*Bolboschoenus maritimus*	Kaluhā
Screw pine	*Pandanus tectorius*	Hala
Sea purslane	*Sesuvium portulacastrum*	ʻAkulikuli
Seaside heliotrope	*Heliotropium curassavicum*	Kīpūkai
Sedge	*Pycreus (Cyperus) polystachyos*	
Scarlet spiderling	*Boerhavia coccinea*	
Slender mimosa	*Desmanthus virgatus*	
Smooth flatsedge	*Cyperus laevigatus*	Makaloa
Sourbush	*Pluchea odorata*	
Sprangletop	*Leptochloa uninervia*	
Torpedo grass	*Panicum repens*	
Uhaloa	*Waltheria indica*	ʻUhaloa
Yellow ilima	*Sida fallax*	ʻIlima

Appendix B. Compatibility Determinations and Appropriate Use Findings

B.1 Introduction

The compatibility determinations (CD) developed during the CCP planning process evaluate uses projected to occur at the Kakahaiʻa NWR over the next 15 years. The evaluation of funds needed for management and implementation of each use also assumes implementation as described in Chapter 2.

B.1.1 Uses Evaluated At This Time

The following CD are included in this CCP:

Table B.1. Summary of Compatibility Determinations.

Refuge Use	Page	Compatible?	Year Due for Reevaluation
Wildlife Observation, Photography, and Interpretation	B-5	Yes	2026
Environmental Education	B-11	Yes	2026
Research, Scientific Collecting, and Surveys	B-13	Yes	2021

B.1.2 Compatibility – Legal and Historical Context

Compatibility is a tool refuge managers use to ensure that recreational and other uses do not interfere with wildlife conservation, the primary focus of refuges. Compatibility is not new to the Refuge System and dates back to 1918 as a concept. As policy, it has been used since 1962. The Refuge Recreation Act of 1962 directed the Secretary of the Interior to allow only those public uses of Refuge lands that were "compatible with the primary purposes for which the area was established."

Legally, Refuges outside of Alaska are closed to all public uses until officially opened. Regulations require that adequate funds be available for administration and protection of refuges before opening them to any public uses. However, wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, EE, and interpretation) are to receive enhanced consideration and cannot be rejected simply for lack of funding resources unless the refuge has made a concerted effort to seek out funds from all potential partners. Once found compatible, wildlife-dependent recreational uses are deemed the priority public uses at the refuge. If a proposed use is found not compatible, the refuge manager is legally precluded from approving it. Economic uses that are conducted by or authorized by the refuge also require CD.

Under compatibility policy, uses are defined as recreational, economic/commercial, or management use of a refuge by the public or a non-Refuge System entity. Uses generally providing an economic return (even if conducted for the purposes of habitat management) are also subject to CD. The Service does not prepare CD for uses when the Service does not have jurisdiction. In addition, aircraft overflights, emergency actions, some activities on navigable waters, and activities by other Federal agencies on "overlay Refuges" are exempt from the compatibility review process.

New compatibility regulations were adopted by the Service in October 2000. The regulations require that a use must be compatible with both the Refuge System mission and the purpose(s) of the individual refuge. This standard helps to ensure consistency in application across the Refuge System. The Administration Act also requires that CD be in writing and that the public have an opportunity to comment on all use evaluations.

The Refuge System mission emphasizes that the needs of fish, wildlife, and plants must be of primary consideration. The Administration Act defined a compatible use as one that ". . . in the sound professional judgment of the Director, will not materially interfere with or detract from the fulfillment of the mission of the System or the purposes of the Refuge." Sound professional judgment is defined under the Administration Act as ". . . a finding, determination, or decision, that is consistent with principles of sound fish and wildlife management and administration, available science and resources . . ." Compatibility for wildlife-dependent uses may depend on the level or extent of a use.

Court interpretations of the compatibility standard have found that compatibility is a biological standard and cannot be used to balance or weigh economic, political, or recreational interests against the primary purpose of the refuge (*Defenders of Wildlife* v. *Andrus*).

The Service recognizes that CD are complex. For this reason, refuge managers are required to consider "principles of sound fish and wildlife management" and "best available science" in making these determinations (House of Representatives Report 105-106). Evaluations of the existing uses on the Kakahai‘a NWR are based on the professional judgment of Refuge and planning personnel including observations of Refuge uses and reviews of relevant scientific literature.

B.1.3 Appropriate Use Findings

The Appropriate Refuge Uses Policy outlines the process that the Service uses to determine when general public uses on refuges may be considered. Priority public uses previously defined as wildlife-dependent uses (hunting, fishing, wildlife observation and photography and EE and interpretation) under the Administration Act are generally exempt from appropriate use review. Other exempt uses include situations where the Service does not have adequate jurisdiction to control the activity and refuge management activities. In essence, the Appropriate Refuge Use policy, 603 FW 1 (2006), provides refuge managers with a consistent procedure to first screen and then document decisions concerning a public use. When a use is determined to be appropriate, a refuge manager must then decide if the use is compatible before allowing it on a refuge. The policy also requires review of existing public uses. During the CCP process, the refuge manager evaluated all existing and proposed refuge uses at Kakahai‘a NWR using the guidelines and criteria as outlined in the appropriate use policy.

Using this process, and as documented on the following pages, the refuge manager determined the following use is appropriate for the purposes of the Refuge System and Kakahai‘a NWR, and directed that a CD be completed for these uses: research, scientific collecting, and surveys.

B.1.4 References

Compatibility regulations, adopted by the Service in October 2000: http://Refuges.fws.gov/policymakers/nwrpolicies.html

Defenders of Wildlife v. *Andrus* (Ruby Lake Refuge I). 11 Envtl. Rptr. Case 2098 (D.D.C. 1978), p. 873.

Fish and Wildlife Service. 2011. Kakahaiʻa National Wildlife Refuge: *Draft Comprehensive Conservation Plan and Environmental Assessment.*

House of Representatives Report 105-106 http://refuges.fws.gov/policyMakers/mandates/HR1420/part1.html

B.2 Compatibility Determination for Wildlife Observation, Photography, and Interpretation

Refuge Name(s): Kakahaiʻa National Wildlife Refuge

County and State: Maui County, Hawaiʻi

Establishing and Acquisition Authority(ies):

Kakahaiʻa NWR was established in 1976 under the authority of the:

- Fish and Wildlife Coordination Act of 1956, as amended (16 U.S.C. 742a – 742j)
- Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544)

Refuge Purpose(s):

"…to conserve (A) fish and wildlife which, are listed as endangered or threatened species… or (B) Plants …" 16 U.S.C. 1534, Endangered Species Act of 1973.

National Wildlife Refuge System Mission:

"The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use(s):

The National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 identifies wildlife observation, photography, and interpretation among wildlife-dependent public uses which, when compatible with the purpose(s) of the refuge, are priority public uses and receive special consideration in planning for and management of the Refuge System.

Wildlife observation, photography, and interpretation are non-consumptive, wildlife-dependent public uses with similar elements and so are considered together in this CD. Kakahaiʻa NWR is unstaffed and not currently open to the public except for special events, under Special Use Permits (SUP), and individual group requests. Viewing of waterbirds and wetland habitats is accessible from the Refuge entrance road and from Old and New Pond levees. Wildlife observation opportunities are limited with the loss of water and open habitat leading to absence of waterbirds, except for the 2-4 days after a rainstorm.

If wetlands are restored and the endangered and migratory birds are once again using the Refuge for foraging, nesting, and resting, there will be an increased opportunities for wildlife observation, photography, and interpretation. With the addition of on-site staff under our preferred management strategy, construction of an elevated viewing platform and kiosk along the entrance road outside the fence has been proposed. Wildlife observation from the Refuge entrance road would provide year-round opportunities because it is not reliant on whether or not staff members are on-site or the

Refuge gates are open. With construction of a viewing platform, Kakahaiʻa NWR would have one primary area where the public could engage in wildlife observation and photography. From this vantage point, the public could see into all of New Pond and portions of Old Pond. The viewing platform would be located 50-75 feet from New Pond and the fence would provide a physical barrier for protecting waterbirds and minimize disturbance. In the event birds are nesting on the western edge of New Pond and negative impacts are observed, the area would be closed.

Both New Pond and Old Pond levees serve as trails to view wetland habitats. Because of the relatively small size of the ponds (5.5 and 15 acres, respectively), it may be necessary to block portions of the southeastern levees to minimize disturbance to birds. Although this means the ponds cannot be circumvented, it will retain quality wildlife observation opportunities for the majority of viewers. Maintenance of the earthen levees is an on-going activity that will require pest plant control and periodic repairs to retain their integrity and provide the public unobstructed and safe access. Compaction of the levees will allow wheelchair accessibility, as well.

Disturbance to endangered and migratory waterbirds will be monitored and areas will be closed from public access, particularly during aeʻo and ʻalae keʻokeʻo nesting. If necessary, the Refuge would be closed to all access during these critical periods.

Future opportunities to develop interpretive panels, particularly on the outside of the fence along the entrance road are planned. These panels will introduce the wetlands and endangered waterbirds present on the Refuge and will enhance public viewing opportunities.

Availability of Resources:

Category and Itemization	One-time $	Annual $/yr
Administration and management:	$0	$2,600
Maintenance:	$0	$5,400
Monitoring costs:	$0	$3,600
Special equipment, facilities, or improvements:	$50,000	$2,600
Offsetting revenues:	$0	$0

The Refuge Complex has a minimal budget and staff to manage this use, at this time. Although wildlife observation, photography, and interpretation on the Refuge require minimal resources when the public is on their own, the absence of staff on Molokaʻi limits accessibility. Future wetland restoration, additional staff, and volunteer recruitment will enable an expansion of these programs.

Anticipated Impacts of the Use(s):

There are different types of human-wildlife conflicts (direct or indirect; human-caused or wildlife-caused) that occur when people are in nature. Public use activities at Kakahaiʻa NWR would be planned and designed to eliminate direct conflicts (e.g., harassment, direct mortality) and minimize indirect conflicts (disturbance as defined by a change in the wildlife's behavior). Wildlife observation, photography, and interpreation is identified as a priority use because of the importance of sharing what is being protected and the opportunities to increase visitors' awareness, appreciation

for, and stewardship towards the natural resources. A balance needs to be attained in order for human activities to coexist with waterbird needs. This can be accomplished by minimizing activities and designing public use facilities that allow birds to engage in their natural behaviors.

Human activities on unconfined trails may result in direct effects on wildlife through harassment, a form of disturbance that can cause physiological effects or varying levels of behavioral modifications (Smith and Hunt 1995). Various studies have shown that the severity of the effects depends upon the distance to the disturbance and its duration, frequency, predictability, and visibility to wildlife (Knight and Cole 1991). The variables found to have the greatest influence on wildlife behavior are: a) the distance from the animal to the disturbance and b) duration of the disturbance. In addition, the type of movement by people elicits different responses; for examples, birds show a greater flight response from a human moving quickly and unpredictably (erratic) than to humans moving slowly following a distinct path. Excessive human noises, especially with erratic behavior, are also a factor in bird disturbance by humans.

Short-term impacts: Kakahaiʻa NWR has been closed to the public except for special events and/or under SUP since its inception as a national wildlife refuge. If the wetland is restored and the endangered species return to the Refuge, the presence of people observing or photographing wildlife has potential to cause short-term disturbance to wildlife. Large non-wildlife-dependent groups are not the norm; however, if excessive disturbance is observed, the Refuge would close the area and mitigate through group education and interpretation. In order to minimize negative impacts to endangered waterbirds, it's important that the groups understand the causes of their endangerment, such as habitat loss and human disturbance. By explaining the negative consequences of disturbance, we strive to change the behavior and instill positive stewardship ethics.

The potential impact of human activities to endangered waterbirds is well documented at Keālia Pond NWR on Maui where strategies to minimize those impacts are implemented. These same restrictions apply to Kakahaiʻa NWR whereby areas are closed during critical periods in the waterbirds life history (e.g., nesting and brood rearing). New Pond and the adjacent grassland are open and unimpeded by vegetation allowing public to view birds from a distance without disturbance. Activities are limited to pedestrian access only. Vehicles and bikes are not allowed on the levees and pets (even on leashes) are not permitted. With additional on-island staff, the Refuge would be able to monitor public use, identify when birds are most susceptible to human disturbance, and implement measures to eliminate and/or minimize the human activities for the benefit of endangered waterbirds.

Long-term impacts: Wildlife disturbance can be minimized when planning the restoration of wetlands or facilities. Refuge staff will evaluate potential disturbance in future planning and design of public use facilities such as the proposed viewing platform. During nesting season, trails are closed to public access to eliminate disturbance to waterbirds incubating eggs and rearing young. In the past, this closure has occurred during ʻalae keʻokeʻo nesting period as needed; however, this is not necessary every year, likely due to the location of their nests (in emergent vegetation) hidden from view. In addition, during brood rearing, the young have the capability of swimming into the vegetation away from people. In contrast, closures are more typical during aeʻo nesting season (May-June) because of the location of their nests (on the ground, adjacent to water) and the chicks' limited ability to escape.

Restoration of the ponds will be based on the needs of endangered waterbirds; therefore, specific planning and design of non-wetland areas will simultaneously occur to evaluate options for public access that minimizes impacts to waterbirds yet increases the quality of the viewing experiences. Areas outside of the perimeter levees for both ponds will be planted with native species to provide a barrier between the public and waterbirds. This natural blind will minimize disturbance to waterbirds and provide quality viewing opportunities by the public. A viewing platform along the entrance road will be designed to provide a higher vantage point for the viewing public but not at such a height that would minimize their exposure from the waterbirds' vantage point. This type of planning is expected to minimize short- and long-term effects to waterbirds.

Refuge staff will continue to monitor public use activities and evaluate potential disturbance in future planning and design of public use facilities. Future planning will also include methods to provide a high-quality experience to the public.

Cumulative impacts: The level and type of use from activities described in this CD is not expected to result in any significant cumulative impacts.

Public Review and Comment:

Public review and comments were solicited in conjunction with release of the draft Kakahai‘a NWR draft CCP/ EA (2011) in order to comply with the National Environmental Policy Act and Service policy. This CD was released as integral part of the CCP and received the same level of public review and comments as the CCP, in accordance with Service planning policy.

Determination: (check one below)

___ Use is Not Compatible

_✓_ Use is Compatible With Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- Visitors under SUP are required to stay on trails and designated paths throughout the year;
- Use of proposed viewing platform would be restricted to daylight hours only;
- Pets are not allowed;
- Regulations and information will be available to the public through a Refuge brochure and interpretive kiosk;
- Directional, informational, and interpretive signs will be available and maintained to help educate the public on minimizing wildlife and habitat disturbance;
- Human use levels will be monitored by Refuge staff during SUP programs, as well as periodic site visits; and
- Temporary closure of trails will occur during waterbird nesting season, if necessary, to eliminate disturbance.

Justification:

Wildlife observation, photography, and interpretation are three of the six wildlife-dependent recreational uses of the Refuge System identified in the Administration Act as legitimate and appropriate priority general public uses. The six uses — hunting, fishing, wildlife observation and photography, and EE and interpretation — are to receive enhanced consideration in planning and management over all other general public uses of the Refuge System. Wildlife observation, photography, and interpretation receive enhanced consideration in the CCP process, and are considered priority public uses when determined compatible. Although these activities can result in disturbance to wildlife, these activities would occur on a small percentage of Refuge acres. The relatively limited number of individual plants and animals expected to be adversely affected will not cause wildlife populations to materially decline, the physiological condition and production of Refuge species will not be impaired, their behavior and normal activity patterns will not be altered dramatically, and their overall welfare will not be negatively impacted. Thus, allowing wildlife observation, photography, and interpretation to occur under the stipulations described above will not materially detract or interfere with the purpose for which the Refuge was established or the Refuge System mission. Wildlife observation, photography, and interpretation programs complement the Refuge purpose, vision, and goals, and help fulfill the mission of the Refuge System.

Mandatory Reevaluation Date:

September
____2026_ Mandatory 15-year reevaluation date (for wildlife-dependent public uses)

_____ Mandatory 10-year reevaluation date (for all uses other than wildlife-dependent public uses)

NEPA Compliance for Refuge Use Decision: (check one below)

____ Categorical Exclusion without Environmental Action Statement

____ Categorical Exclusion and Environmental Action Statement

_✓_ Environmental Assessment and Finding of No Significant Impact

____ Environmental Impact Statement and Record of Decision

Refuge Determination:

Prepared by:

Refuge Planner,
Hawaiian and Pacific Islands NWRC

Laura Beauregard — 9-20-11
(Signature) (Date)

Project Leader,
Maui National Wildlife Refuge Complex
Approval:

[signature] — 09-20-11
(Signature) (Date)

Concurrence:

Project Leader,
Hawaiian and Pacific Islands NWRC

Barry W. Stieg — 9/22/11
(Signature) (Date)

Regional Chief,
National Wildlife Refuge System:

Ard L. West — 9/25/11
(Signature) (Date)

B.3 Compatibility Determination for Environmental Education

Refuge Name(s): Kakahaiʻa National Wildlife Refuge

County and State: Maui County, Hawaiʻi

Establishing and Acquisition Authority(ies):

Kakahaiʻa NWR was established in 1976 under the authority of the:

- Fish and Wildlife Coordination Act of 1956, as amended (16 U.S.C. 742a – 742j)
- Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544)

Refuge Purpose(s):

"…to conserve (A) fish and wildlife which, are listed as endangered or threatened species… or (B) Plants …" 16 U.S.C. 1534, Endangered Species Act of 1973.

National Wildlife Refuge System Mission:

"The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use(s):

The National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 identifies environmental education among wildlife-dependent public uses which, when compatible with the purpose(s) of the refuge, are priority public uses and receive special consideration in planning for and management of the Refuge System.

Environmental education is a non-consumptive, wildlife-dependent public use. Environmental education programs at Kakahaiʻa NWR are conducted by nongovernmental organizations (Nēnē O Molokaʻi, Maui Digital Bus) under a Special Use Permit (SUP). All outdoor classes are coordinated to not impact the Refuge's management programs (e.g., maintenance). Nēnē O Molokaʻi is a non-profit corporation that emphasizes education through community involvement. They have a longstanding relationship with the Refuge and SUP approvals since 1997 to access the Refuge to host school and other EE groups. The organization provides educational and volunteer opportunities to groups that include a well-rounded overview of the different types of wetland habitats on Molokaʻi with emphasis on the endangered waterbirds. Learning activities include wetland ecology, biology, cultural history, and the life history of endangered waterbirds, as well as volunteer efforts. A majority of the organization's participants are from the local community and although the number of students is less than 100 each year, the value in exposing students to Molokaʻi's natural resources is invaluable.

As the Refuge currently has a degraded wetland without suitable habitat for endangered waterbirds,

EE programs lately have been focusing on pest species and how they impact wetlands. Kakahaiʻa NWR is used as a comparison to functional wetlands on the Island such as ʻŌhiʻapilo Pond Bird Sanctuary, Kaunakakai Wastewater Reclamation Facility, and Kōheo Wetland.

The Maui Digital Bus is in the process of developing and implementing their program on Molokaʻi and once it is operational, the program is expected to reach more students. Both programs have quality EE programs that have shown to be successful on Maui. With the addition of a new visitor services manager for the Maui NWR Complex, Refuge-specific EE programs will be developed for local school groups of varying age levels. Volunteers would be recruited and trained to assist with the program. All EE programs will have a stewardship component where students would participate in a wetland restoration project.

Availability of Resources:

Category and Itemization	One-time $	Annual $/yr
Administration and management:	$0	$1,000
Maintenance:	$0	$900
Materials:	$0	$1,000
Special equipment, facilities, or improvements:	$0	$1,000
Offsetting revenues:	$0	$

Minimal costs of EE will be covered by Refuge visitor services funding provided in the annual Refuge budget.

Anticipated Impacts of the Use(s):

Short-term impacts: The number of school groups and students visiting the Refuge may vary from year to year but this variation is already considered in the guidelines and structure established for the program. There is a limit of 25 people per group and no more than 5 group visits are allowed annually, during the non-breeding season only. To date, the highest number of students to visit in one year was 35. A Refuge staff member or Refuge-approved volunteer docent accompanies each group under SUP to monitor the activity. The primary impacts come from temporary disturbance to individual animals (primarily birds) due to the presence and activity of the students as they are guided around the wetlands. The animals may flush, swim away, or seek cover and hide in vegetation. These impacts are mitigated by restricting the days, maximum number of students, and routes that EE activities take place. This allows the students to participate in the EE experience while causing temporary disturbance over the smallest area and to the fewest birds.

Because we anticipate 5 visitor groups of no more than 25 people each will visit the Refuge over the course of the school year and EE groups will only be allowed access to designated levee trails during non-breeding seasons, wildlife will have ample quantities of sanctuary for feeding and resting. Thus, allowing EE to occur under the described program will not result in any significant short-term impacts.

Long-term impacts: The current, ongoing EE program covered by this CD will not cause any significant long-term impacts. The EE program is expected to increase with restoration of the

wetlands, recruitment of a Visitor Services Manager, and development of a formal program designed to meet Hawaiʻi Department of Education curriculum requirements. A thorough evaluation of the impacts to existing resources and capability of the site to withstand additional groups will be reviewed in a Visitor Services Plan within 5 years.

Cumulative impacts: This EE program has been conducted in the current manner since 1997 and no cumulative impacts to wildlife resources on the Refuge have been observed or are anticipated.

Public Review and Comment:

Public review and comments were solicited in conjunction with release of the draft CCP/EA (2011) in order to comply with the NEPA and Service policy.

Determination: (check one below)

___ Use is Not Compatible

_✓_ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

User stipulations:

- Groups are required to stay on trails and designated paths throughout the year;
- Use is restricted to daylight hours only;
- Groups are limited to 25, including students, chaperones, and teachers;
- Special Use Permits will only be issued during non-breeding seasons and when no nesting is occurring;
- Use levels will be monitored by Refuge staff and/or approved volunteer docents; and
- Refuge staff periodically participates with the group to ensure compliance with Refuge's conditions and accuracy of information is maintained.

Justification:
Environmental education is one of the six wildlife-dependent recreational uses of the Refuge System as stated in the Improvement Act. The six uses — hunting, fishing, wildlife observation and photography, and EE and interpretation — are to receive enhanced consideration in planning and management over all other general public uses of the Refuge System. Environmental education receives enhanced consideration in the CCP process, and is considered a priority public use when determined compatible. By limiting the size of groups, providing structured activities, and providing closed areas for wildlife away from human disturbance, this program would limit disturbance to wildlife. There is a sufficient amount of undisturbed habitat available to Refuge wildlife for escape and cover, and wildlife populations will find sufficient food resources and resting places. The relatively limited number of individual plants and animals expected to be adversely affected will not cause wildlife populations to materially decline, the physiological condition and production of Refuge species will not be impaired, their behavior and normal activity patterns will not be altered

dramatically, and their overall welfare will not be negatively impacted. Thus, allowing EE to occur under the stipulations described above will not materially detract or interfere with the purposes for which the Refuge was established or the Refuge System mission. Environmental education contributes to the mission of the Refuge System by providing wildlife-dependent educational benefits to visitors. Environmental education programs on Refuge lands are inherently valuable to the Service because they will enhance the public's knowledge of the Refuge and its resources, and expand the number of visitors who engage in the Refuge's conservation mission.

Mandatory Reevaluation Date: (provide month and year for "allowed" uses only)

September
__2026__ Mandatory 15-year reevaluation date (for wildlife-dependent public uses)

_____ Mandatory 10-year reevaluation date (for uses other than wildlife-dependent public uses)

NEPA Compliance for Refuge Use Decision: (check one below)

_____ Categorical Exclusion without Environmental Action Statement
_____ Categorical Exclusion and Environmental Action Statement
__✓__ Environmental Assessment and Finding of No Significant Impact
_____ Environmental Impact Statement and Record of Decision

Refuge Determination:

Prepared by:

Refuge Planner,
Hawaiian and Pacific Islands NWRC

Laura Beauregard 9-20-11
(Signature) (Date)

Project Leader,
Maui National Wildlife Refuge Complex
Approval:

09-20-11
(Signature) (Date)

Concurrence:

Project Leader,
Hawaiian and Pacific Islands NWRC

Barry W. 9/22/11
(Signature) (Date)

Regional Chief,
National Wildlife Refuge System:

9/25/11
(Signature) (Date)

B.4 Compatibility Determination for Research, Scientific Collecting, and Surveys

CD Terminology:

Research: Planned, organized, and systematic investigation of a scientific nature.
Scientific collecting: Gathering of Refuge natural resources or cultural artifacts for scientific purposes.
Surveys: Scientific inventory or monitoring.

Refuge Name(s): Kakahaiʻa National Wildlife Refuge

County and State: Maui County, Hawaiʻi

Establishing and Acquisition Authority(ies):

Kakahaiʻa NWR was established in 1976 under the authority of the:

- Fish and Wildlife Coordination Act of 1956, as amended (16 U.S.C. 742a – 742j)
- Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544)

Refuge Purpose(s):

"…to conserve (A) fish and wildlife which, are listed as endangered or threatened species… or (B) Plants …" 16 U.S.C. 1534, Endangered Species Act of 1973.

National Wildlife Refuge System Mission:

"The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use(s):

The Refuge staff receives periodic requests from non-Service entities (e.g., universities, State agencies, other Federal agencies, nongovernmental organizations) to conduct research, scientific collecting, and surveys on Refuge lands. These project requests can involve a wide range of natural and cultural resources as well as public use management issues, including basic absence/presence surveys, collection of new species for identification, habitat use and life-history requirements for specific species/species groups, practical methods for habitat restoration, extent and severity of environmental contaminants, techniques to control or eradicate pest species, effects of climate change on environmental conditions and associated habitat/wildlife response, identification and analyses of paleontological specimens, modeling wildlife populations, and assessing response of habitat/wildlife to disturbance from public uses. Projects may be species-specific, Refuge-specific, or evaluate the relative contribution of the Refuge to larger landscapes (e.g., eco-region, region, flyway, national, international) issues and trends.

The Service’s research and management and Appropriate Refuge Uses (603 FW1.10D(4)) policies indicate priority for scientific investigatory studies that contribute to the enhancement, protection, use, preservation, and management of native wildlife populations and their habitat as well as their natural diversity. Projects that contribute to Refuge-specific needs for resource management goals and objectives, where applicable, would be given a higher priority over other requests.

Availability of Resources:

Refuge staff responsibilities for projects by non-Service entities will primarily be limited to the following: review of proposals, prepare Special Use Permits (SUP) and other compliance documents (e.g., Section 7 of the ESA, Section 106 of the National Historic Preservation Act), and monitor project implementation to ensure that impacts and conflicts remain within acceptable levels (compatibility) over time. Additional administrative support, logistical and operational support may also be provided depending on each specific request. Estimated costs for one-time (e.g., prepare SUP) and annually recurring tasks by Refuge staff and other Service employees will be determined for each project. Sufficient funding in the general operating budget of the Refuge must be available to cover expenses for these projects. The terms and conditions for funding and staff support necessary to administer each project on the Refuge will be clearly stated in the SUP.

The Refuge has the following staffing and funding to administratively support and monitor research that is currently taking place on Refuge lands (see table below). Any substantial increase in the number of projects would create a need for additional resources to oversee the administration and monitoring of the investigators and their projects. Any substantial additional costs above those itemized below may result in finding a project not compatible unless expenses are offset by the investigator(s), sponsoring agency, or organization.

Category and Itemization	**One-time $**	**Annual $/yr**
Administration and management	$0	$4,000
Maintenance	$0	$0
Monitoring	$0	$6,900
Special equipment, facilities, or improvement	$0	$0
Offsetting revenues	$0	$0

Anticipated Impacts of the Use:

Use of the Refuge(s) to conduct research, scientific collecting, and surveys will generally provide information that would benefit fish, wildlife, plants, and their habitats. Scientific findings gained through these projects provide important information regarding life-history needs of species and species groups as well as identify or refine management actions to achieve resource management objectives in Refuge management plans (especially CCPs). Reducing uncertainty regarding wildlife and habitat responses to management actions in order to achieve desired outcomes reflected in resource management objectives is essential for adaptive management in accordance with Department of Interior (DOI) policy 522 DM 1.

If project methods impact or conflict with Refuge-specific resources, priority wildlife-dependent public uses, other high-priority research, and Refuge habitat and wildlife management programs, then

it must be clearly demonstrated that the scientific findings will contribute to resource management and that the project cannot be conducted off-Refuge for the project to be compatible. The investigator(s) must identify methods/strategies in advance required to eliminate or minimize the potential impact(s) and conflict(s). If unacceptable impacts cannot be avoided, then the project will not be compatible.

Impacts would be project- and site-specific, where they will vary depending upon nature and scope of the field work. Data collection techniques will generally have minimal animal mortality or disturbance, habitat destruction, no introduction of contaminants, or no introduction of nonnative species. In contrast, projects involving the collection of biotic samples (plants or animals) or requiring intensive ground-based data or sample collection will have short-term impacts. To reduce impacts, the minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) will be collected for identification and/or experimentation and statistical analysis. Where possible, researchers would coordinate and share collections to reduce sampling needed for multiple projects.

Investigator(s) obtaining required State and Federal collecting permits will also ensure minimal impacts to fish, wildlife, plants, and their habitats. If, after incorporating the above strategies, the project results in long-term or cumulative effects, it will not be deemed compatible. A Section 7 consultation under the ESA will be required for activities that may affect a federally listed species and/or critical habitat. Only projects that have no effect or will result in not likely to adversely affect determinations will be considered compatible.

Spread of pest plants and/or pathogens is possible from ground disturbance and/or transportation of project equipment and personnel, but it will be minimized or eliminated by requiring proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary. If after all practical measures are taken, an unacceptable spread of pest species is anticipated to occur, then the project will be found not compatible without a restoration or mitigation plan.

Localized and temporary effects may occur from vegetation trampling, collecting of soil and plant samples, or trapping and handling of wildlife. Impacts may also occur from infrastructure necessary to support a project (e.g., permanent transects or plot markers, exclosure devices, monitoring equipment, solar panels to power unattended monitoring equipment). Some level of disturbance is expected with these projects, especially if investigator(s) enter areas closed to the public and collect samples or handle wildlife. However, wildlife disturbance (including altered behavior) will usually be localized and temporary in nature. Where long-term or cumulative unacceptable effects cannot be avoided, the project will not be found compatible. Project proposals will be reviewed by Refuge staff and others, as needed, to assess the potential impacts (short-term, long-term, and cumulative) relative to benefits of the investigation to Refuge management issues and understanding of natural systems.

At least 6 months before initiation of field work (unless an exception is made by prior approval of the refuge manager), project investigator(s) must submit a detailed proposal. Project proposals will be reviewed by Refuge staff and others, as needed, to assess the potential impacts (short-term, long-term, and cumulative) relative to benefits of the investigation to Refuge management issues and understanding of natural systems. This assessment will form the primary basis for allowing or denying a specific project. Projects that result in unacceptable Refuge impacts will not be found compatible.

If the proposal is approved, then the refuge manager will issue a SUP(s) with required stipulations (terms and conditions) of the project to avoid and/or minimize potential impacts to Refuge resources as well as conflicts with other public-use activities and Refuge field management operations. After approval, projects also are monitored during implementation to ensure impacts and conflicts remain within acceptable levels based upon documented stipulations.

Projects that are not covered by the CCP will require additional NEPA documentation.

Public Review and Comment:

Public review and comments were solicited in conjunction with release of the draft CCP/EA (2011) in order to comply with the NEPA and Service policy.

Determination: (check one below)

____ The use is not compatible.

_✓_ The use is compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

Each project will require an SUP. Annual or other short-term SUPs are preferred; however, some permits will be a longer period, if needed, to allow completion of the project. All SUPs will have a definite termination date. Permit renewals will be subject to Refuge Manager review and approval based on timely submission of and content in progress reports, compliance with SUP stipulations, and required permits. Other stipulations and provisions would include the following:

- Projects will adhere to scientifically defensible protocols for data collection, where available and applicable.
- Investigators must possess appropriate and comply with conditions of State and Federal permits for their projects.
- If unacceptable impacts to natural resources or conflicts arise or are documented by the Refuge staff, then the refuge manager can suspend, modify conditions of, or terminate an on-going project already permitted by SUP(s) on a Refuge.
- Progress reports are required at least annually for multiple-year projects.
- Final reports are due 1 year after completion of the project unless negotiated otherwise with the refuge manager.
- Continuation of existing projects will require approval by the refuge manager.
- The Refuge staff will be given the opportunity to review draft manuscript(s) from the project before being submitted to a scientific journal(s) for consideration of publication.
- The Refuge staff will be provided with copies (including, but not limited to: reprints, videos, and CD) of all publications resulting from a Refuge project.
- The Refuge staff will be provided with copies of raw data (preferably electronic database format) at the conclusion of the project.
- Upon completion of the project or annually, all equipment and markers (unless required for long-term projects), must be removed and sites must restored to the refuge manager’s satisfaction. Conditions for clean-up and removal of equipment and physical markers will be stipulated in the SUP(s).

- All samples collected on Refuge lands are the property of the Service even while in the possession of the investigator(s). Any future work with previously collected samples not clearly identified in the project proposal will require submission of a subsequent proposal for review and approval. In addition, a new SUP will be required for additional project work. For samples or specimens to be stored at other facilities (e.g., museums), a memorandum of understanding will be necessary.
- Sampling equipment as well as investigator(s) clothing and vehicles (e.g., ATV, boats) will be thoroughly cleaned (free of dirt and plant material) before being allowed for use on Refuge lands and/or waters to prevent the introduction and/or spread of pests.
- The Service, specific Refuge unit, names of Refuge staff and other Service personnel who supported or contributed to the project will be appropriately cited and acknowledged in all written and oral presentations resulting from projects on Refuge lands.
- At any time, Refuge staff may accompany investigator(s) in the field.
- Investigator(s) and support staff will follow all Refuge-specific regulations that specify access and travel on the Refuge.

Justification:

Research, scientific collecting, and surveys on Refuge lands are inherently valuable to the Service because they will expand scientific information available for resource management decisions. In addition, only projects that directly or indirectly contribute to the enhancement, protection, use, preservation, and management of Refuge wildlife populations and their habitats generally will be authorized on Refuge lands. In many cases, if it were not for the Refuge staff providing access to Refuge lands and waters along with some support, the research project would likely not occur and less scientific information would be available to the Service to aid in managing and conserving resources. By allowing the use to occur under the stipulations described above, it is anticipated that wildlife species that could be disturbed during the use would find sufficient food resources and resting places so their abundance and use will not be measurably lessened on the Refuge. Additionally, it is anticipated that monitoring, as needed, will prevent unacceptable or irreversible impacts to fish, wildlife, plants, and their habitats. The combination of stipulations identified above and conditions included in any SUP(s) will ensure that proposed projects contribute to the enhancement, protection, conservation, and management of native wildlife populations and their habitats on the Refuge. As a result, these projects will not materially interfere with or detract from fulfilling Refuge purpose(s); contributing to the mission of the Service and Refuge System; and maintaining the biological integrity, diversity, and environmental health of the Refuge.

Mandatory Re-evaluation Date: (provide month and year for "allowed" uses only)

_____ Mandatory 15-year re-evaluation date (wildlife-dependent public uses)
September
__2021__ Mandatory 10-year re-evaluation date (uses other than wildlife-dependent public uses)

NEPA Compliance for Refuge Use Decision: (check one below)

_____ Categorical Exclusion without Environmental Action Statement
_____ Categorical Exclusion and Environmental Action Statement
__✓__ Environmental Assessment and Finding of No Significant Impact
_____ Environmental Impact Statement and Record of Decision

Refuge Determination:

Prepared by:

Refuge Planner,
Hawaiian and Pacific Islands NWRC

Laura Beaurgard 9-20-11
(Signature) (Date)

Project Leader,
Maui National Wildlife Refuge Complex
Approval:

[signature] 09-20-11
(Signature) (Date)

Concurrence:

Project Leader,
Hawaiian and Pacific Islands NWRC

Barry W. [signature] 9/22/11
(Signature) (Date)

Regional Chief,
National Wildlife Refuge System:

Lyle L. West 9/28/11
(Signature) (Date)

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Kakahai'a National Wildlife Refuge

Use: Research, Scientific Collecting, and Surveys

This form is not required for wildlife-dependent recreational uses; take regulated by the State, or uses already described in a Refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✓	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the Refuge manager has consulted with State fish and wildlife agencies. Yes ✓ No __

When the Refuge manager finds the use appropriate based on sound professional judgment, the Refuge manager must justify the use in writing on an attached sheet and obtain the Refuge supervisor's concurrence. Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate_____ Appropriate ✓

Refuge Manager: _____ Date: 09-20-11

If found to be **Not Appropriate**, the Refuge supervisor does not need to sign concurrence if the use is a new use. If an existing use is found **Not Appropriate** outside the CCP process, the Refuge supervisor must sign concurrence. If found to be **Appropriate**, the Refuge supervisor must sign concurrence.

Refuge Supervisor: Barry W. _____ Date: 9/22/11

FWS Form 3-2319

A compatibility determination is required before the use may be allowed. **02/06**

Attachment 1: Appropriate Uses Justification

Date: **May 5, 2011**

Refuge: Kakahaiʻa National Wildlife Refuge (Refuge)

Project: Research, Scientific Collecting, and Surveys

Summary: The Refuge receives requests to conduct scientific research on Refuge lands and waters. Research applicants must submit a proposal that would outline: 1) objectives of the study; 2) justification for the study; 3) detailed methodology and schedule; 4) potential impacts on Refuge wildlife and/or habitat, including disturbance (short-term and long-term), injury, or mortality; 5) personnel required; 6) costs to Refuge, if any; and 7) end products (i.e., reports, publications). Research proposals would be reviewed by Refuge staff, Regional Office Branch of Refuge Biology, and others as appropriate prior to the Refuge issuing a SUP. Projects will not be open-ended, and, at a minimum, will be reviewed annually.

For each of the findings listed on FWS Form 3-2319, a justification has been provided below:

a. Do we have jurisdiction over the use?

Some or all of the proposed activities would take place within Refuge boundaries. The Refuge has jurisdiction over those research projects that are sited within Refuge boundaries.

b. Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?

Proposed research activities should comply with all applicable laws and regulations. Any restrictions or qualifications that are required to comply with law and regulations would be specified in the SUP. The State of Hawaiʻi DLNR was invited on two occasions to participate on core planning teams, but declined due to insufficient staffing. However, as this Appropriate Use Justification does not propose a significant deviation from the status quo, and no comments on this topic were received from the State during the comment period, we believe additional coordination is not necessary.

c. Is the use consistent with applicable Executive orders and Department and Service policies?

Through the review of individual projects, the Refuge would ensure that they are consistent with applicable policies, especially Research on Service Lands Policy (803 FW 1).

d. Is the use consistent with public safety?

Through individual project review, the Refuge will ensure that each project is consistent with public safety. If necessary, stipulations to ensure public safety will be included in the project's SUP.

e. Is the use consistent with goals and objectives in an approved management plan or other document?

Research activities are approved in instances where they can provide meaningful data that may contribute to Refuge management and public appreciation of natural resources.

f. Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?

Earlier documented analysis has approved the use and touted the benefits of research, scientific collecting, and surveys on national wildlife refuges.

g. Is the use manageable within available budget and staff?

The Refuge receives <10 requests per year for this activity, and it is manageable with available budget and staff.

h. Will this be manageable in the future within existing resources?

The proposed activity at current levels would be manageable in the future with the existing resources.

i. Does the use contribute to the public's understanding and appreciation of the Refuge's natural or cultural resources, or is the use beneficial to the Refuge's natural or cultural resources?

The proposed use is beneficial to the Refuge's natural and cultural resources because the types of research projects approved are those that have the distinct likelihood to help achieve Refuge purposes by providing information useful for the management of trust resources and may contribute to the public's understanding and appreciation of natural and/or cultural resources.

j. Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?

The Refuge will ensure that the research activities will not impair existing or future wildlife-dependent recreational use of the Refuge during individual project review, prior to issuing a SUP for the project.

Appendix C. Plan Implementation and Costs

C.1 Administration

Kakahaiʻa NWR is administered as part of the Maui National Wildlife Refuge Complex (Complex). The Complex also includes the Keālia Pond NWR comprised of a large natural wetland with associated flats, constructed ponds, and forested habitats on the south-central coast of Maui. The Complex office is located at Keālia Pond NWR, where all administrative functions for Kakahaiʻa NWR are based. The current staff of five is stationed on Maui and has shared responsibilities for the operation and maintenance of Kakahaiʻa NWR. The Service is currently in the process of establishing Molokini Islet as an overlay refuge unit of the Keālia Pond NWR that will also have oversight from the Complex office.

C.2 Staffing

All staff positions share responsibilities and duties for two refuges, in addition to Molokini Islet Unit, once established; e.g., no staff is assigned or performs duties only on specific refuges within the Complex. Due to projected Complex-wide workload, priorities, Federal budget, logistics, and supervisory considerations, this arrangement is expected to continue. However, when more personnel are added to the Complex (e.g., a Maintenance Worker or Equipment Operator), staff may be assigned more specific duties on individual refuges.

At a minimum, the Maintenance Worker makes trips every other week to check on the property and perform habitat and maintenance duties. Unfortunately, the only airline flying direct between Maui and Molokaʻi has limited flights and frequent delays or cancellations resulting in relatively short days to accomplish work. In addition, this limited number of days on Molokaʻi makes it difficult to coordinate community work projects. Periodically, the entire Refuge staff travel to Molokaʻi to assist with large projects (e.g., fence construction).

The Service's National Staffing Model generated eight positions for the Complex, one of which would have primary responsibility for field work at Kakahaiʻa NWR. The existing, core-funded staff is five. The additional staffing would provide increased capacity to conduct biological inventory and monitoring, and research; increased visitor opportunities; EE and interpretation of Refuge resources; collaborative efforts with other Federal, State, and County agencies in addition to non-government organizations; improved maintenance facilities; and increase invasive species control efforts for the benefit of endangered waterbirds.

A new visitor center is currently under construction for Keālia Pond NWR. It was not planned when staffing models were finalized; therefore, the need for staff to operate and maintain the new building was not included. Increased staffing with specific responsibilities in the development of the visitor, volunteer, and education programs, and maintaining the new facility is necessary to provide quality customer service and ensure safe conditions for visitors. Although these staff would be stationed on Maui, their responsibilities would extend to the public use programs at Kakahaiʻa NWR, including volunteer, EE, and interpretation programs.

Current and Necessary Permanent Full-time Staffing for Maui NWR Complex, including Kakahaiʻa NWR (Current staff positions are highlighted)

Staff Position	Salary Rating	Identified in National Staffing Model	HQ/VC
Project Leader	GS-12	✓	
Deputy Project Leader	GS-9/11	✓	
Wildlife Biologist	GS-11	✓	
Biological Science Technician	GS-5/7	✓	
Visitor Services Manager	GS-7/9/11	✓	✓
Refuge Ranger	GS-5/7		✓
Administrative Support Assistant	GS-7	✓	
Maintenance Worker (Habitat & Facilities)	WG-8	✓	
Maintenance Worker (Facilities)	WG-7/8		✓
Equipment Operator	WG-6/7	✓	
Law Enforcement Officer	GS-7/9		✓

C.3 Refuge Funding and Budget Requests

Successful implementation of the CCP relies on our ability to secure funding, personnel, infrastructure, and other resources to accomplish the actions identified. Full implementation of the actions and strategies in this CCP will incur costs including staffing, construction projects, and individual resource program expansions. In addition to annual budget allocations, funding can be received through special funding sources and programs geared toward specific resource issues/needs. Examples include grants or project specific funding for endangered species, pest species control, wetlands, coastal habitats, climate change, and Service initiatives (Youth in the Great Outdoors, Connecting People with Nature).

Currently there are two sources of funding that will enable Kakahaiʻa NWR to carry out its plans under the CCP, including additional staff; these sources includes the Refuge Operating Needs System (RONS) and Service Asset Maintenance Management System (SAMMS) for repair/renovation of existing facilities. The RONS and SAMMS systems will be updated with new/additional projects that are approved under this CCP.

Project	Dates	Cost Estimate
Grub and dredge Old Pond	2012	$ 846,000
Restore Old Pond levees with 4:1 slopes	2012	$ 554,976
Rehabilitate 0.9 mile boundary fence	2012	$ 40,000
Restore New Pond	2013	$ 376,000
Grub and restore New Pond Levees	2013	$ 650,000
Relocate and replace Old Pond water control structure	2015	$ 12,600
Construct viewing platform and interpretive kiosk	2016	$ 40,000
Interpretive signs for fence	2017	$ 10,000

C. 4 Stepdown Plans

The CCP is one of several plans necessary for Refuge management. The CCP provides guidance in the form of goals, objectives, and strategies for several Refuge program areas may lack some of the specifics needed for implementation. Stepdown management plans will be developed for individual program areas within approximately 5 years after CCP completion. Stepdown plans, where feasible, will be prepared to cover all Refuges in the Complex. All stepdown plans require appropriate NEPA compliance and implementation may require additional permits. Stepdown plans for the Refuge follow in the table below. Project-specific plans, with appropriate NEPA compliance, may be prepared outside of these stepdown plans.

Stepdown Management Plan Status

Completed	**Date**
• Habitat Management Plan	2011 (CCP meets requirements for HMP)
• Integrated Pest Management Plan	2011 (Prepared concurrently with CCP, Appendix E)
• Fire Management Plan	2004 (Appendix G)
• Occupational Safety and Health Plan	2009
Scheduled	
• Inventory and Monitoring Plan	Initiated by 2013
• Visitor Services Plan	Initiated by 2013
• Archeological and Cultural Investigation	Initiated by 2013
Studies Identified in CCP Strategies	
• Topographical mapping	2012
• Comprehensive Water Resources Assessment	2012
• Soils and Geomorphological Assessment	2012
• Climate Change Monitoring Plan	2012-2014

Appendix D. Wilderness Review for Kakahai‘a NWR

General Information on Wilderness Reviews

Wilderness review is the process used to determine whether or not to recommend lands or waters in the Refuge System to the Congress for designation as wilderness. Planning policy for the Refuge System (602 FW 3) mandates conducting wilderness reviews every 15 years through the CCP process.

The wilderness review process has three phases: inventory, study, and recommendation. After first identifying lands and waters that meet the minimum criteria for wilderness, the resulting wilderness study areas (WSA) are further evaluated to determine if they merit recommendation from the Service to the Secretary of the Interior for inclusion in the National Wilderness Preservation System (NWPS). Areas recommended for designation are managed to maintain wilderness character in accordance with management goals, objectives, and strategies outlined in the final CCP until Congress makes a decision or the CCP is amended to modify or remove the wilderness proposal. A brief discussion of wilderness inventory, study, and recommendation follows.

Wilderness Inventory

The wilderness inventory consists of identifying areas that minimally meet the requirements for wilderness as defined in the Wilderness Act of 1964 (Wilderness Act). Wilderness is defined as an area which:

- Has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition, or be capable of restoration to wilderness character through appropriate management at the time of review, or be a roadless island;
- Generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable;
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation; and
- May also contain ecological, geological, or other features of scientific, educational, scenic, or historic value. These features and values, though desirable, are not necessary for an area to qualify as a wilderness.

Wilderness Study

During the study phase, lands and waters qualifying for wilderness as a result of the inventory are studied to analyze values (ecological, recreational, cultural, spiritual), resources (wildlife, water, vegetation, minerals, soils), and uses (habitat management, public use) within the area. The findings of the study help determine whether to recommend the area for designation as wilderness.

Wilderness Recommendation

Once a wilderness study determines that a WSA meets the requirements for inclusion in the NWPS, a wilderness study report that presents the results of the wilderness review, accompanied by a Legislative Environmental Impact Statement (LEIS), is prepared. The wilderness study report and LEIS that support wilderness designation are then transmitted through the Secretary of the Interior to the President of the United States, and ultimately to the Congress for approval.

The following section summarizes the inventory phase of the wilderness review for Kakahai‘a NWR.

Wilderness Inventory

The wilderness inventory is a broad look at the planning area to identify WSAs. These WSAs are roadless areas within refuge boundaries, including submerged lands and their associated water column, that meet the minimum criteria for wilderness identified in Sect. 2. (c) of the Wilderness Act. A WSA must meet the minimum size criteria (or be a roadless island), appear natural, and provide outstanding opportunities for solitude or primitive recreation. Other supplemental values are evaluated, but not required.

Evaluation of Size Criteria for Roadless Areas, Roadless Islands, and Submergent Lands and Associated Water Column

Identification of roadless areas, roadless islands, and submerged lands and associated water column, required gathering land status maps, land use and road inventory data, satellite imagery, aerial photographs, and personal observations of areas within refuge boundaries. "Roadless" refers to the absence of improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use.

Inventory units meet the size criteria for a WSA if any one of the following standards applies:

- An area with over 5,000 contiguous acres. State and private lands are not included in making this acreage determination.
- A roadless island of any size. A roadless island is defined as an area surrounded by permanent waters or that is markedly distinguished from the surrounding lands by topographical or ecological features.
- An area of less than 5,000 contiguous Federal acres that is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and of a size suitable for wilderness management.
- An area of less than 5,000 contiguous Federal acres that is contiguous with a designated wilderness, recommended wilderness, or area under wilderness review by another Federal wilderness managing agency such as the Forest Service, National Park Service, or Bureau of Land Management.

Kakahaiʻa NWR is a highly modified 44.6-acre parcel of land which does not meet the size criteria.

Evaluation of the Naturalness Criteria

A WSA must meet the naturalness criteria. Section 2.(c) of the Wilderness Act defines wilderness as an area that "…generally appears to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable." The area must appear natural to the average visitor rather than "pristine." The presence of ecologically accurate, historical landscape conditions is not required. An area may include some manmade features and human impacts provided they are substantially unnoticeable in the unit as a whole. Human-caused hazards, such as the presence of unexploded ordnance from military activity, and the physical impacts of refuge management facilities and activities are also considered in the evaluation of the naturalness criteria. An area may not be considered unnatural in appearance solely on the basis of "sights and sounds" of human impacts and activities outside the boundary of the unit. The cumulative effects of these factors were considered in the evaluation of naturalness for each wilderness inventory unit.

In the wilderness inventory, specific manmade features and other human impacts need to be identified that affect the overall apparent naturalness of the tract. The following factors were primary considerations in evaluating the naturalness of the Refuge:

- Storage container, shed, refuge boundary sign;
- Pumps, earthen dikes, water control structures; and
- Fences, gates, parking lots, and roadways.

Kakahaiʻa NWR is bounded and bisected by State-owned and Refuge-owned roadways maintained for travel by passenger vehicles. This inventory unit contains numerous earthen dikes, ditches, a perimeter roadway, water control structures, and storage sheds. Although the shed and storage container could be moved, the other infrastructure cannot as it is absolutely required to achieve the refuge's purpose. It does not meet the naturalness criteria.

Evaluation of Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation

In addition to meeting the size and naturalness criteria, a WSA must provide outstanding opportunities for solitude or primitive recreation. The area does not have to possess outstanding opportunities for both solitude and primitive and unconfined recreation, and does not need to have outstanding opportunities on every acre. Further, an area does not have to be open to public use and access to qualify under these criteria. Congress has designated a number of wilderness areas in the NWPS that are closed to public access to protect ecological resource values.

Opportunities for solitude refers to the ability of a visitor to be alone and secluded from other visitors in the area. Primitive and unconfined recreation means non-motorized, dispersed outdoor recreation activities that do not require developed facilities or mechanical transport. These primitive recreation activities may provide opportunities to experience challenge and risk, self-reliance, and adventure.

These two opportunity "elements" are not well defined by the Wilderness Act but in most cases can be expected to occur together. However, an outstanding opportunity for solitude may be present in an area offering only limited primitive recreation potential. Conversely, an area may be so attractive for recreation use that experiencing solitude is not an option.

This inventory unit does not offer opportunities for solitude or primitive and unconfined recreation. Recreational and educational activities are only conducted in group settings, and only allowed as staff-guided activities.

Evaluation of Supplemental Values

Supplemental values are defined by the Wilderness Act as "ecological, geological, or other features of scientific, educational, scenic, or historic value." Based upon the findings of the required components for WSA designation, supplemental values were not evaluated.

Findings

Kakahaiʻa NWR does not meet the minimum criteria for consideration as WSA (see Table D.1, next page).

Table D.1 Wilderness Inventory Summary

Wilderness Inventory Summary Kakahai‘a NWR (44.6 acres)	
Required Components	
(1) Has at least 5,000 ac of land or is of sufficient size to make practicable its preservation and use in an unconfined condition, or is a roadless island.	No. Does not contain 5,000 acres, is not a roadless island, and is not practicable to manage as a wilderness.
(2) Generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable.	No. Landscape is highly modified and actively managed.
(3a) Has outstanding opportunities for solitude.	No. Refuge is immediately adjacent to a State highway and residential development.
(3b) Has outstanding opportunities for a primitive and unconfined type of recreation.	No. Recreation is highly regulated and requires staff presence.
Other Components	
(4) Contains ecological, geological or other features of scientific, educational, scenic, or historic value.	Not evaluated.
Summary	
Parcel qualifies as a wilderness study area (meets criteria 1, 2 & 3a or 3b).	No.

Appendix E. Integrated Pest Management Program, Kakahai‘a NWR

1.0 Background

Integrated Pest Management (IPM) is an interdisciplinary approach utilizing methods to prevent, eliminate, contain, and/or control pest species in concert with other management activities on Refuge lands and waters to achieve wildlife and habitat management goals and objectives. The IPM is also a scientifically based, adaptive management process where available scientific information and best professional judgment of the Refuge staff as well as other resource experts would be used to identify and implement appropriate management strategies that can be modified and/or changed over time to ensure effective, site-specific management of pest species to achieve desired outcomes. In accordance with 43 CFR 46.145, adaptive management would be particularly relevant where long-term impacts may be uncertain and future monitoring would be needed to make adjustments in subsequent implementation decisions. After a tolerable pest population (threshold) is determined considering achievement of Refuge resource objectives and the ecology of pest species, one or more methods, or combinations thereof, are selected that are feasible, efficacious, and most protective of nontarget resources, including native species (fish, wildlife, and plants), and Service personnel, Service authorized agents, volunteers, and the public. Staff time and available funding will be considered when determining feasibility/practicality of various treatments.

Our IPM techniques to address pests are presented as CCP strategies prescriptions (see Section 2.0 of this CCP) in an adaptive management context to achieve Refuge resource objectives. In order to satisfy requirements for IPM planning as identified in the Director’s Memo (dated September 9, 2004) entitled *Integrated Pest Management Plans and Pesticide Use Proposals: Updates, Guidance, and an Online Database*, the following elements of an IPM program have been incorporated into this CCP:

- Habitat and/or wildlife objectives that identify pest species and appropriate thresholds to indicate the need for and successful implementation of IPM techniques; and
- Monitoring before and/or after treatment to assess progress toward achieving objectives including pest thresholds.

Where pesticides would be necessary to address pests, this Appendix provides a structured procedure to evaluate potential effects of proposed uses involving ground-based applications to Refuge biological resources and environmental quality. Only pesticide uses that likely would cause minor, temporary, or localized effects to Refuge biological resources and environmental quality with appropriate best management practices (BMPs), where necessary, would be allowed for use on the Refuge.

This Appendix does not describe the more detailed process to evaluate potential effects associated with aerial applications of pesticides. Moreover, it does not address effects of mosquito control with pesticides (larvicides, pupacides, or adulticides) based upon identified human health threats and presence of disease-carrying mosquitoes in sufficient numbers from monitoring conducted on a Refuge. However, the basic framework to assess potential effects to Refuge biological resources and environmental quality from aerial application of pesticides or use of insecticides for mosquito management would be similar to the process described in this Appendix for ground-based treatments of other pesticides.

2.0 Pest Management Laws and Policies

In accordance with 517 DM and 569 FW 1(Integrated Pest Management), plant, invertebrate, and vertebrate pests on units of the National Wildlife Refuge System can be controlled to assure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on Federal (Refuge) lands and waters also is authorized under the following legal mandates:

- National Wildlife Refuge System Administration Act of 1966, as amended (16 USC 668dd-668ee);
- Plant Protection Act of 2000 (7 USC 7701 *et seq*.);
- Noxious Weed Control and Eradication Act of 2004 (7 USC 7781-7786, Subtitle E);
- Federal Insecticide, Fungicide, and Rodenticide Act of 1996 (7 USC 136-136y);
- National Invasive Species Act of 1996 (16 USC 4701);
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 USC 4701);
- Food Quality Protection Act of 1996 (7 USC 136);
- Executive Order 13148, Section 601(a);
- Executive Order 13112; and
- Animal Damage Control Act of 1931 (7 USC 426-426c, 46 Stat. 1468).

Pests are defined as "…living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety" from Department policy 517 DM 1 (Integrated Pest Management Policy). Similarly, 569 FW 1 defines pests as "…invasive plants and introduced or native organisms that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety." 517 DM 1 also defines an invasive species as "a species that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Throughout the remainder of this CCP, the terms pest and invasive species are used interchangeably because both can prevent/impede achievement of Refuge wildlife and habitat objectives and/or degrade environmental quality.

In general, control of pests (vertebrate or invertebrate) on the Refuge would conserve and protect the nation's fish, wildlife, and plant resources as well as maintain environmental quality. From 569 FW 1, animal or plant species, which are considered pests, may be managed if the following criteria are met:

- Threat to human health and well-being or private property, the acceptable level of damage by the pest has been exceeded, or State or local government has designated the pest as noxious;
- Detrimental to resource objectives as specified in a Refuge resource management plan (e.g., comprehensive conservation plan, habitat management plan), if available; and
- Control would not conflict with attainment of resource objectives or the purposes for which the Refuge was established.

The specific justifications for pest management activities on the Refuge are the following:

- Protect human health and well-being;
- Prevent substantial damage to important to Refuge resources;
- Protect newly introduced or re-establish native species;

- Control nonnative (exotic) species in order to support existence for populations of native species;
- Prevent damage to private property; and
- Provide the public with quality, compatible wildlife-dependent recreational opportunities.

In accordance with Service policy 620 FW 1 (Habitat Management Plans), there are additional management directives regarding invasive species found on the Refuge:

- "We are prohibited by Executive Order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere."
- "Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and prevent new and expanded infestations of invasive species. Conduct Refuge habitat management activities to prevent, control, or eradicate invasive species..."

Animal species damaging/destroying Federal property and/or detrimental to the management program of a Refuge may be controlled as described in 50 CFR 31.14 (Official Animal Control Operations)**.**

Trespass and feral animals also may be controlled on Refuge lands. Based upon 50 CFR 28.43 (Destruction of Dogs and Cats), dogs and cats running at large on a national wildlife refuge and observed in the act of killing, injuring, harassing or molesting humans or wildlife may be disposed of in the interest of public safety and protection of the wildlife.

Feral animals should be disposed by the most humane method(s) available and in accordance with relevant Service directives (including Executive Order 11643). Disposed wildlife specimens may be donated or loaned to public institutions. Donation or loans of resident wildlife species will only be made after securing State approval (50 CFR 30.11 [Donation and Loan of Wildlife Specimens]**).** Surplus wildlife specimens may be sold alive or butchered, dressed and processed subject to Federal and State laws and regulations (50 CFR 30.12 [Sale of Wildlife Specimens]**).**

3.0 Strategies

To fully embrace IPM as identified in 569 FW 1, the following strategies, where applicable, would be carefully considered on the Refuge for each pest species:

Prevention. This would be the most effective and least expensive long-term management option for pests. It encompasses methods to prevent new introductions or the spread of the established pests to un-infested areas. It requires identifying potential routes of invasion to reduce the likelihood of infestation. Hazard Analysis and Critical Control Points (HACCP) planning can be used determine if current management activities on a Refuge may introduce and/or spread invasive species in order to identify appropriate BMPs for prevention.

Prevention may include source reduction, using pathogen-free or weed-free seeds or fill; exclusion methods (e.g., barriers) and/or sanitation methods (e.g., wash stations) to prevent re-introductions by various mechanisms including vehicles and personnel. Because invasive species are frequently the first to establish newly disturbed sites, prevention would require a reporting mechanism for early detection of new pest occurrences with quick response to eliminate any new satellite pest populations. Prevention would require consideration of the scale and scope of land

management activities that may promote pest establishment within un-infested areas or promote reproduction and spread of existing populations. Along with preventing initial introduction, prevention would involve halting the spread of existing infestations to new sites (Mullin et al. 2000). The primary reason of prevention would be to keep pest-free lands or waters from becoming infested. Executive Order 11312 emphasizes the priority for prevention with respect to managing pests.

The following would be methods to prevent the introduction and/or spread of pests on Refuge lands:

- Before beginning ground-disturbing activities (e.g., disking, scraping), inventory and prioritize pest infestations in project operating areas and along access routes. Refuge staff would identify pest species on site or within reasonably expected potential invasion vicinity. Where possible, Refuge staff would begin project activities in un-infested areas before working in pest-infested areas.
- Refuge staff would locate and use pest-free project staging areas. They would avoid or minimize travel through pest-infested areas, or restrict to those periods when spread of seed or propagules of invasive plants would be least likely.
- Refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned of pests. Where possible, Refuge staff would clean equipment before entering lands at on-Refuge approved cleaning site(s). This practice does not pertain to vehicles traveling frequently in and out of the project area that will remain on roadways. Seeds and plant parts of pest plants would need to be collected, where practical. Refuge staff would remove mud, dirt, and plant parts from project equipment before moving it into a project area.
- Refuge staff would clean all equipment, before leaving the project site, if operating in areas infested with pests. Refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned.
- Refuge staffs, their authorized agents, and Refuge volunteers would, where possible, inspect, remove, and properly dispose of seed and parts of invasive plants found on their clothing and equipment. Proper disposal means bagging the seeds and plant parts and then properly discarding of them (e.g., incinerating).
- Refuge staff would evaluate options, including closure, to restrict the traffic on sites with on-going restoration of desired vegetation. Refuge staff would revegetate disturbed soil (except travel ways on surfaced projects) to optimize plant establishment for each specific site. Revegetation may include topsoil replacement, planting, seeding, fertilization, liming, and weed-free mulching as necessary. Refuge staff would use native material, where appropriate and feasible. Refuge staff would use certified weed-free or weed-seed-free hay or straw where certified materials are reasonably available.
- Refuge staff would provide information, training and appropriate pest identification materials to Refuge staffs, permit holders, and recreational visitors. Refuge staff would educate them about pest identification, biology, impacts, and effective prevention measures.
- Refuge staff would inspect borrow material for invasive plants prior to use and transport onto and/or within Refuge lands.
- Refuge staff would consider invasive plants in planning for road maintenance activities.
- Refuge staff would restrict off road travel to designated routes.

The following would be methods to prevent the introduction and/or spread of pests into Refuge waters:

- Refuge staff would inspect boats (including air boats), trailers, and other boating equipment and, where possible, remove any visible plants, animals, or mud before leaving any waters or boat launching facilities. Where possible, staff would drain water from motor, live well, bilge, and transom wells while on land before leaving the site.

If possible, Refuge staff would wash and dry boats, downriggers, anchors, nets, floors of boats, propellers, axles, trailers, and other boating equipment to kill pests not visible at the boat launch. These prevention methods to minimize/eliminate the introduction and/or spread of pests were taken verbatim or slightly modified from Appendix E of US Forest Service (2005).

- **Mechanical/Physical Methods.** These methods would remove and destroy, disrupt the growth of, or interfere with the reproduction of pest species. For plants species, these treatments can be accomplished by hand, hand tool (manual), or power tools (mechanical) and include pulling, grubbing, digging, tilling/disking, cutting, swathing, grinding, sheering, girdling, mowing, and mulching of the pest plants.

  For animal species, Service employees or their authorized agents could use mechanical/physical methods (including trapping) to control pests as a refuge management activity. Based upon 50 CFR 31.2, trapping can be used on a refuge to reduce surplus wildlife populations for a "balanced conservation program" in accordance with Federal or State laws and regulations. In some cases, nonlethally trapped animals would be relocated to off-refuge sites with prior approval from the State.

  Each of these tools would be efficacious to some degree and applicable to specific situations. In general, mechanical controls can effectively control annual and biennial pest plants. However, to control perennial plants, the root system has to be destroyed or it would resprout and continue to grow and develop. Mechanical controls are typically not capable of destroying a perennial plants root system. Although some mechanical tools (e.g., disking, plowing) may damage root systems, they may stimulate regrowth producing a denser plant population that may aid in the spread depending upon the target species. In addition, steep terrain and soil conditions would be major factors that can limit the use of many mechanical control methods.

  Some mechanical control methods (e.g., mowing), which would be used in combination with herbicides, can be a very effective technique to control perennial species. For example, mowing perennial plants followed sequentially by treating the plant regrowth with a systemic herbicide often would improve the efficacy of the herbicide compared to herbicide treatment only.

- **Cultural Methods.** These methods would involve manipulating habitat to increase pest mortality by reducing its suitability to the pest. Cultural methods would include water-level manipulation, , prescribed burning (facilitate revegetation, increase herbicide efficacy, and remove litter to assist in emergence of desirable species), planting or seeding desirable species to shade or out-compete invasive plants, applying fertilizer to enhance desirable vegetation, irrigation, and other habitat alterations.

- **Biological Control Agents.** Classical biological control would involve the deliberate introduction and management of natural enemies (parasites, predators, or pathogens) to reduce

pest populations. Many of the most ecologically or economically damaging pest species in the United States originated in foreign countries. These newly introduced pests, which are free from natural enemies found in their country or region of origin, may have a competitive advantage over cultivated and native species. This competitive advantage often allows introduced species to flourish, and they may cause widespread economic damage to crops or out compete and displace native vegetation. Once the introduced pest species population reaches a certain level, traditional methods of pest management may be cost prohibitive or impractical. Biological controls typically are used when these pest populations have become so widespread that eradication or effective control would be difficult or no longer practical.

Biological control has advantages as well as disadvantages. Benefits would include reducing pesticide usage, host specificity for target pests, long-term self-perpetuating control, low cost/acre, capacity for searching and locating hosts, synchronizing biological control agents to hosts' life cycles, and the unlikelihood that hosts will develop resistance to agents. Disadvantages would include the following: limited availability of agents from their native lands, the dependence of control on target species density, slow rate at which control occurs, biotype matching, the difficulty and expense of conflicts over control of the target pest, and host specificity when host populations are low.

A reduction in target species populations from biological controls is typically a slow process, and efficacy can be highly variable. It may not work well in a particular area although it does work well in other areas. Biological control agents would require specific environmental conditions to survive over time. Some of these conditions are understood; whereas, others are only partially understood or not at all.

Biological control agents would not eradicate a target pest. When using biological control agents, residual levels of the target pest typically are expected; the agent population level or survival would be dependent upon the density of its host. After the pest population decreases, the population of the biological control agent would decrease correspondingly. This is a natural cycle. Some pest populations (e.g., invasive plants) would tend to persist for several years after a biological control agent becomes established due to seed reserves in the soil, inefficiencies in the agents search behavior, and the natural lag in population buildup of the agent.

The full range of pest groups potentially found on refuge lands and waters would include diseases, invertebrates (insects, mollusks), vertebrates and invasive plants (most common group). Often it is assumed that biological control would address many if not most of these pest problems. Introduced species without desirable close relatives in the United States would generally be selected as biological controls. Natural enemies that are restricted to one or a few closely related plants in their country of origin are targeted as biological controls (Center et al. 1997, Hasan and Ayres 1990).

The Hawaiʻi Department of Agriculture (HDOA) has a highly successful bio-control program for the erythrina gall wasp which has resulted in the rebounding of the native wiliwili trees. In June 2010, HDOA began another biological control program that releases a tiny parasitic insect to control the stinging Nettle Caterpillar. The release of Brazilian scale to slow the growth rate and spread of strawberry guava has recently been proposed to give Hawaiʻi's native plants a chance for survival, protect the ability of the forests to provide water, and provide better protection for agricultural crops from the fruit flies that breed in the overabundance of strawberry guava fruit.

Due to the success of Hawaiʻi's biocontrol programs, the State has become a leader in the world on the use of biological control to fight invasive pests.

Refuge staff would ensure introduced agents are approved by the applicable authorities. Except for a small number of formulated biological control products registered by EPA under FIFRA, most biological control agents are regulated by the U.S. Department of Agriculture (USDA)-Animal Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ). State departments of agriculture and, in some cases, county agricultural commissioners or weed districts, have additional approval authority.

Federal permits (USDA-APHIS-PPQ Form 526) are required to import biocontrol agents from another State. Form 526 may be obtained by writing:

USDA-APHIS-PPQ
Biological Assessment and Taxonomic Support
4700 River Road, Unit 113
Riverdale, MD 20737

or

through the internet at URL address:
http://www.aphis.usda.gov/ppq/permits/bioligical/weedbio.html.

The Service strongly supports the development, and legal and responsible use of appropriate, safe, and effective biological control agents for nuisance and nonindigenous or pest species.

State and county agriculture departments may also be sources for biological control agents or they may have information about where biological control agents may be obtained. Commercial sources should have an Application and Permit to Move Live Plant Pests and Noxious Weeds (USDA-PPQ Form 226 USDA-APHIS-PPQ, Biological Assessment and Taxonomic Support, 4700 River Road, Unit 113, Riverdale, MD 20737) to release specific biological control agents in a State and/or county. Furthermore, certification regarding the biological control agent's identity (genus, specific epithet, sub-species and variety) and purity (e.g., parasite free, pathogen free, and biotic and abiotic contaminants) should be specified in purchase orders.

Biological control agents are subject to 569 FW 1. In addition, Refuge staff would follow the International Code of Best Practice for Classical Biological Control of Weeds (http://sric.ucdavis.edu/exotic /exotic.htm) as ratified by delegates to the X International Symposium on Biological Control of Weeds, Bozeman, MT, July 9, 1999. This code identifies the following:

- Release only approved biological control agents,
- Use the most effective agents,
- Document releases, and
- Monitor for impact to the target pest, nontarget species and the environment.

Biological control agents formulated as pesticide products and registered by the EPA (e.g., *Bti*) are also subject to PUP review and approval (see below).

A record of all releases would be maintained with date(s), location(s), and environmental conditions of the release site(s); the identity, quantity, and condition of the biological control

agents released; and other relevant data and comments such as weather conditions. Systematic monitoring to determine the establishment and effectiveness of the release is also recommended.

NEPA documents regarding biological and other environmental effects of biological control agents prepared by another Federal agency, where the scope is relevant to evaluation of releases on Refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management (BLM), U.S. Forest Service, National Park Service, U.S. Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s) from the review. Incorporating by reference (43 CFR 46.135) is a technique used to avoid redundancies in analysis. It also can reduce the bulk of a Service NEPA document, which only must identify the documents that are incorporated by reference. In addition, relevant portions must be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

- **Pesticides.** The selective use of pesticides would be based upon pest ecology (including mode of reproduction), the size and distribution of its populations, site-specific conditions (e.g., soils, topography), known efficacy under similar site conditions, and the capability to utilize BMPs to reduce/eliminate potential effects to nontarget species, sensitive habitats, and potential to contaminate surface and groundwater. All pesticide usage (pesticide, target species, application rate, and method of application) would comply with the applicable Federal (FIFRA) and State regulations pertaining to pesticide use, safety, storage, disposal, and reporting. Before pesticides can be used to eradicate, control, or contain pests on Refuge lands and waters, pesticide use proposals (PUPs) would be prepared and approved in accordance with 569 FW 1. PUP records would provide a detailed, time-, site-, and target-specific description of the proposed use of pesticides on Refuge. All PUPs would be created, approved or disapproved, and stored in the Pesticide Use Proposal System (PUPS), which is a centralized database only accessible on the Service’s intranet (https://systems.fws.gov/pups). Only Service employees would be authorized to access PUP records for a Refuge in this database.

  Application equipment would be selected to provide site-specific delivery to target pests while minimizing/eliminating direct or indirect (e.g., drift) exposure to nontarget areas and degradation of surface and groundwater quality. Where possible, target-specific equipment (e.g., backpack sprayer, wiper) would be used to treat target pests. Other target-specific equipment to apply pesticides would include soaked wicks or paint brushes for wiping vegetation and lances, hatchets, or syringes for direct injection into stems. Granular pesticides may be applied using seeders or other specialized dispensers. In contrast, aerial spraying (e.g., fixed wing or helicopter) would only be used where access is difficult (remoteness) and/or the size/distribution of infestations precludes practical use of ground-based methods.

  Because repeated use of one pesticide may allow resistant organisms to survive and reproduce, multiple pesticides with variable modes of action would be considered for treatments on Refuge lands and waters. This is especially important if multiple applications within years and/or over a growing season likely would be necessary for habitat maintenance and restoration activities to achieve resource objectives. Integrated chemical and nonchemical controls also are highly effective, where practical, because pesticide resistant organisms can be removed from the site.

Cost may not be the primary factor in selecting a pesticide for use on the Refuge. If the least expensive pesticide would potentially harm natural resources or people, then a different product would be selected, if available. The most efficacious pesticide available with the least potential to degrade environment quality (soils, surface water, and groundwater) as well as least potential effect to native species and communities of fish, wildlife, plants, and their habitats would be acceptable for use on Refuge lands in the context of an IPM approach.

- **Habitat restoration/maintenance.** Restoration and/or proper maintenance of Refuge habitats associated with achieving wildlife and habitat objectives would be essential for long-term prevention, eradication, or control (at or below threshold levels) of pests. Promoting desirable plant communities through the manipulation of species composition, plant density, and growth rate is an essential component of invasive plant management (Masters et al. 1996, Masters and Shelly 2001, Brooks et al. 2004). The following three components of succession could be manipulated through habitat maintenance and restoration: site availability, species availability, and species performance (Cox and Anderson 2004). Although a single method (e.g., herbicide treatment) may eliminate or suppress pest species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the species and/or other invasive plants. On degraded sites where desirable species are absent or in low abundance, revegetation with native/desirable grasses, forbs, and legumes may be necessary to direct and accelerate plant community recovery, and achieve site-specific objectives in a reasonable time frame. The selection of appropriate species for revegetation would be dependent on a number of factors including resource objectives and site-specific, abiotic factors (e.g., soil texture, precipitation/temperature regimes, and shade conditions). Seed availability and cost, ease of establishment, seed production, and competitive ability also would be important considerations.

- **Predator Control.** The predator management plan for Kakahaiʻa NWR is implemented to reduce depredation of endangered waterbirds. Control measures would include indirect, non-lethal and lethal techniques in addition to prevention and direct control measures that would have minimal effects on the human environment.

  Indirect Measures at Kakahaiʻa NWR will include installation of a perimeter predator proof fence (Alternative C). In the absence of this fence, dense vegetation will remain to discourage visitors from disturbing endangered waterbirds and nesting areas will be temporarily closed to access. Cattle egret roost trees will be mechanically removed or treated with herbicides.

  Most cats and dogs will be removed by cage traps and transported to an animal shelter. Other predators (mongooses, rats) would be controlled by cage traps or humane lethal means. Control measures will minimize loss of non-target native wildlife. Except for nuisance alien species, all uninjured non-target species captured will be released near the site of capture or at a suitable location at the discretion of Refuge staff.

  Most of Kakahaiʻa NWR is closed to the public and posted. In public access areas (Kakahaiʻa Beach Park), rodenticides would be placed in tamper-resistant bait boxes and the area signed. Egret control by firearms will occur when the Refuge is closed to the public.

  Direct Measures include a range of predator management equipment and methods . The preferred control method will be cage traps for dogs and cats. Mongooses and rodents will be controlled by a combination of cage traps, lethal traps, and rodenticides. Direct control of cattle

egrets would be with firearms. In rare instances, a Timms™ kill trap (a type of snap trap) or padded leghold trap would be used on cats that avoid cage traps. All cage traps will be checked every 48 hours or less. Trapping will occur seasonally just prior to the aeʻo nesting season through the end of the breeding/chick rearing period (April-September). Spot trapping may occur when signs of depredation of endangered species are observed outside the nesting season. Predator monitoring will occur throughout the year by direct observations, tracks, tracking tunnels, and trail cameras. Cage trapped dogs and cats will be transported to a local animal shelter. Any cage trapped birds will be released at the trap site. Live trapped mongooses will the euthanized using approved humane methods.

4.0 Priorities for Treatments

The magnitude (number, distribution, and sizes of infestations) for pest problems is too extensive and beyond the available capital resources to effectively address during any single field season. To manage pests in Refuge, it would be essential to prioritize treatment of infestations. Highest priority treatments would be focused on early detection and rapid response to eliminate infestations of new pests, if possible. This would be especially important for aggressive pests potentially impacting species, species groups, communities, and/or habitats associated Refuge purpose(s), System resources of concern (federally listed species, migratory birds, selected marine mammals, and interjurisdictional fish), and native species for maintaining/restoring biological integrity, diversity, and environmental health.

The next priority would be treating established pests that appear in one or more previously uninfested areas. Moody and Mack (1988) demonstrated through modeling that small, new outbreaks of invasive plants eventually would infest an area larger than the established, source population. They also found that control efforts focusing on the large, main infestation rather than the new, small satellites reduced the chances of overall success. The lowest priority would be treating large infestations (sometimes monotypic stands) of well-established pests. In this case, initial efforts would focus upon containment of the perimeter followed by work to control/eradicate the established infested area. If containment and/or control of a large infestation is not effective, then efforts would focus upon halting pest reproduction or managing source populations. Maxwell et al. (2009) found treating fewer populations that are sources represents an effective long-term strategy to reduce of total number of invasive populations and decreasing meta-population growth rates.

Although State listed noxious weeds would always of high priority for management, other pest species known to cause substantial ecological impact would also be considered. For example, short-spined kiawe may not be listed by a State as noxious, but it can greatly alter fire regimes in the coastal dryland shrub habitat resulting in large monotypic stands that displace native bunch grasses, forbs, and shrubs. Pest control would likely require a multi-year commitment from Refuge staff. Essential to the long-term success of pest management would be pre- and post-treatment monitoring, assessment of the successes and failures of treatments, and development of new approaches when proposed methods do not achieve desired outcomes.

5.0 Best Management Practices

Best Management Practices (BMPs) can minimize or eliminate possible effects associated with pesticide usage to nontarget species and/or sensitive habitats as well as degradation of water quality from drift, surface runoff, or leaching. Based upon the Department of the Interior Pesticide Use

Policy (517 DM 1) and the Service Pest Management Policy and Responsibilities (30 AM 12), the use of applicable BMPs (where feasible) also would likely ensure that pesticide uses may not adversely affect federally listed species and/or their critical habitats through determinations made using the process described in 50 CFR part 402.

The following are BMPs pertaining to mixing/handling and applying pesticides for all ground-based treatments of pesticides, which would be considered and utilized, where feasible, based upon target- and site-specific factors and time-specific environmental conditions. Although not listed below, the most important BMP to eliminate/reduce potential impacts to nontarget resources would be an IPM approach to prevent, control, eradicate, and contain pests.

5.1 Pesticide Handling and Mixing

- As a precaution against spilling, spray tanks would not be left unattended during filling.
- All pesticide containers would be triple rinsed and the rinsate would be used as water in the sprayer tank and applied to treatment areas.
- All pesticide spray equipment would be properly cleaned. Where possible, rinsate would be used as part of the make-up water in the sprayer tank and applied to treatment areas.
- Refuge staff would empty, triple rinsed pesticide containers that can be recycled at local herbicide container collections.
- All unused pesticides would be properly discarded at a local "safe send" collection.
- Pesticides and pesticide containers would be lawfully stored, handled, and disposed of in accordance with the label and in a manner safeguarding human health, fish, and wildlife and prevent soil and water contaminanation.
- Refuge staff would consider the water quality parameters (e.g., pH, hardness) that are important to ensure greatest efficacy where specified on the pesticide label.
- All pesticide spills would be addressed immediately using procedures identified in Refuge spill respond plan.

5.2 Applying Pesticides

- Pesticide treatments would only be conducted by or under the supervision of Service personnel and non-Service applicators with the appropriate, State or BLM certification to safely and effectively conduct these activities on Refuge lands and waters.
- Refuge staff would comply with all Federal, State, and local pesticide use laws and regulations as well as Service pesticide-related policies. For example, Refuge staff would use application equipment and apply rates for the specific pest(s) identified on the pesticide label as required under FIFRA.
- Before each treatment season and prior to mixing or applying any product for the first time each season, all applicators would review the labels, MSDSs, and Pesticide Use Proposal (PUPs) for each pesticide, determining the target pest, appropriate mix rate(s), PPE, and other requirements listed on the pesticide label.
- A 1' no-spray buffer from the water's edge would be used, where applicable, and it does not detrimentally influence effective control of pest species.
- Use low impact herbicide application techniques (e.g., spot treatment, cut stump, oil basal, Thinvert system applications) rather than broadcast foliar applications (e.g., boom sprayer, other larger tank wand applications), where practical.
- Use low volume rather than high volume foliar applications where low impact methods above are not feasible or practical, to maximize herbicide effectiveness and ensure correct and uniform application rates.

- Applicators would use and adjust spray equipment to apply the coarsest droplet size spectrum with optimal coverage of the target species while reducing drift.
- Applicators would use the largest droplet size that results in uniform coverage.
- Applicators would use drift reduction technologies such as low-drift nozzles, where possible.
- Where possible, spraying would occur during low (average<7mph and preferably 3-5 mph) and consistent direction wind conditions with moderate temperatures (typically <85 ^{o}F).
- Where possible, applicators would avoid spraying during inversion conditions (often associated with calm and very low wind conditions) that can cause large-scale herbicide drift to nontarget areas.
- Equipment would be calibrated regularly to ensure that the proper rate of pesticide is applied to the target area or species.
- Spray applications would be made at the lowest height for uniform coverage of target pests to minimize/eliminate potential drift.
- If windy conditions frequently occur during afternoons, spraying (especially boom treatments) would typically be conducted during early morning hours.
- Spray applications would not be conducted on days with >30% forecast for rain within 6 hours, except for pesticides that are rapidly rain fast (e.g., glyphosate in 1 hour) to minimize/eliminate potential runoff.
- Where possible, applicators would use drift retardant adjuvants during spray applications, especially adjacent to sensitive areas.
- Where possible, applicators would use a nontoxic dye to aid in identifying target area treated as well as potential over spray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, the application would be stopped until repairs can be made to the sprayer.
- For pesticide uses associated with facilities management, buffers, as appropriate, would be used to protect sensitive habitats, especially wetlands and other aquatic habitats.
- When drift cannot be sufficiently reduced through altering equipment set up and application techniques, buffer zones may be identified to protect sensitive areas downwind of applications. Refuge staff would only apply adjacent to sensitive areas when the wind is blowing the opposite direction.
- Applicators would utilize scouting for early detection of pests to eliminate unnecessary pesticide applications.
- Refuge staff would consider timing of application so native plants are protected (e.g., senescence) while effectively treating invasive plants.
- Rinsate from cleaning spray equipment after application would be recaptured and reused or applied to an appropriate pest plant infestation.
- Application equipment (e.g., sprayer, ATV, tractor) would be thoroughly cleaned and PPE would be removed/disposed of on-site by applicators after treatments to eliminate the potential spread of pests to un-infested areas.

6.0 Safety

6.1 Personal Protective Equipment

All applicators would wear the specific personal protective equipment (PPE) identified on the pesticide label. The appropriate PPE will be worn at all times during handling, mixing, and applying. PPE can include the following: disposable (e.g., Tyvek) or laundered coveralls; gloves (latex, rubber, or nitrile); rubber boots; and/or an NIOSH-approved respirator. Because exposure to concentrated product is usually greatest during mixing, extra care should be taken while preparing

pesticide solutions. Persons mixing these solutions can be best protected if they wear long gloves, an apron, footwear, and a face shield.

Coveralls and other protective clothing used during an application would be laundered separately from other laundry items. Transporting, storing, handling, mixing and disposing of pesticide containers will be consistent with label requirements, EPA and OSHA requirements, and Service policy.

If a respirator is necessary for a pesticide use, then the following requirements would be met in accordance with Service safety policy: a written Respirator Program, fit testing, physical examination (including pulmonary function and blood work for contaminants), and proper storage of the respirator.

6.2 Notification

The restricted entry interval (REI) is the time period required after the application at which point someone may safely enter a treated area without PPE. Refuge staff, authorized management agents of the Service, volunteers, and members of the public who could be in or near a pesticide treated area within the stated re-entry time period on the label would be notified about treatment areas. Posting would occur at any site where individuals might inadvertently become exposed to a pesticide during other activities on the Refuge. Where required by the label and/or State-specific regulations, sites would also be posted on its perimeter and at other likely locations of entry. Refuge staff would also notify appropriate private property owners of an intended application, including any private individuals have requested notification. Special efforts would be made to contact nearby individuals who are beekeepers or who have expressed chemical sensitivities.

6.3 Medical Surveillance

Medical surveillance may be required for Service personnel and approved volunteers who mix, apply, and/or monitor use of pesticides (see 242 FW 7 [Pesticide Users] and 242 FW 4 [Medical Surveillance]). In accordance with 242 FW 7.12A, Service personnel would be medically monitoring if 1 or more of the following criteria is met: exposed or may be exposed to concentrations at or above the published permissible exposure limits or threshold limit values (see 242 FW 4); use pesticides in a manner considered "frequent pesticide use"; or use pesticides in a manner that requires a respirator (see 242 FW 14 for respirator use requirements). In 242 FW7.7A, **"Frequent Pesticide Use"** means when a person applying pesticide handles, mixes, or applies pesticides, with a Health Hazard rating of 3 or higher, for 8 or more hours in any week or 16 or more hours in any 30-day period." Under some circumstances, individuals may be medically monitored who use pesticides infrequently (see section 7.7), experience an acute exposure (sudden, short term), or use pesticides with a health hazard ranking of 1 or 2. This decision would consider the individual's health and fitness level, the pesticide's specific health risks, and the potential risks from other pesticide-related activities. Refuge cooperators and other authorized agents (e.g., State and County employees) would be responsible for their own medical monitoring needs and costs.

Standard examinations (at Refuge expense) of appropriate Refuge staff would be provided by the nearest certified occupational health and safety physician as determined by Federal Occupational Health.

6.4 Certification and Supervision of Pesticide Applicators

Appropriate Refuge staff or approved volunteers handling, mixing, and/or applying or directly

supervising others engaged in pesticide use activities would be trained and State or federally licensed to apply pesticides to Refuge lands or waters. In accordance with 242 FW7.18A and 569 FW 1, certification is required to apply restricted use pesticides based upon EPA regulations. For safety reasons, all individuals participating in pest management activities with general use pesticides also are encouraged to attend appropriate training or acquire pesticide applicator certification. The certification requirement would be for a commercial or private applicator depending upon the State. New staff unfamiliar with proper procedures for storing, mixing, handling, applying, and disposing of herbicides and containers would receive orientation and training before handling or using any products. Documentation of training would be kept in the files at the Refuge office.

6.5 Record Keeping

6.5.1 Labels and material safety data sheets

Pesticide labels and material safety data sheets (MSDSs) would be maintained at the Refuge shop and laminated copies in the mixing area. These documents also would be carried by field applicators, where possible. A written reference (e.g., note pad, chalk board, dry erase board) for each tank to be mixed would be kept in the mixing area for quick reference while mixing is in progress. In addition, approved PUPs stored in the PUPS database typically contain website links (URLs) to pesticide labels and MSDSs.

6.5.2 Pesticide use proposals (PUPs)

A PUP would be prepared for each proposed pesticide use associated with annual pest management on Refuge lands and waters. A PUP would include specific information about the proposed pesticide use including the common and chemical names of the pesticide(s), target pest species, size and location of treatment site(s), application rate(s) and method(s), and federally listed species determinations, where applicable.

In accordance with 30 AM 12 and 7 RM 14, PUPs would be required for the following:

- Uses of pesticides on lands and facilities owned or managed by the Service, including properties managed by Service personnel as a result of the Food Security Act of 1985;
- Service projects by non-Service personnel on Service owned or controlled lands and facilities and other pest management activities that would be conducted by Service personnel; and
- Where the Service would be responsible or provides funds for pest management identified in protective covenants, easements, contracts, or agreements off Service lands.

In accordance with Service guidelines (Director’s memo [December 12, 2007]), Refuge staff may receive up to 5-year approvals for Washington Office and field reviewed proposed pesticide uses based upon meeting identified criteria including an approved IPM plan, where necessary (see http://www.fws.gov/contaminants/Issues/IPM.cfm). For a refuge, an IPM plan (requirements described herein) can be completed independently or in association with a CCP or HMP if IPM strategies and potential environmental effects are adequately addressed within appropriate NEPA documentation.

PUPs would be created, approved or disapproved, and stored as records in the Pesticide Use Proposal System (PUPS), which is centralized database on the Service’s intranet (https://systems.fws.gov/pups). Only Service employees can access PUP records in this database.

6.5.3 Pesticide usage

In accordance with 569 FW 1, the Refuge Project Leader would be required to maintain records of all pesticides annually applied on lands or waters under Refuge jurisdiction. This would encompass pesticides applied by other Federal agencies, State and county governments, nongovernment applicators including cooperators and their pest management service providers with Service permission. For clarification, pesticide means all insecticides, insect and plant growth regulators, dessicants, herbicides, fungicides, rodenticides, acaricides, nematicides, fumigants, avicides, and piscicides.

The following usage information can be reported for approved PUPs in the PUPS database:

- Pesticide trade name(s)
- Active ingredient(s)
- Total acres treated
- Total amount of pesticides used (lbs or gallons)
- Total amount of active ingredient(s) used (lbs)
- Target pest(s)
- Efficacy (% control)

To determine whether treatments are efficacious (eradicating, controlling, or containing the target pest) and achieving resource objectives, habitat and/or wildlife response would be monitored both pre- and post-treatment, where possible. Considering available annual funding and staffing, appropriate monitoring data regarding characteristics (attributes) of pest infestations (e.g., area, perimeter, degree of infestation-density, % cover, density) as well as habitat and/or wildlife response to treatments may be collected and stored in a relational database (e.g., Refuge Habitat Management Database), preferably a geo-referenced data management system (e.g., Refuge Lands GIS [RLGIS]) to facilitate data analyses and subsequent reporting. In accordance with adaptive management, data analysis and interpretation would allow treatments to be modified or changed over time, as necessary, to achieve resource objectives considering site-specific conditions in conjunction with habitat and/or wildlife responses. Monitoring could also identify short- and long-term impacts to natural resources and environmental quality associated with IPM treatments in accordance with adaptive management principles identified in 43 CFR 46.145.

7.0 Evaluating Pesticide Use Proposals

Pesticides would only be used on Refuge lands for habitat management as well as facilities maintenance after approval of a PUP. In general, proposed pesticide uses on Refuge lands would only be approved where there would likely be minor, temporary, or localized effects to fish and wildlife species as well as minimal potential to degrade environmental quality. Potential effects to listed and nonlisted species would be evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality would be based upon pesticide characteristics of environmental fate (water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments as well as characteristics of environmental fate and potential to degrade environmental quality for pesticides would be documented in Chemical Profiles (see Section 7.5). These profiles would include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality. In general, only pesticide uses with appropriate BMPs (see Section 4.0) for habitat management and facilities

maintenance on Refuge lands that would potentially have minor, temporary, or localized effects on Refuge biological and environmental quality (threshold values not exceeded) would be approved.

7.1 Overview of Ecological Risk Assessment

An ecological risk assessment process would be used to evaluate potential adverse effects to biological resources as a result of a pesticide(s) proposed for use on Refuge lands. It is an established quantitative and qualitative methodology for comparing and prioritizing risks of pesticides and conveying an estimate of the potential risk for an adverse effect. This quantitative methodology provides an efficient mechanism to integrate best available scientific information regarding hazard, patterns of use (exposure), and dose-response relationships in a manner that is useful for ecological risk decision-making. It would provide an effective way to evaluate potential effects where there is missing or unavailable scientific information (data gaps) to address reasonable, foreseeable adverse effects in the field as required under 40 CFR Part 1502.22. Protocols for ecological risk assessment of pesticide uses on the Refuge were developed through research and established by the US Environmental Protection Agency (EPA). Assumptions for these risk assessments are presented in Section 6.2.3.

The toxicological data used in ecological risk assessments are typically results of standardized laboratory studies provided by pesticide registrants to the EPA to meet regulatory requirements under the Federal Insecticide, Fungicide and Rodenticide Act of 1996 (FIFRA). These studies assess the acute (lethality) and chronic (reproductive) effects associated with short- and long-term exposure to pesticides on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. Other effects data publicly available would also be utilized for risk assessment protocols described herein. Toxicity endpoint and environmental fate data are available from a variety of resources (Section 7.6).

Table E.1. Ecotoxicity tests used to evaluate potential effects to birds, fish, and mammals to establish toxicity endpoints for risk quotient calculations.

Species Group	Exposure	Measurement endpoint
Bird	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[1]
Fish	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[2]
Mammal	Acute	Oral Lethal Dose (LD_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[3]

[1]Measurement endpoints typically include a variety of reproductive parameters (e.g., number of eggs, number of offspring, eggshell thickness, and number of cracked eggs).
[2]Measurement endpoints for early life stage/life cycle typically include embryo hatch rates, time to hatch, growth, and time to swim-up.
[3]Measurement endpoints include maternal toxicity, teratogenic effects or developmental anomalies, evidence of mutagenicity or genotoxicity, and interference with cellular mechanisms such as DNA synthesis and DNA repair.

7.2 Determining Ecological Risk to Fish and Wildlife

The potential for pesticides used on the Refuge to cause direct adverse effects to fish and wildlife would be evaluated using EPA's Ecological Risk Assessment Process (EPA 2004). This deterministic approach, which is based upon a two-phase process involving estimation of environmental concentrations and then characterization of risk, would be used for ecological risk assessments. This method integrates exposure estimates (estimated environmental concentration [EEC] and toxicological endpoints [e.g., LC_{50} and oral LD_{50}]) to evaluate the potential for adverse effects to species groups (birds, mammals, and fish) representative of legal mandates for managing units of the NWRS. This integration is achieved through risk quotients (RQs) calculated by dividing the EEC by acute and chronic toxicity values selected from standardized toxicological endpoints or published effect (Table 1).

$$RQ = EEC/Toxicological\ Endpoint$$

The level of risk associated with direct effects of pesticide use would be characterized by comparing calculated RQs to the appropriate Level of Concern (LOC) established by EPA (1998 [Table 2]). The LOC represents a quantitative threshold value for screening potential adverse effects to fish and wildlife resources associated with pesticide use. The following are four exposure-species group scenarios that would be used to characterize ecological risk to fish and wildlife on the Refuge: acute-listed species, acute-nonlisted species, chronic-listed species, and chronic-nonlisted species.

Acute risk would indicate the potential for mortality associated with short-term dietary exposure to pesticides immediately after an application. For characterization of acute risks, median values from LC_{50} and LD_{50} tests would be used as toxicological endpoints for RQ calculations. In contrast, chronic risks would indicate the potential for adverse effects associated with long-term dietary exposure to pesticides from a single application or multiple applications over time (within a season and over years). For characterization of chronic risks, the no observed concentration (NOAEC) or no observed effect concentration (NOEC) for reproduction would be used as toxicological endpoints for RQ calculations. Where available, the NOAEC would be preferred over a NOEC value.

Listed species are those federally designated as threatened, endangered, or proposed in accordance with the Endangered Species Act of 1973 (16 USC 1531-1544, 87 Stat. 884, as amended-Public Law 93-205). For listed species, potential adverse effects would be assessed at the individual level because loss of individuals from a population could detrimentally impact a species. In contrast, risks to nonlisted species would consider effects at the population level. A RQ<LOC would indicate the proposed pesticide use "may affect, not likely to adversely effect" individuals (listed species) and it would not pose an unacceptable risk for adverse effects to populations (nonlisted species) for each taxonomic group (Table E.2). In contrast, a RQ>LOC would indicate a "may affect, likely to adversely affect" for listed species and it would also pose unacceptable ecological risk for adverse effects to nonlisted species.

Table E.2. Presumption of unacceptable risk for birds, fish, and mammals (US EPA 1998).

Risk Presumption		Level of Concern	
		Listed Species	Nonlisted Species
Acute	Birds	0.1	0.5
	Fish	0.05	0.5
	Mammals	0.1	0.5
Chronic	Birds	1.0	1.0
	Fish	1.0	1.0
	Mammals	1.0	1.0

7.2.1 Environmental exposure

Following release into the environment through application, pesticides would experience several different routes of environmental fate. Pesticides which would be sprayed can move through the air (e.g., particle or vapor drift) and may eventually end up in other parts of the environment such as nontarget vegetation, soil, or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water (e.g., surface runoff) or may percolate through the soil to lower soil layers and groundwater (e.g., leaching) (Baker and Miller 1999, Pope et. al. 1999, Butler et. al. 1998, Ramsay et. al. 1995, EXTOXNET 1993*a*). Pesticides which would be injected into the soil may also be subject to the latter two fates. The aforementioned possibilities are by no means complete, but it does indicate movement of pesticides in the environment is very complex with transfers occurring continually among different environmental compartments. In some cases, these exchanges occur not only between areas that are close together, but it also may involve transportation of pesticides over long distances (Barry 2004, Woods 2004).

7.2.1.1 Terrestrial exposure

The estimated environmental concentration (ECC) for exposure to terrestrial wildlife would be quantified using an EPA screening-level approach (EPA 2004). This screening-level approach is not affected by product formulation because it evaluates pesticide active ingredient(s). This approach would vary depending upon the proposed pesticide application method: spray or granular.

7.2.1.1.1 Terrestrial-spray application

For spray applications, exposure would be determined using the Kanaga nomogram method (EPA 2005*a*, EPA 2004, Pfleeger et al. 1996) through the EPA's Terrestrial Residue Exposure model (T-REX) version 1.2.3 (EPA 2005*b*). To estimate the maximum (initial) pesticide residue on short grass (<8"m tall) as a general food item category for terrestrial vertebrate species, T-REX input variables would include the following from the pesticide label: maximum pesticide application rate (pounds active ingredient [acid equivalent]/acre) and pesticide half-life (days) in soil. Although there are other food item categories (tall grasses; broadleaf plants and small insects; and fruits, pods, seeds and large insects), short grass was selected because it would yield maximum EECs (240 ppm per lb ai/acre) for worse-case risk assessments. Short grass is not representative of forage for carnivorous species (e.g., raptors), but it would characterize the maximum potential exposure through the diet of avian and mammalian prey items. Consequently, this approach would provide a conservative screening tool for pesticides that do not biomagnify.

For RQ calculations in T-REX, the model would require the weight of surrogate species and Mineau scaling factors (Mineau et. al. 1996). Body weights of bobwhite quail and mallard are included in T-REX by default, but body weights of other organisms (Table e.3) would be entered manually. The

Mineau scaling factor accounts for small-bodied bird species that may be more sensitive to pesticide exposure than would be predicted only by body weight. Mineau scaling factors would be entered manually with values ranging from 1 to 1.55 that are unique to a particular pesticide or group of pesticides. If specific information to select a scaling factor is not available, then a value of 1.15 would be used as a default. Alternatively, zero would be entered if it is known that body weight does not influence toxicity of pesticide(s) being assessed. The upper bound estimate output from the T-REX Kanaga nomogram would be used as an EEC for calculation of RQs. This approach would yield a conservative estimate of ecological risk.

Table E.3. Average body weight of selected terrestrial wildlife species frequently used in research to establish toxicological endpoints (Dunning 1984).

Species	Body Weight (kg)
Mammal (15 g)	0.015
House sparrow	0.0277
Mammal (35 g)	0.035
Starling	0.0823
Red-winged blackbird	0.0526
Common grackle	0.114
Japanese quail	0.178
Bobwhite quail	0.178
Rat	0.200
Rock dove (aka pigeon)	0.542
Mammal (1000 g)	1.000
Mallard	1.082
Ring-necked pheasant	1.135

7.2.1.1.2 Terrestrial – granular application

Granular pesticide formulations and pesticide-treated seed would pose a unique route of exposure for avian and mammalian species. The pesticide is applied in discrete units which birds or mammals might ingest accidentally with food items or intentionally as in the case of some bird species actively seeking and picking up gravel or grit to aid digestion or seed as a food source. Granules may also be consumed by wildlife foraging on earthworms, slugs or other soft-bodied soil organisms to which the granules may adhere.

Terrestrial wildlife RQs for granular formulations or seed treatments would be calculated by dividing the maximum milligrams of active ingredient (ai) exposed (e.g., EEC) on the surface of an area equal to 1 square foot by the appropriate LD_{50} value multiplied by the surrogate's body weight (Table 3). An adjustment to surface area calculations would be made for broadcast, banded, and in-furrow applications. An adjustment also would be made for applications with and without incorporation of the granules. Without incorporation, it would be assumed that 100% of the granules remain on the soil surface available to foraging birds and mammals. Press wheels push granules flat with the soil surface, but they are not incorporated into the soil. If granules are incorporated in the soil during band or T-band applications or after broadcast applications, it would be assumed only 15% of the applied granules remain available to wildlife. It would be assumed that only 1% of the granules are available on the soil surface following in-furrow applications.

EECs for pesticides applied in granular form and as seed treatments would be determined considering potential ingestion rates of avian or mammalian species (e.g., 10-30% body weight/day). This would provide an estimate of maximum exposure that may occur as a result of granule or seed treatment spills such as those that commonly occur at end rows during application and planting. The availability of granules and seed treatments to terrestrial vertebrates would also be considered by calculating the loading per unit area (LD_{50}/ft^2) for comparison to EPA Level of Concerns (EPA 1998). The T-REX version 1.2.3 (EPA 2005*b*) contains a submodel which automates Kanaga exposure calculations for granular pesticides and treated seed.

The following formulas will be used to calculate EECs depending upon the type of granular pesticide application:

- In-furrow applications assume a typical value of 1% granules, bait, or seed remain unincorporated.

mg a.i./ft.^{2} = [(lbs. product/acre)(% a.i.)(453,580 mg/lbs)(1% exposed))] / {[(43,560 ft.^{2}/acre)/(row spacing (ft.))] / (row spacing (ft.)}

or

mg a.i./ft^2 = [(lbs product/1000 ft. row)(% a.i.)(1000 ft row)(453,580 mg/lb.)(1% exposed)

EEC = [(mg a.i./ft.^{2})(% of pesticide biologically available)]

- Incorporated banded treatments assume that 15% of granules, bait, seeds are unincorporated.

mg a.i./ft.^{2} = [(lbs. product/1000 row ft.)(% a.i.)(453,580 mg/lb.)(1-% incorporated)] / (1,000 ft.)(band width (ft.))

EEC = [(mg a.i./ft.^{2})(% of pesticide biologically available)]

- Broadcast treatment without incorporation assumes 100% of granules, bait, seeds are unincorporated.

mg a.i./ft.^{2} = [(lbs. product/acre)(% a.i.)(453,590 mg/lb.)] / (43,560 ft.^{2}/acre)

EEC = [(mg a.i./ft.^{2})(% of pesticide biologically available)]

Where:

- *% of pesticide biologically available = 100% without species specific ingestion rates*

- *Conversion for calculating mg a.i./ft.^{2} using ounces: 453,580 mg/lb. /16 = 28,349 mg/oz.*

The following equation would used to calculate a RQ based on the EEC calculated by one of the above equations. The EEC would divided by the surrogate LD_{50} toxicological endpoint multiplied by the body weight (Table 3) of the surrogate.

*RQ = EEC / [LD_{50} (mg/kg) * body weight (kg)]*

As with other risk assessments, a RQ>LOC would be a presumption of unacceptable ecological risk. A RQ<LOC would be a presumption of acceptable risk with only minor, temporary, or localized effects to species.

7.2.1.2 Aquatic exposure

Exposures to aquatic habitats (e.g., wetlands, meadows, ephemeral pools, water delivery ditches) would be evaluated separately for ground-based pesticide treatments of habitats managed for fish and wildlife compared with cropland/facilities maintenance. The primary exposure pathway for aquatic organisms from any ground-based treatments likely would be particle drift during the pesticide application. However, different exposure scenarios would be necessary as a result of contrasting application equipment and techniques as well as pesticides used to control pests on agricultural lands and facilities maintenance (e.g., roadsides, parking lots, trails) compared with other managed habitats on the Refuge. In addition, pesticide applications may be done <25'of the high water mark of aquatic habitats for habitat management treatments; whereas, no-spray buffers (≥25') would be used for facilities maintenance treatments.

Table E.4. Estimated Environmental Concentrations (ppb) of pesticides in aquatic habitats (1' depth) immediately after direct application (Urban and Cook 1986).

Lbs/acre	EEC (ppb)
0.10	36.7
0.20	73.5
0.25	91.9
0.30	110.2
0.40	147.0
0.50	183.7
0.75	275.6
1.00	367.5
1.25	459.7
1.50	551.6
1.75	643.5
2.00	735.7
2.25	827.6
2.50	919.4
3.00	1103.5
4.00	1471.4
5.00	1839
6.00	2207
7.00	2575
8.00	2943
9.00	3311
10.00	3678

7.2.1.2.1 Habitat treatments

For the worst-case exposure scenario to nontarget aquatic habitats, EECs (Table E. 4) would be would be derived from Urban and Cook (1986) that assumes an intentional overspray to an entire, nontarget water body (1-foot depth) from a treatment <25' from the high water mark using the max application rate (acid basis [see above]). However, use of BMPs for applying pesticides (see Section 4.2) would likely minimize/eliminate potential drift to nontarget aquatic habitats during actual treatments. If there would be unacceptable (acute or chronic) risk to fish and wildlife with the simulated 100% overspray (RQ>LOC), then the proposed pesticide use may be disapproved or the PUP would be approved at a lower application rate to minimize/eliminate unacceptable risk to aquatic organisms (RQ=LOC).

7.2.1.2.2 Facilities maintenance treatments

Field drift studies conducted by the Spray Drift Task Force, which is a joint project of several agricultural chemical businesses, were used to develop a generic spray drift database. From this database, the AgDRIFT computer model was created to satisfy EPA pesticide registration spray drift data requirements and as a scientific basis to evaluate off-target movement of pesticides from particle drift and assess potential effects of exposure to wildlife. Several versions of the computer model have been developed (i.e., v2.01 through v2.10). The Spray Drift Task Force AgDRIFT® model version 2.01 (SDTF 2003, AgDRIFT 2001) would be used to derive EECs resulting from drift of pesticides to Refuge aquatic resources from ground-based pesticide applications >25' from the high water mark. The Spray Drift Task Force AgDRIFT model is publicly available at http://www.agdrift.com. At this website, click "AgDRIFT 2.0" and then click "Download Now" and follow the instructions to obtain the computer model.

The AgDRIFT model is composed of submodels called tiers. Tier I Ground submodel would be used to assess ground-based applications of pesticides. Tier outputs (EECs) would be calculated with AgDRIFT using the following input variables: max application rate (acid basis [see above]), low boom (20"), fine to medium droplet size, EPA-defined wetland, and a ≥25-foot distance (buffer) from treated area to water.

7.2.2 Use of information on effects of biological control agents, pesticides, degradates, and adjuvants

NEPA documents regarding biological and other environmental effects of biological control agents, pesticides, degradates, and adjuvants prepared by another Federal agency, where the scope would be relevant to evaluation of effects from pesticide uses on Refuge lands, would be reviewed. Possible source agencies for such NEPA documents would include the BLM , US Forest Service, National Park Service, US Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s). Incorporating by reference (40 CFR 1502.21) is a technique used to avoid redundancies in analysis. It also would reduce the bulk of a Service NEPA document, which only would identify the documents that are incorporated by reference. In addition, relevant portions would be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

In accordance with the requirements set forth in 43 CFR 46.135, the Service would specifically incorporate through reference ecological risk assessments prepared by the US Forest Service (http://www.fs.fed.us/r6/invasiveplant-eis/Risk-Assessments/Herbicides-Analyzed-InvPlant-EIS.htm) and BLM (http://www.blm.gov/wo/st/en/prog/more/veg_eis.html). These risk assessments and associated documentation also are available in total with the administrative record for the Final Environmental Impact Statement entitled *Pacific Northwest Region Invasive Plant Program – Preventing and Managing Invasive Plants* (US Forest Service 2005) and *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS (PEIS)* (BLM 2007). In accordance with 43 CFR 46.120(d), use of existing NEPA documents by supplementing, tiering to, incorporating by reference, or adopting previous NEPA environmental analyses would avoid redundancy and unnecessary paperwork.

As a basis for completing "Chemical Profiles" for approving or disapproving PUPs, ecological risk assessments for the following herbicide and adjuvant uses prepared by the USFS would be incorporated by reference:

- 2,4-D
- Chlorosulfuron
- Clopyralid
- Dicamba
- Glyphosate
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl
- Triclopyr
- Nonylphenol polyethylate (NPE) based surfactants

As a basis for completing "Chemical Profiles" for approving or disapproving Refuge PUPs, ecological risk assessments for the following herbicide uses as well as evaluation of risks associated with pesticide degradates and adjuvants prepared by the BLM would be incorporated by reference:

- Bromacil
- Chlorsulfuron
- Diflufenzopyr
- Diquat
- Diuron
- Fluridone
- Imazapic
- Overdrive (diflufenzopyr and dicamba)
- Sulfometuron methyl
- Tebuthiuron
- Pesticide degradates and adjuvants (*Appendix D – Evaluation of risks from degradates, polyoxyethylene-amine (POEA) and R-11, and endocrine disrupting chemicals*)

7.2.3 Assumptions for ecological risk assessments

There are a number of assumptions involved with the ecological risk assessment process for terrestrial and aquatic organisms associated with utilization of the EPA 's (2004) process. These assumptions may be risk neutral or may lead to an over- or under-estimation of risk from pesticide exposure depending upon site-specific conditions. The following describes these assumptions, their application to the conditions typically encountered, and whether or not they may lead to recommendations that are risk neutral, underestimate, or overestimate ecological risk from potential pesticide exposure.

- Indirect effects would not be evaluated by ecological risk assessments. These effects include the mechanisms of indirect exposure to pesticides: consuming prey items (fish, birds, or small mammals), reductions in the availability of prey items, and disturbance associated with pesticide application activities.
- Exposure to a pesticide product can be assessed based upon the active ingredient. However, exposure to a chemical mixture (pesticide formulation) may result in effects that are similar or substantially different compared to only the active ingredient. Nontarget organisms may be exposed directly to the pesticide formulation or only various constituents of the formulation as they dissipate and partition in the environment. If toxicological information for both the active ingredient and formulated product are available, then data representing the greatest potential toxicity would be selected for use in the risk assessment process (EPA 2004). As a result, this

conservative approach may lead to an overestimation of risk characterization from pesticide exposure.

- Because toxicity tests with listed or candidate species or closely related species are not available, data for surrogate species would be most often used for risk assessments. Specifically, bobwhite quail and mallard duck are the most frequently used surrogates for evaluating potential toxicity to federally listed avian species. Bluegill sunfish, rainbow trout, and fathead minnow are the most common surrogates for evaluating toxicity for freshwater fishes. However, sheep's head minnow can be an appropriate surrogate marine species for coastal environments. Rats and mice are the most common surrogates for evaluating toxicity for mammals. Interspecies sensitivity is a major source of uncertainty in pesticide assessments. As a result of this uncertainty, data is selected for the most sensitive species tested within a taxonomic group (birds, fish, and mammals) given the quality of the data is acceptable. If additional toxicity data for more species of organisms in a particular group are available, the selected data will not be limited to the species previously listed as common surrogates.
- The Kanaga nomogram outputs maximum EEC values that may be used to calculate an average daily concentration over a specified interval of time, which is referred to as a time-weighted-average (TWA). The maximum EEC would be selected as the exposure input for both acute and chronic risk assessments in the screening-level evaluations. The initial or maximum EEC derived from the Kanaga nomogram represents the maximum expected instantaneous or acute exposure to a pesticide. Acute toxicity endpoints are determined using a single exposure to a known pesticide concentration typically for 48 to 96 hours. This value is assumed to represent ecological risk from acute exposure to a pesticide. On the other hand, chronic risk to pesticide exposure is a function of pesticide concentration and duration of exposure to the pesticide. An organism's response to chronic pesticide exposure may result from either the concentration of the pesticide, length of exposure, or some combination of both factors. Standardized tests for chronic toxicity typically involve exposing an organism to several different pesticide concentrations for a specified length of time (days, weeks, months, years or generations). For example, avian reproduction tests include a 10-week exposure phase. Because a single length of time is used in the test, time response data is usually not available for inclusion into risk assessments. Without time response data it is difficult to determine the concentration which elicited a toxicological response.
- Using maximum EECs for chronic risk estimates may result in an overestimate of risk, particularly for compounds that dissipate rapidly. Conversely, using TWAs for chronic risk estimates may underestimate risk if it is the concentration rather than the duration of exposure that is primarily responsible for the observed adverse effect. The maximum EEC would be used for chronic risk assessments although it may result in an overestimate of risk. TWAs may be used for chronic risk assessments, but they will be applied judiciously considering the potential for an underestimate or overestimate of risk. For example, the number of days exposure exceeds a Level of Concern may influence the suitability of a pesticide use. The greater the number of days the EEC exceeds the Level of Concern translates into greater the ecological risk. This is a qualitative assessment, and is subject to reviewer's expertise in ecological risk assessment and tolerance for risk.
- The length of time used to calculate the TWA can have a substantial effect on the exposure estimates and there is no standard method for determining the appropriate duration for this estimate. The T-REX model assumes a 21-week exposure period, which is equivalent to avian reproductive studies designed to establish a steady-state concentration for bioaccumulative compounds. However, this does not necessarily define the true exposure duration needed to elicit a toxicological response. Pesticides, which do not bioaccumulate, may achieve a steady-state

concentration earlier than 21 weeks. The duration of time for calculating TWAs will require justification and it will not exceed the duration of exposure in the chronic toxicity test (approximately 70 days for the standard avian reproduction study). An alternative to using the duration of the chronic toxicity study is to base the TWA on the application interval. In this case, increasing the application interval would suppress both the estimated peak pesticide concentration and the TWA. Another alternative to using TWAs would be to consider the number of days that a chemical is predicted to exceed the LOC.

- Pesticide dissipation is assumed to be first-order in the absence of data suggesting alternative dissipation patterns such as bi-phasic. Field dissipation data would generally be the most pertinent for assessing exposure in terrestrial species that forage on vegetation. However, this data is often not available and it can be misleading particularly if the compound is prone to "wash-off". Soil half-life is the most common degradation data available. Dissipation or degradation data that would reflect the environmental conditions typical of Refuge lands would be utilized, if available.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column.
- Actual habitat requirements of any particular terrestrial species are not considered, and it is assumed that species exclusively and permanently occupy the treated area, or adjacent areas receiving pesticide at rates commensurate with the treatment rate. This assumption would produce a maximum estimate of exposure for risk characterization. This assumption would likely lead to an overestimation of exposure for species that do not permanently and exclusively occupy the treated area (EPA 2004).
- Exposure through incidental ingestion of pesticide contaminated soil is not considered in the EPA risk assessment protocols. Research suggests <15% of the diet can consist of incidentally ingested soil depending upon species and feeding strategy (Beyer et al. 1994). An assessment of pesticide concentrations in soil compared to food item categories in the Kanaga nomogram indicates incidental soil ingestion will not likely increase dietary exposure to pesticides. Inclusion of soil into the diet would effectively reduce the overall dietary concentration compared to the present assumption that the entire diet consists a contaminated food source (Fletcher et al. 1994). An exception to this may be soil-applied pesticides in which exposure from incidental ingestion of soil may increase. Potential for pesticide exposure under this assumption may be underestimated for soil-applied pesticides and overestimated for foliar-applied pesticides. The concentration of a pesticide in soil would likely be less than predicted on food items.
- Exposure through inhalation of pesticides is not considered in the EPA risk assessment protocols. Such exposure may occur through three potential sources: spray material in droplet form at time of application, vapor phase with the pesticide volatilizing from treated surfaces, and airborne particulates (soil, vegetative matter, and pesticide dusts). The EPA (1990) reported exposure from inhaling spray droplets at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size (particles reaching the lung) in birds is limited to maximum diameter of 2 to 5 microns. The spray droplet spectra covering the majority of pesticide application scenarios indicate that less than 1% of the applied material is within the respirable particle size. This route of exposure is further limited because the permissible spray drop size distribution for ground pesticide applications is restricted to ASAE medium or coarser drop size distribution.
- Inhalation of a pesticide in the vapor phase may be another source of exposure for some pesticides under certain conditions. This mechanism of exposure to pesticides occurs post application and it would pertain to those pesticides with a high vapor pressure. The EPA is currently evaluating protocols for modeling inhalation exposure from pesticides including near-

field and near-ground air concentrations based upon equilibrium and kinetics-based models. Risk characterization for exposure with this mechanism is unavailable.

- The effect from exposure to dusts contaminated with the pesticide cannot be assessed generically as partitioning issues related to application site soils and chemical properties of the applied pesticides render the exposure potential from this route highly situation specific.
- Dermal exposure may occur through three potential sources: direct application of spray to terrestrial wildlife in the treated area or within the drift footprint, incidental contact with contaminated vegetation, or contact with contaminated water or soil. Interception of spray and incidental contact with treated substrates may pose risk to avian wildlife (Driver et al. 1991). However, available research related to wildlife dermal contact with pesticides is extremely limited, except dermal toxicity values are common for some mammals used as human surrogates (rats and mice). The EPA is currently evaluating protocols for modeling dermal exposure. Risk characterization may be underestimated for this route of exposure, particularly with high risk pesticides such as some organophosphates or carbamate insecticides. If protocols are established by the EPA for assessing dermal exposure to pesticides, they will be considered for incorporation into pesticide assessment protocols.
- Exposure to a pesticide may occur from consuming surface water, dew or other water on treated surfaces. Water soluble pesticides have potential to dissolve in surface runoff and puddles in a treated area may contain pesticide residues. Similarly, pesticides with lower organic carbon partitioning characteristics and higher solubility in water have a greater potential to dissolve in dew and other water associated with plant surfaces. Estimating the extent to which such pesticide loadings to drinking water occurs is complex and would depend upon the partitioning characteristics of the active ingredient, soils types in the treatment area, and the meteorology of the treatment area. In addition, the use of various water sources by wildlife is highly species-specific. Currently, risk characterization for this exposure mechanism is not available. The EPA is actively developing protocols to quantify drinking water exposures from puddles and dew. If and when protocols are formally established by the EPA for assessing exposure to pesticides through drinking water, these protocols will be incorporated into pesticide risk assessment protocols.
- Risk assessments are based upon the assumption that the entire treatment area would be subject to pesticide application at the rates specified on the label. In most cases, there is potential for uneven application of pesticides through such plausible incidents such as changes in calibration of application equipment, spillage, and localized releases at specific areas in or near the treated field that are associated with mixing and handling and application equipment as well as applicator skill. Inappropriate use of pesticides and the occurrence of spills represent a potential underestimate of risk. It is likely not an important factor for risk characterization. All pesticide applicators are required to be certified by the State in which they apply pesticides. Certification training includes the safe storage, transport, handling, and mixing of pesticides, equipment calibration and proper application with annual continuing education.
- The EPA relies on Fletcher (1994) for setting the assumed pesticide residues in wildlife dietary items. The EPA (2004) "believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify". Fletcher's (1994) research suggests that the pesticide active ingredient residue assumptions used by the EPA represent a 95^{th} percentile estimate. However, research conducted by Pfleeger et al. (1996) indicates EPA residue assumptions for short grass was not exceeded. Baehr and Habig (2000) compared EPA residue assumptions with distributions of measured pesticide residues for the EPA's UTAB database. Overall residue selection level will tend to overestimate risk characterization. This is particularly evident when

wildlife individuals are likely to have selected a variety of food items acquired from multiple locations. Some food items may be contaminated with pesticide residues whereas others are not contaminated. However, it is important to recognize differences in species feeding behavior. Some species may consume whole above-ground plant material, but others will preferentially select different plant structures. Also, species may preferentially select a food item although multiple food items may be present. Without species specific knowledge regarding foraging behavior characterizing ecological risk other than in general terms is not possible.

- Acute and chronic risk assessments rely on comparisons of wildlife dietary residues with LC_{50} or NOEC values expressed as concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed. Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods are not accounting for a potentially important aspect of food requirements.
- There are several other assumptions that can affect nontarget species not considered in the risk assessment process. These include possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic and biotic factors) and behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse affects to nontarget species, but they are usually characterized in the published literature in only a general manner limiting their value in the risk assessment process.
- It is assumed that aquatic species exclusively and permanently occupy the water body being assessed. Actual habitat requirements of aquatic species are not considered. With the possible exception of scenarios where pesticides are directly applied to water, it is assumed that no habitat use considerations specific for any species would place the organisms in closer proximity to pesticide use sites. This assumption produces a maximum estimate of exposure or risk characterization. It would likely be realistic for many aquatic species that may be found in aquatic habitats within or in close proximity to treated terrestrial habitats. However, the spatial distribution of wildlife is usually not random because wildlife distributions are often related to habitat requirements of species. Clumped distributions of wildlife may result in an under- or over-estimation of risk depending upon where the initial pesticide concentration occurs relative to the species or species habitat.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column. Additional chemical exposure from materials associated with suspended solids or food items is not considered because partitioning onto sediments likely is minimal. Adsorption and bioconcentration occurs at lower levels for many newer pesticides compared with older more persistent bioaccumulative compounds. Pesticides with RQs close to the listed species level of concern, the potential for additional exposure from these routes may be a limitation of risk assessments, where potential pesticide exposure or risk may be underestimated.
- Mass transport losses of pesticide from a water body (except for losses by volatilization, degradation and sediment partitioning) would not be considered for ecological risk assessment. The water body would be assumed to capture all pesticide active ingredients entering as runoff, drift, and adsorbed to eroded soil particles. It would also be assumed that pesticide active ingredient is not lost from the water body by overtopping or flow-through, nor is concentration

reduced by dilution. In total, these assumptions would lead to a near maximum possible water-borne concentration. However, this assumption would not account for potential to concentrate pesticide through the evaporative loss. This limitation may have the greatest impact on water bodies with high surface-to-volume ratios such as ephemeral wetlands, where evaporative losses are accentuated and applied pesticides have low rates of degradation and volatilization.

- For acute risk assessments, there would be no averaging time for exposure. An instantaneous peak concentration would be assumed, where instantaneous exposure is sufficient in duration to elicit acute effects comparable to those observed over more protracted exposure periods (typically 48 to 96 hours) tested in the laboratory. In the absence of data regarding time-to-toxic event, analyses and latent responses to instantaneous exposure, risk would likely be overestimated.
- For chronic exposure risk assessments, the averaging times considered for exposure are commensurate with the duration of invertebrate life-cycle or fish-early life stage tests (e.g., 21-28 days and 56-60 days, respectively). Response profiles (time to effect and latency of effect) to pesticides likely vary widely with mode of action and species and should be evaluated on a case-by-case basis as available data allow. Nevertheless, because the EPA relies on chronic exposure toxicity endpoints based on a finding of no observed effect, the potential for any latent toxicity effects or averaging time assumptions to alter the results of an acceptable chronic risk assessment prediction is limited. The extent to which duration of exposure from water-borne concentrations overestimate or underestimate actual exposure depends on several factors. These include the following: localized meteorological conditions, runoff characteristics of the watershed (e.g., soils, topography), the hydrological characteristics of receiving waters, environmental fate of the pesticide active ingredient, and the method of pesticide application. It should also be understood that chronic effects studies are performed using a method that holds water concentration in a steady state. This method is not likely to reflect conditions associated with pesticide runoff. Pesticide concentrations in the field increase and decrease in surface water on a cycle influenced by rainfall, pesticide use patterns, and degradation rates. As a result of the dependency of this assumption on several undefined variables, risk associated with chronic exposure may in some situations underestimate risk and overestimate risk in others.
- There are several other factors that can affect nontarget species not considered in the risk assessment process. These would include the following: possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic [not pesticides] and biotic factors), and sub-lethal effects such as behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse affects to nontarget species, but they are not routinely assessed by regulatory agencies. Therefore, information on the factors is not extensive limiting their value for the risk assessment process. As this type of information becomes available, it would be included, either quantitatively or qualitatively, in this risk assessment process.
- EPA is required by the Food Quality Protection Act to assess the cumulative risks of pesticides that share common mechanisms of toxicity, or act the same within an organism. Currently, EPA has identified four groups of pesticides that have a common mechanism of toxicity requiring cumulative risk assessments. These four groups are: the organophosphate insecticides, N-methyl carbamate insecticides, triazine herbicides, and chloroacetanilide herbicides.

7.3 Pesticide Mixtures and Degradates

Pesticide products are usually a formulation of several components generally categorized as active ingredients and inert or other ingredients. The term active ingredient is defined by the FIFRA as preventing, destroying, repelling, or mitigating the effects of a pest, or it is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. In accordance with FIFRA, the active ingredient(s) must be identified by name(s) on the pesticide label along with its relative composition expressed in percentage(s) by weight. In contrast, inert ingredient(s) are not intended to affect a target pest. Their role in the pesticide formulation is to act as a solvent (keep the active ingredient is a liquid phase), an emulsifying or suspending agent (keep the active ingredient from separating out of solution), or a carrier such as clay in which the active ingredient is impregnated on the clay particle in dry formulations. For example, if isopropyl alcohol would be used as a solvent in a pesticide formulation, then it would be considered an inert ingredient. FIFRA only requires that inert ingredients identified as hazardous and associated percent composition, and the total percentage of all inert ingredients must be declared on a product label. Inert ingredients that are not classified as hazardous are not required to be identified.

The EPA (September 1997) issued Pesticide Regulation Notice 97-6 which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" for "inert ingredients" in the ingredient statement. This change recognized that all components in a pesticide formulation potentially could elicit or contribute to an adverse effect on nontarget organisms and, therefore, are not necessarily inert. Whether referred to as "inerts" or "other ingredients," these constituents within a pesticide product have the potential to affect species or environmental quality. The EPA categorizes regulated inert ingredients into the following four lists (http://www.epa.gov/opprd001/inerts/index.html):

- List 1 – Inert Ingredients of Toxicological Concern
- List 2 – Potentially Toxic Inert Ingredients
- List 3 – Inerts of Unknown Toxicity
- List 4 – Inerts of Minimal Toxicity

Several of the List 4 compounds are naturally-occurring earthen materials (e.g., clay materials, simple salts) that would not elicit toxicological response at applied concentrations. However, some of the inerts (particularly the List 3 compounds and unlisted compounds) may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

Comprehensively assessing potential effects to nontarget fish, wildlife, plants, and/or their habitats from pesticide use is a complex task. It would be preferable to assess the cumulative effects from exposure to the active ingredient, its degradates, and inert ingredients as well as other active ingredients in the spray mixture. However, it would only be feasible to conduct deterministic risk assessments for each component in the spray mixture singly. Limited scientific information is available regarding ecological effects (additive or synergistic) from chemical mixtures that typically rely upon broadly encompassing assumptions. For example, the US Forest Service (2005) found that mixtures of pesticides used in land (forest) management likely would not cause additive or synergistic effects to nontarget species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (ATSDR 2004). Moreover, information on inert ingredients, adjuvants, and degradates is often limited by the availability of and access to reliable toxicological data for these constituents.

Toxicological information regarding "other ingredients" may be available from sources such as the following:

- TOMES (a proprietary toxicological database including EPA's IRIS, the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS]).
- EPA's ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms).
- TOXLINE (a literature searching tool).
- Material Safety Data Sheets (MSDSs) from pesticide suppliers.
- Other sources such as the Farm Chemicals Handbook.

Because there is a lack of specific inert toxicological data, inert(s) in a pesticide may cause adverse ecological effects. However, inert ingredients typically represent only a small percentage of the pesticide spray mixture, and it would be assumed that negligible effects would be expected to result from inert ingredient(s).

Although the potential effects of degradates should be considered when selecting a pesticide, it is beyond the scope of this assessment process to consider all possible breakdown chemicals of the various product formulations containing an active ingredient. Degradates may be more or less mobile and more or less hazardous in the environment than their parent pesticides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent pesticides and degradates would make assessing potential degradate effects extremely difficult. For example, a less toxic and more mobile, bioaccumulative, or persistent degradate may have potentially greater effects on species and/or degrade environmental quality. The lack of data on the toxicity of degradates for many pesticides would represent a source of uncertainty for assessing risk.

An EPA-approved label specifies whether a product can be mixed with one or more pesticides. Without product-specific toxicological data, it would not possible to quantify the potential effects of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific information allowed a determination of whether the joint action of a mixture would be additive, synergistic, or antagonistic. Such information would not likely exist unless the mode of action would be common among the chemicals and receptors. Moreover, the composition of and exposure to mixtures would be highly site- and/or time-specific and, therefore, it would be nearly impossible to assess potential effects to species and environmental quality.

To minimize or eliminate potential negative effects associated with applying two or more pesticides as a mixture, the use would be conducted in accordance with the labeling requirements. Labels for two or more pesticides applied as a mixture should be completely reviewed, where products with the least potential for negative effects would be selected for use on the Refuge. This is especially relevant when a mixture would be applied in a manner that may already have the potential for an effect(s) associated with an individual pesticide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions would increase the level of uncertainty in terms of risk to species or potential to degrade environmental quality.

Adjuvants generally function to enhance or prolong the activity of pesticide. For terrestrial herbicides, adjuvants aid in the absorption into plant tissue. Adjuvant is a broad term that generally applies to surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration requirements as pesticides and the EPA does not register or approve the labeling of spray adjuvants.

Individual pesticide labels identify types of adjuvants approved for use with it. In general, adjuvants compose a relatively small portion of the volume of pesticides applied. Selection of adjuvants with limited toxicity and low volumes would be recommended to reduce the potential for the adjuvant to influence the toxicity of the pesticide.

7.4 Determining Effects to Soil and Water Quality

The approval process for pesticide uses would consider potential to degrade water quality on and off Refuge lands. A pesticide can only affect water quality through movement away from the treatment site. After application, pesticide mobilization can be characterized by one or more of the following (Kerle et al. 1996):

- Attach (sorb) to soil, vegetation, or other surfaces and remain at or near the treated area;
- Attach to soil and move off-site through erosion from run-off or wind;
- Dissolve in water that can be subjected to run-off or leaching.

As an initial screening tool, selected chemical characteristics and rating criteria for a pesticide can be evaluated to assess potential to enter ground and/or surface waters. These would include the following: persistence, sorption coefficient (K_{oc}), groundwater ubiquity score (GUS), and solubility.

Persistence, which is expressed as half-life ($t_{½}$), represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially). Persistence in the soil can be categorized as the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996). Half-life data is usually available for aquatic and terrestrial environments.

Another measure of pesticide persistence is dissipation time (DT_{50}). It represents the time required for 50% of the deposited pesticide to degrade and move from a treated site; whereas, half-life describes the rate for degradation only. As for half-life, units of dissipation time are usually expressed in days. Field or foliar dissipation time is the preferred data for use to estimate pesticide concentrations in the environment. However, soil half-life is the most common persistence data cited in published literature. If field or foliar dissipation data is not available, soil half-life data may be used. The average or representative half-life value of most important degradation mechanism will be selected for quantitative analysis for both terrestrial and aquatic environments.

Mobility of a pesticide is a function of how strongly it is adsorbed to soil particles and organic matter, its solubility in water, and its persistence in the environment. Pesticides strongly adsorbed to soil particles, relatively insoluble in water, and not environmentally persistent would be less likely to move across the soil surface into surface waters or to leach through the soil profile and contaminate groundwater. Conversely, pesticides that are not strongly adsorbed to soil particles, are highly water soluble, and are persistent in the environment would have greater potential to move from the application site (off-site movement).

The degree of pesticide adsorption to soil particles and organic matter (Kerle et. al. 1996) is expressed as the soil adsorption coefficient (K_{oc}). The soil adsorption coefficient is measured as micrograms of pesticide per gram of soil (µg/g) that can range from near zero to the thousands. Pesticides with higher Koc values are strongly sorbed to soil and, therefore, would be less subject to movement.

Water solubility describes the amount of pesticide that will dissolve in a known quantity of water. The water solubility of a pesticide is expressed as milligrams of pesticide dissolved in a liter of water

(mg/l or ppm). Pesticide with solubility <0.1 ppm are virtually insoluble in water, 100-1000 ppm are moderately soluble, and >10,000 ppm highly soluble (US Geological Survey 2000). As pesticide solubility increases, there would be greater potential for off-site movement.

The Groundwater Ubiquity Score (GUS) is a quantitative screening tool to estimate a pesticide's potential to move in the environment. It utilizes soil persistence and adsorption coefficients in the following formula.

$$GUS = \log_{10}(t_{½}) \times [4 - \log_{10}(K_{oc})]$$

The potential pesticide movement rating would be based upon its GUS value. Pesticides with a GUS <0.1 would considered to have an extremely low potential to move toward groundwater. Values of 1.0-2.0 would be low, 2.0-3.0 would be moderate, 3.0-4.0 would be high, and >4.0 would have a very high potential to move toward groundwater.
Water solubility describes the amount of pesticide dissolving in a specific quantity of water, where it is usually measured as mg/l or parts per million (ppm). Solubility is useful as a comparative measure because pesticides with higher values are more likely to move by run-off or leaching. GUS, water solubility, $t_{½}$, and K_{oc} values are available for selected pesticides from the OSU Extension Pesticide Properties Database at http://npic.orst.edu/ppdmove.htm. Many of the values in this database were derived from the SCS/ARS/CES Pesticide Properties Database for Environmental Decision Making (Wauchope et al. 1992).

Soil properties influence the fate of pesticides in the environment. The following six properties are mostly likely to affect pesticide degradation and the potential for pesticides to move off-site by leaching (vertical movement through the soil) or runoff (lateral movement across the soil surface).

- Permeability is the rate of water movement vertically through the soil. It is affected by soil texture and structure. Coarse textured soils (e.g., high sand content) have a larger pore size and they are generally more permeable than fine textured soils (i.e., high clay content). The more permeable soils would have a greater potential for pesticides to move vertically down through the soil profile. Soil permeability rates (inches/hour) are usually available in county soil survey reports.
- Soil texture describes the relative percentage of sand, silt, and clay. In general, greater clay content with smaller the pore size would lower the likelihood and rate water that would move through the soil profile. Clay also serves to adsorb (bind) pesticides to soil particles. Soils with high clay content would adsorb more pesticide than soils with relatively low clay content. In contrast, sandy soils with coarser texture and lower water holding capacity would have a greater potential for water to leach through them.
- Soil structure describes soil aggregation. Soils with a well developed soil structure have looser, more aggregated, structure that would be less likely to be compacted. Both characteristics would allow for less restricted flow of water through the soil profile resulting in greater infiltration.
- Organic matter would be the single most important factor affecting pesticide adsorption in soils. Many pesticides are adsorbed to organic matter which would reduce their rate of downward movement through the soil profile. Also, soils high in organic matter would tend to hold more water, which may make less water available for leaching.
- Soil moisture affects how fast water would move through the soil. If soils are already wet or saturated before rainfall or irrigation, excess moisture would runoff rather than infiltrate into the soil profile. Soil moisture also would influence microbial and chemical activity in soil, which effects pesticide degradation.

- Soil pH would influence chemical reactions that occur in the soil which in turn determines whether or not a pesticide will degrade, rate of degradation, and, in some instances, which degradation products are produced.

Based upon the aforementioned properties, soils most vulnerable to groundwater contamination would be sandy soils with low organic matter. In contrast, the least vulnerable soils would be well-drained clayey soils with high organic matter. Consequently, pesticides with the lowest potential for movement in conjunction with appropriate best management practices (see below) would be used in an IPM framework to treat pests while minimizing effects to nontarget biota and protecting environmental quality.

Along with soil properties, the potential for a pesticide to affect water quality through run-off and leaching would consider site-specific environmental and abiotic conditions including rainfall, water table conditions, and topography (Huddleston 1996).

- Water is necessary to separate pesticides from soil. This can occur in two basic ways. Pesticides that are soluble move easily with runoff water. Pesticide-laden soil particles can be dislodged and transported from the application site in runoff. The concentration of pesticides in the surface runoff would be greatest for the first runoff event following treatment. The rainfall intensity and route of water infiltration into soil, to a large extent, determine pesticide concentrations and losses in surface runoff. The timing of the rainfall after application also would have an effect. Rainfall interacts with pesticides at a shallow soil depth (¼ to ½ inch), which is called the mixing zone (Baker and Miller 1999). The pesticide/water mixture in the mixing zone would tend to leach down into the soil or runoff depending upon how quickly the soil surface becomes saturated and how rapidly water can infiltrate into the soil. Leaching would decrease the amount of pesticide available near the soil surface (mixing zone) to runoff during the initial rainfall event following application and subsequent rainfall events.
- Terrain slope would affect the potential for surface runoff and the intensity of runoff. Steeper slopes would have greater potential for runoff following a rainfall event. In contrast, soils that are relatively flat would have little potential for runoff, except during intense rainfall events. In addition, soils in lower areas would be more susceptible to leaching as a result of receiving excessive water from surrounding higher elevations.
- Depth to groundwater would be an important factor affecting the potential for pesticides to leach into groundwater. If the distance from the soil surface to the top of the water table is shallow, pesticides would have less distance to travel to reach groundwater. Shallower water tables that persist for longer periods would be more likely to experience groundwater contamination. Soil survey reports are available for individual counties. These reports provide data in tabular format regarding the water table depths and the months during which it is persists. In some situations, a hard pan exists above the water table that would prevent pesticide contamination from leaching.

7.5 Determining Effects to Air Quality

Pesticides may volatilize from soil and plant surfaces and move from the treated area into the atmosphere. The potential for a pesticide to volatilize is determined by the pesticide's vapor pressure which would be affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these numbers easier to compare, vapor pressure may be expressed in exponent form ($I \times 10^{-7}$), where I represents a vapor pressure index. In general, pesticides with $I<10$ would have a low potential to volatilize; whereas, pesticides with $I>1{,}000$ would have a high potential to volatilize (Oregon State University 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database.

7.6 Preparing a Chemical Profile

The following instructions would be used by Service personnel to complete Chemical Profiles for pesticides. Specifically, profiles would be prepared for pesticide active ingredients (e.g., glyphosate, imazapic) that would be contained in one or more trade name products that are registered and labeled with EPA. All information fields under each category (e.g., Toxicological Endpoints, Environmental Fate) would be completed for a Chemical Profile. If no information is available for a specific field, then "No data is available in references" would be recorded in the profile. Available scientific information would be used to complete Chemical Profiles. Each entry of scientific information would be shown with applicable references.

Completed Chemical Profiles would provide a structured decision-making process utilizing quantitative assessment/screening tools with threshold values (where appropriate) that would be used to evaluate potential biological and other environmental effects to Refuge resources. For ecological risk assessments presented in these profiles, the "worst-case scenario" would be evaluated to determine whether a pesticide could be approved for use considering the maximum single application rate specified on pesticide labels for habitat management and croplands/facilities maintenance treatments pertaining to Refuges. Where the "worst-case scenario" likely would only result in minor, temporary, and localized effects to listed and nonlisted species with appropriate BMPs (see Section 5.0), the proposed pesticide's use in a PUP would have a scientific basis for approval under any application rate specified on the label that is at or below rates evaluated in a Chemical Profile. In some cases, the Chemical Profile would include a lower application rate than the maximum labeled rate in order to protect Refuge resources. As necessary, Chemical Profiles would be periodically updated with new scientific information or as pesticides with the same active ingredient are proposed for use on the Refuge in PUPs.

Throughout this section, threshold values (to prevent or minimize potential biological and environmental effects) would be clearly identified for specific information presented in a completed Chemical Profile. Comparison with these threshold values provides an explicit scientific basis to approve or disapprove PUPs for habitat management and cropland/facilities maintenance on Refuge lands. In general, PUPs would be approved for pesticides with Chemical Profiles where there would be no exceedances of threshold values. However, BMPs are identified for some screening tools that would minimize/eliminate potential effects (exceedance of the threshold value) as a basis for approving PUPs.

Date: Service personnel would record the date when the Chemical Profile is completed or updated. Chemical Profiles (e.g., currently approved pesticide use patterns) would be periodically reviewed and updated, as necessary. The most recent review date would be recorded on a profile to document when it was last updated.

Trade Name(s): Service personnel would accurately and completely record the trade name(s) from the pesticide label, which includes a suffix that describes the formulation (e.g., WP, DG, EC, L, SP, I, II or 64). The suffix often distinguishes a specific product among several pesticides with the same active ingredient. Service personnel would record a trade name for each pesticide product with the same active ingredient.

Common chemical name(s): Service personnel would record the common name(s) listed on the pesticide label or material safety data sheet (MSDS) for an active ingredient. The common name of a

pesticide is listed as the active ingredient on the title page of the product label immediately following the trade name, and the MSDS, Section 2: Composition/ Information on Ingredients. A Chemical Profile is completed for each active ingredient.

Pesticide Type: Service personnel would record the type of pesticide for an active ingredient as one of the following: herbicide, dessicant, fungicide, fumigant, growth regulator, insecticide, pisicide, or rodenticide.

EPA Registration Number(s): This number (EPA Reg. No.) appears on the title page of the label and MSDS, Section 1: Chemical Product and Company Description. It is not the EPA Establishment Number that is usually located near it. Service personnel would record the EPA Reg. No. for each trade name product with an active ingredient based upon PUPs.

Pesticide Class: Service personnel would list the general chemical class for the pesticide (active ingredient). For example, malathion is an organophosphate and carbaryl is a carbamate.

CAS (Chemical Abstract Service) Number: This number is often located in the second section (Composition/Information on Ingredients) of the MSDS. The MSDS table listing components usually contains this number immediately prior to or following the % composition.

Other Ingredients: From the most recent MSDS for the proposed pesticide product(s), Service personnel would include any chemicals in the pesticide formulation not listed as an active ingredient that are described as toxic or hazardous, or regulated under the Superfund Amendments and Reauthorization Act (SARA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), Occupational Safety and Health Administration (OSHA), State Right-to-Know, or other listed authorities. These are usually found in MSDS sections titled "Hazardous Identifications", "Exposure Control/Personal Protection", and "Regulatory Information". If concentrations of other ingredients are available for any compounds identified as toxic or hazardous, then Service personnel would record this information in the Chemical Profile by trade name. MSDS(s) may be obtained from the manufacturer, manufacturer's website or from an on-line database maintained by Crop Data Management Systems, Inc. (see list below).

Toxicological Endpoints

Toxicological endpoint data would be collected for acute and chronic tests with mammals, birds, and fish. Data would be recorded for species available in the scientific literature. If no data are found for a particular taxonomic group, then "No data available is references" would be recorded as the data entry. Throughout the Chemical Profile, references (including toxicological endpoint data) would be cited using parentheses (#) following the recorded data.

Mammalian LD_{50}: For test species in the scientific literature, Service personnel would record available data for oral lethal dose (LD_{50}) in mg/kg-bw (body weight) or ppm-bw. Most common test species in scientific literature are the rat and mouse. The lowest LD_{50} value found for a rat would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk to mammals (see Table 1 in Section 7.1).

Mammalian LC_{50}: For test species in the scientific literature, Service personnel would record available data for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species in scientific literature are the rat and mouse. The lowest LC_{50} value found for a rat would be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Mammalian Reproduction: For test species listed in the scientific literature, Service personnel would record the test results (e.g., Lowest Observed Effect Concentration [LOEC], Lowest Observed Effect Level [LOEL], No Observed Adverse Effect Level [NOAEL], No Observed Adverse Effect Concentration [NOAEC]) in mg/kg-bw or mg/kg-diet for reproductive test procedure(s) (e.g., generational studies [preferred], fertility, new born weight). Most common test species available in scientific literature are rats and mice. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for a rat would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

Avian LD_{50}: For test species available in the scientific literature, Service personnel would record values for oral lethal dose (LD_{50}) in mg/kg-bw or ppm-bw. Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LD_{50} value found for an avian species would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Avian LC_{50}: For test species available in the scientific literature, Service personnel would record values for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LC_{50} value found for an avian species would be used as a toxicological endpoint for dietary-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Avian Reproduction: For test species available in the scientific literature, Service personnel would record test results (e.g., LOEC, LOEL, NOAEC, NOAEL) in mg/kg-bw or mg/kg-diet consumed for reproductive test procedure(s) (e.g., early life cycle, reproductive). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for an avian species would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

Fish LC_{50}: For test freshwater or marine species listed in the scientific literature, Service personnel would record a LC_{50} in ppm or mg/L. Most common test species available in the scientific literature are the bluegill, rainbow trout, and fathead minnow (marine). Test results for many game species may also be available. The lowest LC_{50} value found for a freshwater fish species would be used as a toxicological endpoint for RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Fish Early Life Stage (ELS)/Life Cycle: For test freshwater or marine species available in the scientific literature, Service personnel would record test results (e.g., LOEC, NOAEL, NOAEC, LOAEC) in ppm for test procedure(s) (e.g., early life cycle, life cycle). Most common test species available in the scientific literature are bluegill, rainbow trout, and fathead minnow. Test results for other game species may also be available. The lowest test value found for a fish species (preferably freshwater) would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

Other: For test invertebrate as well as nonvascular and vascular plant species available in the scientific literature, Service personnel would record $LC_{50,}$ $LD_{50,}$ LOEC, LOEL, NOAEC, NOAEL, or EC_{50} (environmental concentration) values in ppm or mg/L. Most common test invertebrate species available in scientific literature are the honey bee and the water flea (*Daphnia magna*). Green algae (*Selenastrum capricornutum*) and pondweed (*Lemna minor*) are frequently available test species for aquatic nonvascular and vascular plants, respectively.

Ecological Incident Reports: After a site has been treated with pesticide(s), wildlife may be exposed to these chemical(s). When exposure is high relative to the toxicity of the pesticides, wildlife may be killed or visibly harmed (incapacitated). Such events are called ecological incidents. The EPA maintains a database (Ecological Incident Information System) of ecological incidents. This database stores information extracted from incident reports submitted by various Federal and State agencies and nongovernment organizations. Information included in an incident report is date and location of the incident, type and magnitude of affects observed in various species, use(s) of pesticides known or suspected of contributing to the incident, and results of any chemical residue and cholinesterase activity analyses conducted during the investigation.
Incident reports can play an important role in evaluating the effects of pesticides by supplementing quantitative risk assessments. All incident reports for pesticide(s) with the active ingredient and associated information would be recorded.

Environmental Fate

Water Solubility: Service personnel would record values for water solubility (S_w), which describes the amount of pesticide that dissolves in a known quantity of water. S_w is expressed as mg/L (ppm). Pesticide S_w values would be categorized as one of the following: insoluble <0.1 ppm, moderately soluble = 100 to 1000 ppm, highly soluble >10,000 ppm (US Geological Survey 2000). As pesticide S_w increases, there would be greater potential to degrade water quality through run-off and leaching.

Sw would be used to evaluate potential for bioaccumulation in aquatic species [see **Octanol-Water Partition Coefficient (K_{ow})** below].

Soil Mobility: Service personnel would record available values for soil adsorption coefficient (K_{oc} [µg/g]). It provides a measure of a chemical's mobility and leaching potential in soil. K_{oc} values are directly proportional to organic content, clay content, and surface area of the soil. K_{oc} data for a pesticide may be available for a variety of soil types (e.g., clay, loam, sand).

K_{oc} values would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below).

Soil Persistence: Service personnel would record values for soil half-life ($t_{½}$), which represents the length of time (days) required for 50% of the deposited pesticide to degrade (completely or partially) in the soil. Based upon the $t_{½}$ value, soil persistence would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996).

Threshold for Approving PUPs:

If soil $t_{½} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.
If soil $t_{½} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the **Specific Best Management Practices section** *to minimize potential surface run-off and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil $t_{½}$ values would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below).

Soil Dissipation: Dissipation time (DT_{50}) represents the time required for 50% of the deposited pesticide to degrade and move from a treated site; whereas, soil $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Field dissipation time would be the preferred data for use to estimate pesticide concentrations in the environment because it is based upon field studies compared to soil $t_{½}$, which is derived in a laboratory. However, soil $t_{½}$ is the most common persistence data available in the published literature. If field dissipation data is not available, soil half-life data would be used in a Chemical Profile. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Based upon the DT_{50} value, environmental persistence in the soil also would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30-100 days, and persistent >100 days.

Threshold for Approving PUPs:

If soil $DT_{50} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.
If soil $DT_{50} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices section to minimize potential surface run-off and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil DT_{50} values (preferred over soil $t_{½}$) would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below), if available.
Aquatic Persistence: Service personnel would record values for aquatic $t_{½}$, which represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially) in

water. Based upon the $t_{½}$ value, aquatic persistence would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996).

Threshold for Approving PUPs:

If aquatic $t_{½} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.
If aquatic $t_{½} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices section to minimize potential surface run-off and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Aquatic Dissipation: Dissipation time (DT_{50}) represents the time required for 50% of the deposited pesticide to degrade or move (dissipate); whereas, aquatic $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Based upon the DT_{50} value, environmental persistence in aquatic habitats also would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

Threshold for Approving PUPs:

If aquatic $DT_{50} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.
If aquatic $DT_{50} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices section to minimize potential surface run-off and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Potential to Move to Groundwater: Groundwater Ubiquity Score (GUS) = $\log_{10}(\text{soil } t_{½}) \times [4 - \log_{10}(K_{oc})]$. If a DT_{50} value is available, it would be used rather than a $t_{½}$ value to calculate a GUS score. Based upon the GUS value, the potential to move toward groundwater would be recorded as one of the following categories: extremely low potential<1.0, low - 1.0 to 2.0, moderate - 2.0 to 3.0, high - 3.0 to 4.0, or very high>4.0.

Threshold for Approving PUPs:

If GUS ≤ 4.0, then a PUP would be approved without additional BMPs to protect water quality.

If GUS >4.0, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices section to minimize potential surface run-off and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Volatilization: Pesticides may volatilize (evaporate) from soil and plant surfaces and move off-target into the atmosphere. The potential for a pesticide to volatilize is a function of its vapor pressure that is affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these values easier to compare, vapor pressure would be recorded by Service personnel in exponential form ($I \times 10^{-7}$), where I represents a vapor pressure index. In general, pesticides with I<10 would have low potential to volatilize; whereas, pesticides with I >1,000 would have a high potential to volatilize (Oregon State University 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database (see **References**).

Threshold for Approving PUPs:

If I ≤1000, then a PUP would be approved without additional BMPs to minimize drift and protect air quality.
If I >1000, then a PUP would only be approved with additional BMPs specifically to minimize drift and protect air quality. One or more BMPs such as the following would be included in the Specific Best Management Practices section to reduce volatilization and potential to drift and degrade air quality:

- *Do not treat when wind velocities are <2 or >10 mph with existing or potential inversion conditions.*
- *Apply the large-diameter droplets possible for spray treatments.*
- *Avoid spraying when air temperatures >85°F.*
- *Use the lowest spray height possible above target canopy.*
- *Where identified on the pesticide label, soil incorporate pesticide as soon as possible during or after application.*

Octanol-Water Partition Coefficient (K_{ow}): The octanol-water partition coefficient (K_{ow}) is the concentration of a pesticide in octanol and water at equilibrium at a specific temperature. Because octanol is an organic solvent, it is considered a surrogate for natural organic matter. Therefore, K_{ow} would be used to assess potential for a pesticide to bioaccumulate in tissues of aquatic species (e.g., fish). If K_{ow} >1000 or S_w<1 mg/L AND soil $t_{½}$>30 days, then there would be high potential for a pesticide to bioaccumulate in aquatic species such as fish (US Geological Survey 2000).

Threshold for Approving PUPs:

If there is not a high potential for a pesticide to bioaccumulate in aquatic species, then the PUP would be approved.

If there is a high potential to bioaccumulate in aquatic species (K_{ow}>1000 or S_w<1 mg/L AND soil $t_{½}$>30 days), then the PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Bioaccumulation/Bioconcentration: The physiological process where pesticide concentrations in tissue would increase in biota because they are taken and stored at a faster rate than they are metabolized or excreted. The potential for bioaccumulation would be evaluated through bioaccumulation factors (BAFs) or bioconcentration factors (BCFs). Based upon BAF or BCF values, the potential to bioaccumulate would be recorded as one of the following: low – 0 to 300, moderate – 300 to 1000, or high >1000 (Calabrese and Baldwin 1993).

Threshold for Approving PUPs:

If BAF or BCF≤1000, then a PUP would be approved without additional BMPs.
If BAF or BCF>1000, then a PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Worst-Case Ecological Risk Assessment

Max Application Rates (acid equivalent): Service personnel would record the highest application rate of an active ingredient (ae basis) for habitat management and cropland/facilities maintenance treatments in this data field of a Chemical Profile. These rates can be found in Table CP.1 under the column heading "Max Product Rate – Single Application (lbs/acre – AI on acid equiv basis)". This table would be prepared for a chemical profile from information specified in labels for trade name products identified in PUPs. If these data are not available in pesticide labels, then write "NS" for "not specified on label" in this table.

EECs: An estimated environmental concentration (ECC) represents potential exposure to fish and wildlife (birds and mammals) from using a pesticide. EECs would be derived by Service personnel using an EPA screening-level approach (EPA 2004). For each max application rate [see description under **Max Application Rates (acid equivalent)**], Service personnel would record 2 EEC values in a Chemical Profile; these would represent the worst-case terrestrial and aquatic exposures for habitat management and croplands/facilities maintenance treatments. For terrestrial and aquatic EEC calculations, see description for data entry under **Presumption of Unacceptable Risk/Risk Quotients**, which is the next field for a Chemical Profile.

Presumption of Unacceptable Risk/Risk Quotients: Service personnel would calculate and record acute and chronic risk quotients (RQs) for birds, mammals, and fish using the provided tabular formats for habitat management and/or cropland/facilities maintenance treatments. RQs recorded in a Chemical Profile would represent the worst-case assessment for ecological risk. See Section 7.2 for discussion regarding the calculations of RQs.

For aquatic assessments associated with habitat management treatments, RQ calculations would be based upon selected acute and chronic toxicological endpoints for fish and the EEC would be derived from Urban and Cook (1986) assuming 100% overspray to an entire 1-foot deep water body using the max application rate (ae basis [see above]).

For aquatic assessments associated with cropland/facilities maintenance treatments, RQ calculations would be done by Service personnel based upon selected acute and chronic toxicological endpoints for fish and an EEC would be derived from the aquatic assessment in AgDRIFT® model version 2.01 under Tier I ground-based application with the following input variables: max application rate (acid basis [see above]), low boom (20"), fine to medium/coarse droplet size, 20 swaths, EPA-defined wetland, and 25-foot distance (buffer) from treated area to water.

See Section 7.2.1.2 for more details regarding the calculation of EECs for aquatic habitats for habitat management and cropland/facilities maintenance treatments.

For terrestrial avian and mammalian assessments, RQ calculations would be done by Service personnel based upon dietary exposure, where the "short grass" food item category would represent the worst-case scenario. For terrestrial spray applications associated with habitat management and cropland/facilities maintenance treatments, exposure (EECs and RQs) would be determined using the Kanaga nomogram method through the EPA's Terrestrial Residue Exposure model (T-REX) version 1.2.3. T-REX input variables would include the following: max application rate (acid basis [see above]) and pesticide half-life (days) in soil to estimate the initial, maximum pesticide residue concentration on general food items for terrestrial vertebrate species in short (<20 cm tall) grass. For granular pesticide formulations and pesticide-treated seed with a unique route of exposure for terrestrial avian and mammalian wildlife, see Section 7.2.1.1.2 for the procedure that would be used to calculate RQs.

All calculated RQs in both tables would be compared with Levels of Concern (LOCs) established by EPA (see Table 2 in Section 7.2). If a calculated RQ exceeds an established LOC value (in brackets inside the table), then there would be a potential for an acute or chronic effect (unacceptable risk) to federally listed (T&E) species and nonlisted species. See Section 7.2 for detailed descriptions of acute and chronic RQ calculations and comparison to LOCs to assess risk.

Threshold for approving PUPs:

If RQs≤LOCs, then a PUP would be approved without additional BMPs.
If RQs>LOCs, then a PUP would only be approved with additional BMPs specifically to minimize exposure (ecological risk) to bird, mammal, and/or fish species. One or more BMPs such as the following would be included in the Specific Best Management Practices section to reduce potential risk to nonlisted or listed species:

- *Lower application rate and/or fewer number of applications so RQs≤LOCs*
- *For aquatic assessments (fish) associated with cropland/facilities maintenance, increase the buffer distance beyond 25' so RQs≤LOCs.*

Justification for Use: Service personnel would describe the reason for using the pesticide based control of specific pests or groups of pests. In most cases, the pesticide label will provide the appropriate information regarding control of pests to describe in the section.

Specific Best Management Practices: Service personnel would record specific BMPs necessary to minimize or eliminate potential effects to nontarget species and/or degradation of environmental quality from drift, surface runoff, or leaching. These BMPs would be based upon scientific information documented in previous data fields of a Chemical Profile. Where necessary and feasible, these specific practices would be included in PUPs as a basis for approval.

If there are no specific BMPs that are appropriate, then Service personnel would describe why the potential effects to Refuge resources and/or degradation of environmental quality is outweighed by the overall resource benefit(s) from the proposed pesticide use in the BMP section of the PUP. See Section 4.0 of this document for a complete list of BMPs associated with mixing and applying pesticides appropriate for all PUPs with ground-based treatments that would be additive to any necessary, chemical-specific BMPs.

References: Service personnel would record scientific resources used to provide data/information for a chemical profile. Use the number sequence to uniquely reference data in a chemical profile.

The following on-line data resources are readily available for toxicological endpoint and environmental fate data for pesticides:

1. California Product/Label Database. Department of Pesticide Regulation, California Environmental Protection Agency. (http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods)

2. ECOTOX database. Office of Pesticide Programs, EPA , Washington, DC. (http://cfpub.epa.gov/ecotox/)

3. Extension Toxicology Network (EXTOXNET) Pesticide Information Profiles. Cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University and University of Idaho through Oregon State University, Corvallis, Oregon. (http://extoxnet.orst.edu/pips/ghindex.html)

4. FAO specifications and evaluations for plant protection products. Pesticide Management Unit, Plant Protection Services, Food and Agriculture Organization, United Nations. (http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/)

5. Human health and ecological risk assessments. Pesticide Management and Coordination, Forest Health Protection, US Department of Agriculture, US Forest Service. (http://www.fs.fed.us/foresthealth/pesticide/risk.htm)

6. Pesticide Chemical Fact Sheets. Clemson University Pesticide Information Center. (http://entweb.clemson.edu/pesticid/Document/Labels/factshee.htm)

7. Pesticide Fact Sheets. Published by Information Ventures, Inc. for BLM , Dept. of Interior; Bonneville Power Administration, U.S. Dept. of Energy; and Forest Service, US Department of Agriculture. (http://infoventures.com/e-hlth/pesticide/pest-fac.html)

8. Pesticide Fact Sheets. National Pesticide Information Center. (http://npic.orst.edu/npicfact.htm)

9. Pesticide Fate Database. US Environmental Protection Agency, Washington, DC. (http://cfpub.epa.gov/pfate/home.cfm).

10. Pesticide product labels and material safety data sheets. Crop Data Management Systems, Inc. (CDMS) (http://www.cdms.net/pfa/LUpdateMsg.asp) or multiple websites maintained by agrichemical companies.

11. Registered Pesticide Products (Oregon database). Oregon Department of Agriculture. (http://www.oda.state.or.us/dbs/pest_products/search.lasso)

12. Regulatory notes. Pest Management Regulatory Agency, Health Canada, Ontario, Canada. (http://www.hc-sc.gc.ca/pmra-arla/)

13. Reptile and Amphibian Toxicology Literature. Canadian Wildlife Service, Environment Canada, Ontario, Canada. (http://www.cws-scf.ec.gc.ca/nwrc-cnrf/ratl/index_e.cfm)

14. Specific Chemical Fact Sheet – New Active Ingredients, Biopesticide Fact Sheet and Registration Fact Sheet. U.S Environmental Protection Agency, Washington, DC. (http://www.epa.gov/pestidides/factsheets/chemical_fs.htm)

15. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Invasive Species Initiative. The Nature Conservancy. (http://tnsweeds.ucdavis.edu/handbook.html)

16. Wildlife Contaminants Online. US Geological Survey, Department of Interior, Washington, D.C. (http://www.pwrc.usgs.gov/contaminants-online/)

17. One-liner database. 2000. EPA , Office of Pesticide Programs, Washington, D.C.

Chemical Profile

Date:			
Trade Name(s):		**Common Chemical Name(s):**	
Pesticide Type:		**EPA Registration Number:**	
Pesticide Class:		**CAS Number:**	
Other Ingredients:			

Toxicological Endpoints

Mammalian LD_{50}:	
Mammalian LC_{50}:	
Mammalian Reproduction:	
Avian LD_{50}:	
Avian LC_{50}:	
Avian Reproduction:	
Fish LC_{50}:	
Fish ELS/Life Cycle:	
Other:	

Ecological Incident Reports

Environmental Fate

Water solubility (S_w):	
Soil Mobility (K_{oc}):	
Soil Persistence ($t_{½}$):	
Soil Dissipation (DT_{50}):	
Aquatic Persistence ($t_{½}$):	
Aquatic Dissipation (DT_{50}):	
Potential to Move to Groundwater (GUS score):	
Volatilization (mm Hg):	
Octanol-Water Partition Coefficient (K_{ow}):	
Bioaccumulation/Biocentration:	**BAF:`** **BCF:**

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** **Croplands/Facilities Maintenance:**
EECs	**Terrestrial (Habitat Management):** **Terrestrial (Croplands/Facilities Maintenance):** **Aquatic (Habitat Management):** **Aquatic (Croplands/Facilities Maintenance):**

Habitat Management Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

Justification for Use:	
Specific Best Management Practices (BMPs):	
References:	

Table CP.1 Pesticide Name

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)

[a]From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.
[b]Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

7.7 References

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WILDLAND FIRE MANAGEMENT PLAN

KAKAHAI„ANATIONAL WILDLIFE REFUGE

2004

2004 WILDLAND FIRE MANAGEMENT PLAN

KAKAHAI„ANATIONAL WILDLIFE REFUGE

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INTRODUCTION

This document will establish a Fire Management Plan for Kahahaia National Wildlife Refuge (NWR), of the Maui NWR Complex. This plan will meet the requirements of the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA) and the National Historic Preservation Act (NHPA). Compliance with NEPA was met through a Categorical Exclusion and associated Environmental Action Statement (Appendix D). For ESA Section 7 compliance, informal consultation with Ecological Services led to a "May Affect, Not Likely to Adversely Affect" determination (Appendix E). Compliance with the NHPA will be accomplished at the project level through submission of a Request for Cultural Resources Compliance form (Appendix F) to the Regional Archaeologist.

This plan is written as an operational guide for managing the refuge's wildland fire and prescribed fire programs. It defines levels of protection needed to provide for safety, protect facilities and resources, and restore and perpetuate natural processes, given current understanding of the complex relationships in natural ecosystems. It is written to comply with a service-wide requirement that refuges with burnable vegetation develop a fire management plan (620 DM 1).

This plan will outline a program of suppression of all wildland fires and pile burning (as a limited form of prescribed fire). These piles will be generated from habitat enhancement and maintenance activities covered within the refuge's ESA compliance documentation.

There is no dedicated fire management staff on the refuge. Fire Management oversight is provided by the Regional Office located in Portland. Day-to-day fire management responsibilities are provided by the Refuge Manager located onsite. Suppression of wildland and structural fires on the refuge will be provided by Maui County Fire Department, Keonakakai Station, based on County of Maui emergency policy.

COMPLIANCE WITH USFWS POLICY

Kakahaia National Wildlife Refuge was established in 1976 to provide habitat for endangered Hawaiian waterbirds, and migratory waterfowl and shorebirds. The endangered resident species on the 44.6-acre wetland include the Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian coot (*Fulica alai*), and possibly the Hawaiian duck (*Anas wyvilliana*).

This plan meets NEPA / NHPA compliance and will be implemented in cooperation with the Endangered Species Act of 1973, as amended, and will take appropriate action to identify and protect from adverse effects on any rare, threatened, or endangered species. Compliance with NEPA was met through a Categorical Exclusion and associated Environmental Action Statement (Appendix D). For ESA Section 7 compliance, informal consultation with Ecological Services led to May Affect, Not Likely to Adversely Affect determination (Appendix E). Compliance with the NHPA will be accomplished at the project level through submission of a Request for Cultural Resources Compliance form (Appendix F) to the Regional Archaeologist.

At this time, no Master Plan or Comprehensive Conservation Plan (CCP) exists for the Refuge. Development of a CCP for the entire complex is scheduled to begin in 2006. The Refuge purpose and goals can be found in the Maui National Wildlife Refuge Complex's Refuge Management Information System, and are as follows:

Refuge Purpose

- "to conserve (A) fish or wildlife which are listed as endangered species or threatened species...or (B) plants." 16 U.S.C. § 1534 (Endangered Species Act of 1973).

Refuge Goals

- **Endangered Species:** Promote the conservation of endangered species, especially native Hawaiian coot and Hawaiian stilt through healthy functioning of this wetland floodplain.

- **Habitat:** Optimize water levels for maximum habitat size and value for endangered, resident, and migrating waterfowl and shorebirds while reducing the growth and reproduction of problematical exotic species.

- **Visitor Use:** Expand understanding and appreciation of the environment through wildlife-oriented educational opportunities. Provide opportunities for quality, wildlife-dependent recreation, education, and research to enhance public appreciation, understanding, and enjoyment of refuge wildlife and habitats.

- **Habitat Restoration:** Restore and maintain the diversity and abundance of native species naturally occurring on the Refuge.

Authority and guidance for implementing this plan are found in:

- Protection Act of September 20, 1922 (42 Stat. 857; 16 U.S.C.594): authorizes the Secretary of the Interior to protect from fire, lands under the jurisdiction of the Department directly or in cooperation with other Federal agencies, states, or owners of timber.
- Economy Act of June 30, 1932: authorizes contracts for services with other Federal agencies.
- Reciprocal Fire Protection Act of May 27, 1955 (69 Stat. 66, 67; 42 U.S.C. 1856, 1856a and b): authorizes reciprocal fire protection agreements with any fire organization for mutual aid with or without reimbursement and allows for emergency assistance in the vicinity of agency lands in suppressing fires when no agreement exists.

- Disaster Relief Act of May 22, 1974 (88 Stat. 143; 42 U.S.C. 5121): authorizes Federal agencies to assist state and local governments during emergency or major disaster by direction of the President.
- National Wildlife Refuge System Administrative Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd et seq.: defines the National Wildlife Refuge System as including wildlife refuges, areas for the protection and conservation of fish and wildlife which are threatened with extinction, wildlife ranges, game ranges, wildlife management areas and waterfowl production areas. It also establishes a conservation mission for the Refuge System, defines guiding principles and directs the Secretary of the Interior to ensure that biological integrity and environmental health of the system are maintained and that growth of the system supports the mission.
- Federal Fire Prevention and Control Act of October 29, 1974 (88 Stat. 1535; 15 U.S.C.2201): provides for reimbursement to state or local fire services for costs of firefighting on federal property.
- Wildfire Suppression Assistance Act of 1989. (Pub.L. 100-428, as amended by Pub.L 101- 11, April 7, 1989).
- Departmental Manual (Interior), Part 620 DM, Chapter 1, Wildland Fire Management: General Policy and Procedures (April 10, 1998): defines Department of Interior fire management policies.
- Service Manual, Part 621, Fire Management (February 7, 2000): defines U.S. Fish and Wildlife Service fire management policies.
- National Environmental Policy Act of 1969: regulations implementing the National Environmental Policy Act (NEPA) encourages the combination of environmental comments with other agency documents to reduce duplication and paperwork (40 CFR 1500.4(o) and 1506.4).
- Clean Air Act (42 United State Code (USO) 7401 et seq.): requires states to attain and maintain the national ambient air quality standards adopted to protect health and welfare. This encourages states to implement smoke management programs to mitigate the public health and welfare impacts of Wildland and prescribed fires managed for resource benefit.
- Endangered Species Act of 1973.
- U.S. Fish & Wildlife Service Fire Management Handbook.

The authority for funding (normal fire year programming) and all emergency fire accounts is found in the following authorities:

- Section 102 of the General Provisions of the Department of Interior's annual Appropriations Bill provides the authority under which appropriated monies can be expended or transferred to fund expenditures arising from the emergency prevention and suppression of wildland fire.
- P.L. 101-121, Department of the Interior and Related Agencies Appropriation Act of 1990, established the funding mechanism for normal year expenditures of funds for fire management purposes.
- 31 US Code 665(E)(1)(B) provides the authority to exceed appropriations due to wildland fire management activities involving the safety of human life and protection of property.

FIRE MANAGEMENT OBJECTIVES

The overall objective for fire management on Kakahaia NWR is to promote a program to provide for firefighter and public safety, reduce the incidence of human-caused fires, and ensure appropriate suppression response capability to meet expected wildland fire complexity. Specific fire management objectives are:

- Promote a fire management program and control all wildland fires.
- Provide for the protection of life, property, and resources from wildland fires at costs commensurate with resource values at risk.
- Use appropriate suppression tactics and strategies that minimize long-term impacts of suppression actions.
- Use pile burning to safely and efficiently remove debris from resource management activities and reduce hazardous fuels.

DESCRIPTION OF REFUGE

General Description
Kakaha'ia National Wildlife Refuge is a coastal freshwater wetland situated along the south coast of the island of Moloka'i, County of Maui, Hawai'i (Figure 1). The 44.6-acre wetland refuge is owned in fee title by the Federal Government and administered by the Maui National Wildlife Refuge Complex. The southern portion of the refuge is bisected by Kamehameha V Highway (State Route 450) and separates the main wetland from the 2-acre coastal property. The nearest community is Kaunakakai, which lies approximately 5.5 miles northwest of the refuge boundary.

The refuge is comprised of a 15-acre freshwater marsh which is remnant of an ancient Hawaiian fishpond and a 5.5 acre pond constructed in 1983 to provide additional shallow water habitat for endangered Hawaiian stilts. The old fishpond receives water from at least two underground springs that maintains water level at approximately 2.6 feet. The smaller, shallow water pond receives water from the Old Pond, as needed. The public is allowed access to the coastal property (2 acres) which is managed as parkland by the County of Maui. Aside from intermittent moist soil areas adjacent to the ponds there is approximately 22 acres of scrub-shrub/forested habitat along the refuge's north, east, and west boundaries.

Climate
The average daily temperatures are in the 80s (°F) (range 54 to 94°F). Average annual temperature is 75°F with warmest temperatures occurring in August and September. The refuge is located in a dry area of the island and receives 10 to 20 inches of rain annually. The prevailing wind over the island is the northeasterly trades. The refuge is sheltered on the leeward side of the island where average annual wind speed is seven knots (8 mph); however, maximum speed reaches 40 knots (46 mph) during weather fronts. Relative humidity recorded on the refuge ranges from 64% to 98%.

Vegetation
The refuge's upland areas are covered with dense stands of koa-haole (*Leucaena leucocephala*), kiawe trees (*Prosopis pallida*), and Indian marsh fleabane (*Pluchea indica*). Currently, these species also occur on the pond levees from which they will be removed. The 15-acre pond contains 98% California bulrush (*Schoenoplectus californicus*) which is a non-native species that requires intensive management once established. The encroachment of this noxious weed results in decreased availability of deep water habitat for waterbird use. The 5.5-acre shallow water pond is maintained with a diversity of native and non-native grasses (*Brachiaria mutica*, *Cenchrus ciliaris*, *Cynodon dactylon*, and *Leptochloa uninervia*) but continuously needs control of non-native woody vegetation such as kiawe and fleabane, particularly on the islands. The weather conditions on Molokai result in year-round growth of most vegetation.

Fish and Wildlife
Kakaha'ia NWR was established to protect and manage endangered waterbird populations (Hawaiian stilt and Hawaiian coot) and their habitats. The larger of the ponds would typically have deeper water levels (2 ft) from October through March for resident native Hawaiian coots and migratory waterfowl, including: Northern shoveler (*Anas clypeata*) Northern pintail (*A. acuta*), and green-winged teal (*A. crecca*). The 5.5-acre pond contains shallower water conditions to host Hawaiian stilts nesting and foraging and migratory shorebirds during winter months. Typical shorebird species include lesser golden plover (*Pluvialis fulva*), ruddy turnstone (*Arenaria interpres*), sanderling (*Calidris alba*), and wandering tattler (*Heteroscelus incanus*). Black-crowned night herons (*Nycticorax nycticorax hoactli*) are regularly observed around the edge of the open water areas or roosting in nearby trees. Cattle egrets (*Bubulcus ibis*) are introduced species that are common inhabitants observed on the periphery of the wetlands.

Upland bird species also occur on the refuge and include: gray francolin (*Francolinus pondicerianus*), black francolin (*F. francolinus*), spotted doves (*Streptopelia chinensis*), zebra doves (*Geopelia striata*),

maintenance on Refuge lands that would potentially have minor, temporary, or localized effects on Refuge biological and environmental quality (threshold values not exceeded) would be approved. common myna (*Acridotheres tristis*), Northern cardinal (*Cardinalis cardinalis*), and house finch (*Carpodacus mexicanus*).

Mammals found on the refuge are all non-native and include black rat (*Rattus rattus*), Norwegian rat, feral cats, and mongoose, all of which are controlled to protect endangered waterbirds. Introduced Axis deer frequent the refuge (tracks observed) in the thick kiawe forest.

Threatened and Endangered Species
Endangered waterbirds occur in both Old and New Ponds depending upon water level. Hawaiian coots prefer water depth less than 18 inches and will also occur along the water edges in moist soil areas. Nests are built in emergent vegetation from December through March if water level remains constant. Hawaiian stilts are waders and prefer water no more than approximately seven inches in depth. The stilts nest on the ground adjacent to water and vegetation. Typically, this occurs from April through August. A majority of the foraging and nesting areas for stilts occurs in New Pond which has variable topography for nesting islands when water level is low. The critical nesting period for both endangered waterbirds is from December through August. Hawaiian ducks possibly use the refuge, but identification has been difficult due to hybridization.

A majority of the vegetation present on the refuge is non-native, invasive species; there are no threatened or endangered plant species recorded. The refuge does not contain designated Critical Habitat or portions thereof.

Table 1. Threatened and Endangered Species found at Kakahaia NWR.

Common Name	Scientific Name	Federal Status
Hawaiian Coot	*Fulica alai*	Endangered
Hawaiian Stilt	*Himantopus mexicanus knudseni*	Endangered
Hawaiian Duck	*Anas wyvilliana*	Endangered

Cultural Resources
The Service has not conducted a comprehensive archaeological survey on the refuge. Site-specific surveys will be conducted prior to any land-altering activities on the refuge. The larger pond, "Old Pond", is an Hawaiian fishpond and may be eligible for listing; however, the pond has not yet undergone a comprehensive cultural assessment and has not been designated an historic site.

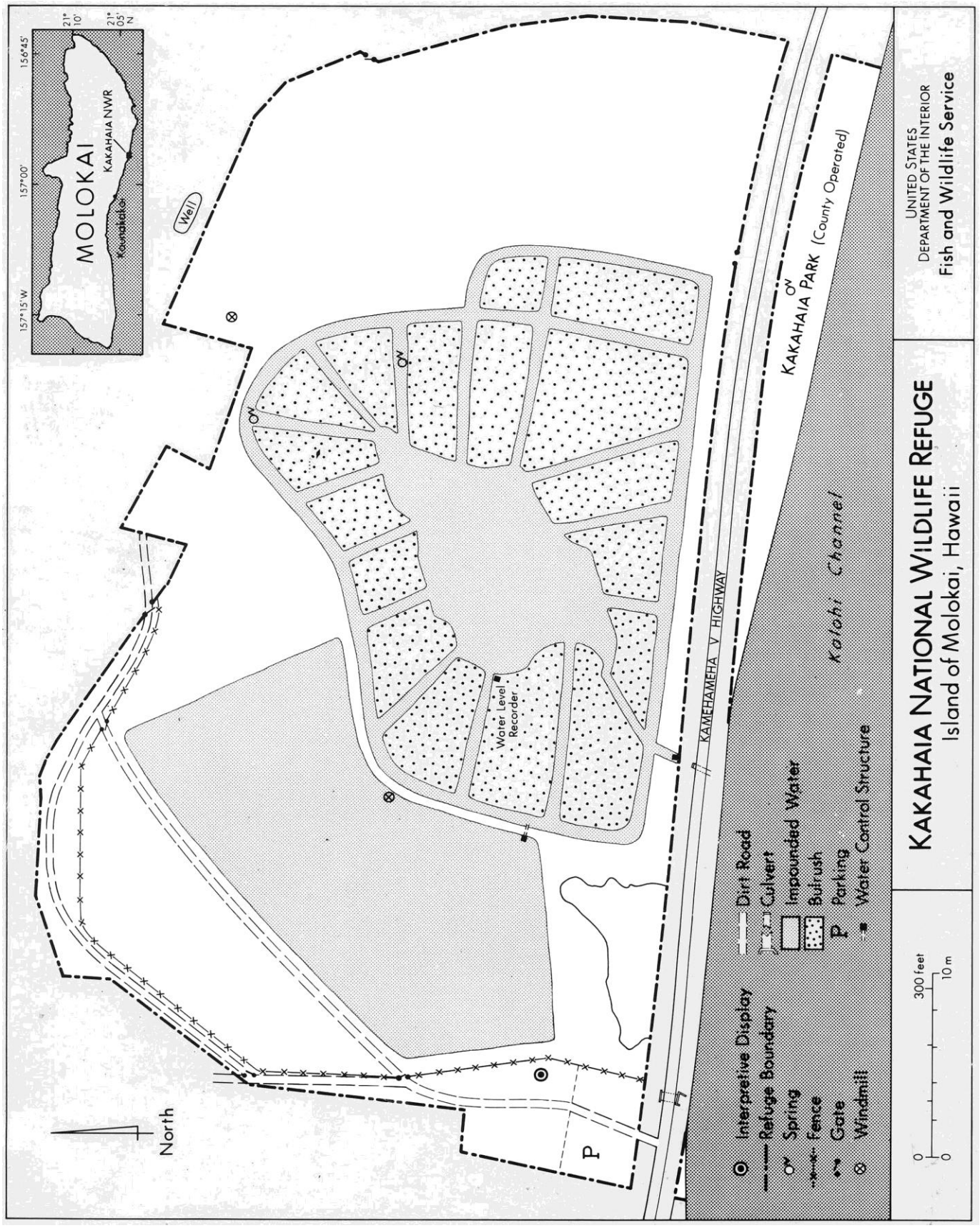
Physical Resources
Elevation of Kakahaia National Wildlife Refuge ranges from sea level to approximately 10 feet. The soils are poorly drained, except for most of the upland areas. During periods of heavy rain, erosion from the upper watershed has delivered large amounts of soil to the northern (upper) edges of the wetlands and will, with time, promote increased sedimentation into the larger pond due to the large stand of bulrush.

Structures and Facilities
Kakahaia NWR is an unstaffed refuge which is visited twice a month to census birds, perform light maintenance duties and to check water conditions. Limited presence at the site results in minimal structures and facilities. To secure property there is one metal storage container (20 ft x 12 ft) and pre-fabricated shed. Other structures include a windmill between the ponds, a submersible pump to draw water from Old to New Pond, and various hydrological staff gages and piezometers. The staff has one refuge vehicle which is parked at the Hoolehua airport between visits.

An electric line is buried within the north levee of New Pond and extends from the entrance road to the maintenance area and ends at the windmill pump.

Public Access
Kakahaia NWR is an un-staffed refuge and has limited public access, except to the coastal property (2 acres) across Kamehameha V Highway which is not fenced. Refuge staff performs maintenance and restoration activities twice per month. Environmental education and public access is limited to pre-arranged days when appropriate staff are available to travel for the day.

Figure 1. Kakahaia National Wildlife Refuge.



WILDLAND FIRE MANAGEMENT SITUATION

Historic Role of Fire

Historic natural fires on Moloka'i have been limited to volcanic eruptions and lightning and are very infrequent. In general the native vegetation is not well adapted to fire disturbances. Non-native (invasive) species typically colonize burned areas to the exclusion of native species.

Pre-settlement Fires

There is no clear indication that fire was an integral part of the native ecosystem. There are no records indicating fire frequency prior to settlement, although rare fire events likely occurred as a result of volcanic activity and lightning.

Post-settlement Fire History

No wildland fires are known to have occurred on the Refuge. The grassy slope inland of the refuge experienced some small wildfires prior to 1984. In 1980, a human-caused wildfire occurred one mile west of the refuge and quickly spread through the dryland vegetation. In 1988, an extensive fire (9,500 acres) occurred through an open kiawe grassland eight miles to the west. Throughout the state, fire season is considered by the Hawaii Department of Forestry and Wildlife (DOFAW) to occur during a three-month period in late summer. However, given the extreme variability of weather in Hawaii, fires may occur at any time during the year. There is no clearly-defined fire season for the refuge.

Prescribed Fire History

There is no history of prescribed fire use on the refuge. Pile burning will occur in September after endangered waterbird breeding season and before winter rains.

Responsibilities

Kakahaia NWR does not have a dedicated fire management organization. The Project Leader and Refuge Manager are responsible for planning and implementing the fire management program on the Refuge. Staff from the Regional Office in Portland will act as the Zone Fire Management Officer (FMO), and are responsible for fire management program oversight. The Project Leader will assign fire management responsibilities as collateral duties to staff who possess appropriate training, experience, and incident qualifications. Preparedness planning and work is accomplished by Refuge staff in accordance with national and regional fire management direction under guidance from the Regional Office. Emergency fire management actions will be handled by Refuge staff according to training and incident qualifications. The Regional Office will be immediately notified of all emergency actions. Additional information and direction is included in the Fire Dispatch Plan (Appendix C).

Refuge Manager

- Is responsible for implementation of all fire management activities within the Refuge and will ensure compliance with Department and Service policies.
- Selects the appropriate management responses to wildland fires.
- Approves any Pile Burn Plan.
- Coordinates Complex programs to ensure personnel and equipment are made available and utilized for fire management activities.
- Ensures that the fire management program is considered during refuge-related planning and project implementation.
- Acts as the primary Resource Advisor during fire management planning and operations.
- Coordinates with cooperators to ensure adequate resources are available for fire operational needs.

Biologist

- Coordinates through Project Leader to provide biological input for the fire program.
- Participates, as requested in fire suppression and rehabilitation projects according to level of training and qualifications.
- May act as primary Refuge Resource Advisor for the Project Leader.

Zone Fire Management Officer

- Responsible for all fire-related planning for the Refuge.
- Solicits program input from the Project Leader and Biologist.
- Coordinates fire related training.
- Coordinates with cooperators to ensure adequate resources are available for fire operational needs.
- Is responsible for preparation of fire reports following the suppression of wildland fires.
- Prepares an annual report detailing fire activities undertaken in each calendar year. This report will serve as a post-year's fire management activities review, as well as provide documentation for development of a comprehensive fire history record for the Complex.
- Submits budget requests and monitors FIREBASE funds.
- Maintains records for all personnel involved in related activities, detailing each individual's qualifications and certifications for such activities.

Incident Commander

Incident Commanders (ICs) of any level use strategies and tactics as directed by the Project Leader and WFSA where applicable to implement selected objectives on a particular incident. A specific Limited Delegation of Authority (Appendix I) will be provided to each Incident Commander prior to assuming responsibility for an incident. Major duties of the Incident Commander are given in the National Wildfire Coordinating Group (NWCG) Fireline Handbook, including:

- Brief subordinates, direct their actions, and provide work tools.
- Ensure that safety standards identified in the Fire Orders, the Watch Out Situations, and agency policies are followed at all times.
- Personally scout and communicate with others to be knowledgeable of fire conditions, fire weather, tactical progress, safety concerns and hazards, condition of personnel, and needs for additional resources.
- Order resources to implement the management objectives for the fire.
- Inform appropriate dispatch of current situation and expected needs.
- Coordinate mobilization and demobilization with dispatch and the Zone FMO.
- Perform administrative duties, i.e., approving work hours, completing fire reports for command period, maintaining property accountability, providing or obtaining medical treatment, and evaluating performance of subordinates.
- Assure aviation safety is maintained to the highest standards.

Resource Advisor

The Resource Advisor (RA) is a technical specialist appointed by the Agency Administrator and reports to the IC or designee and provides guidance for natural and cultural resource protection from suppression operations. The RA provides input to the IC in the development of fire suppression strategies and tactics to minimize or mitigate the expected impacts of fire and fire and fire suppression actions upon natural and cultural resources. The RA also provides input required for the development of rehabilitation plans. Resource Advisor responsibilities include (NWCG 1996):

- Provides analysis, information, and advice to fire managers for areas of concern, including critical watersheds, riparian areas, fisheries, and water sources; threatened or endangered species;

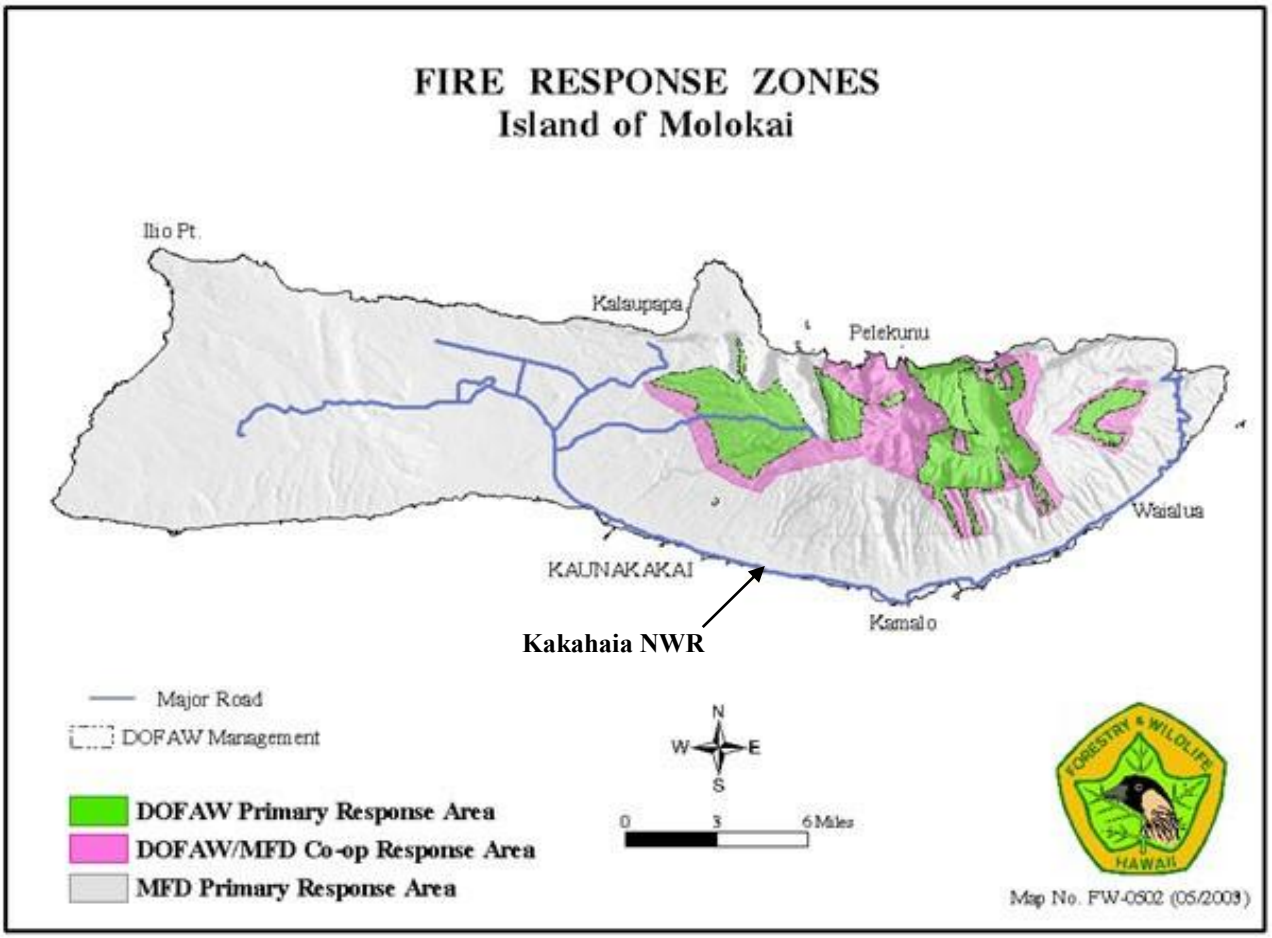
- prehistoric and historic archaeological sites and cultural landscapes; fuel breaks B locations and specifications; urban interface impact B structures and improvements; and hazardous materials
- Assists the planning function in developing fire maps and identifying areas of concern
- Determines environmental restrictions commensurate with FMP resource protection in the fire area
- Provides recommendations to fire management personnel and agency administrators for fire suppression rehabilitation needs
- Documents potential and actual suppression/fire-related resource impacts and the rationale for protection of priority areas
- Provides resource information to local initial attack ICs, dispatchers, or other fire personnel during pre-season training and planning meetings.

Interagency Operations

Maui County Fire Department (Keonakakai Station) will provide initial attack response to wildland and structural fires on the refuge (Figure 2). If qualified resources are not available, resources will be ordered through proper dispatch procedures (Appendix C). The Hawaii Department of Fish and Wildlife (DOFAW) would be able to respond to fires in the white areas of the figure below only under specific conditions (i.e., extreme threats to public safety, local resources fully committed, extreme fire behavior, etc.). In this case, the request for assistance must come from the County Fire Department through the County Civil Defense to State Civil Defense. No formal cooperative agreements exist with these agencies. When they are developed, they will be added to Appendix G.

Kealia Pond will use the Incident Command System (ICS) as a guide for fireline organization. Qualifications for individuals are per DOI Wildland Fire Qualifications and Certification System, part of NIIMS and the National Wildland Fire Coordination Group (NWCG) Prescribed Fire Qualification Guide. Depending on fire complexity, some positions may be filled by the same person.

Figure 2. Fire Response Zones for the Island of Maui.



Protection of Sensitive Resources
Resource Advisors will be required for all wildland fires on the refuge. The advisor will work with the suppression resources to limit environmental impact.

The Regional Archaeologist will work with fire staff, Project Leaders, and Incident Commanders to ensure that cultural resources are protected from fire and fire management activities. The "Request For Cultural Resource Compliance" (RCRC) form (Appendix F) will be used to inform the Regional Archaeologist of impending activities, thereby meeting the regulations and directions governing the protection of cultural resources as outlined in Departmental Manual Part 519, National Historic Preservation Act (NHPA) of 1966, Code of Federal Regulations (36CFR800), the Archaeological Resources Protection Act of 1979, as amended, and the Archaeological and Historic Preservation Act of 1974. The NHPA Section 106 clearance will be followed for any fire management activity that may affect historic properties (cultural resources listed or eligible for listing on the National Register of Historic Places).

Impacts to archaeological resources by fire resources vary. The four basic sources of damage are (1) fire intensity, (2) duration of heat, (3) heat penetration into soil, and (4) suppression actions. Of the four, the most significant threat is from equipment during line construction for prescribed fires or wildfire holding actions (Anderson 1983).

The following actions will be taken to protect archaeological and cultural resources:

Wildland Fires

- Minimum impact fire suppression tactics will be used to the fullest extent possible.
- The Resource Advisor will inform fire suppression personnel of any areas with cultural resources. The Resource Advisor should contact the Regional Archaeologist for more detailed information.
- Foam use will be minimized in areas known to harbor surface artifacts.
- Mechanized equipment should not be used in areas of known cultural significance.
- The location of any sites discovered as the result of fire management activities will be reported to the Regional Archaeologist.
- Rehabilitation plans will address cultural resources impacts and will be submitted to the Regional Archaeologist using the RCRC.

Pile Burns

- The refuge fire staff will submit a completed RCRC to the Regional Archaeologist as soon as the burn area is identified (i.e., as soon as feasible).
- Upon receipt of the RCRC, the Regional Archaeologist will be responsible for consulting with the Zone FMO and evaluating the potential for adverse impacts to cultural resources.
- When necessary, the Regional Archaeologist will coordinate with the State Historic Preservation Officer (SHPO). The SHPO has 30 days to respond. The Refuge will consider all SHPO recommendations.
- Mechanized equipment should not be used in areas of known cultural significance.
- The location of any sites discovered as the result of fire management activities will be reported to the Regional Archaeologist.

WILDLAND FIRE SUPPRESSION ACTIVITIES

Fire program management describes the operational procedures necessary to implement fire management at Kakahaia NWR. Program management includes fire prevention, preparedness, emergency preparedness, fire behavior predictions, fire detection, minimum impact fire suppression, minimum impact rehabilitation, and documentation.

All fires not classified as prescribed fires are wildland fires and will be appropriately suppressed. Maui County will provide wildland fire suppression resources under most circumstances. Most suppression activities will necessitate the use of heavy equipment to create firebreaks or allow the fire to burn to the water.

There is no clearly defined fire season for the refuge and records show that fires may occur at any during the year.

Fire Management Strategies

Although resource impacts of suppression alternatives must always be considered in selecting a fire management strategy, managing fire for resource benefit is not authorized on this refuge. Appropriate suppression action will be taken to provide for firefighter safety, public safety, and protection of resources.

Critical protection areas, including all refuge structures and facilities, will receive priority consideration in fire control planning efforts. In all cases, the primary concerns of fire suppression personnel will be safety. If needed, all individuals not involved in the suppression effort will be evacuated.

Suppression strategies should be applied so that the equipment and tools used to meet the desired objectives are those that inflict the least impacts upon the natural and cultural resources. Minimum impact suppression tactics (MIST) will be employed to protect all resources. Natural and artificial barriers will be used as much as possible for containment. When necessary, fire line construction will be conducted in such a way as to minimize long-term impacts to resources. Sites impacted by fire suppression activities or by the fire will be rehabilitated as necessary, based on an approved course of action for each incident.

Specific wildland fire management and suppression strategies for Kakahaia NWR are:

- All wildland fires will be controlled using the appropriate suppression strategy which considers safety, property, natural and cultural resources, and economics.
- Mechanical treatment will be used to reduce hazardous fuels around structures and improvements.

Preparedness

Preparedness is the work accomplished prior to fire occurrence to ensure that the appropriate response, as directed by the Fire Management Plan, can be carried out. Preparedness activities include: budget planning, equipment acquisition, equipment maintenance, dispatch (initial attack, extended, and expanded), equipment inventory, personnel qualifications, and training. The preparedness objective is to have a well trained and equipped fire management organization to manage all fire situations within the monument. Preparedness efforts are to be accomplished in the time frames outside the normal fire season dates.

Historical Weather Analysis

There is no clearly defined fire season for the refuge and records show that fires may occur at any during the year.

General fire weather information can be obtained through the National Oceanic and Air Administration (NOAA) at fire.boi.noaa.gov. Kakahaia NWR is located in the area serviced by the National Weather Service (NWS) office in Honolulu, Hawaii. The Fire Weather section of the Honolulu NWS website, www.prh.noaa.gov/hnl/pages/firewx.php, contains zone maps, fire weather forecasts, and instructions for requesting a spot weather forecast. The refuge falls within the Molokai Leeward (013) Fire Weather Zone.

Fire Prevention
An active fire prevention program will be conducted, as needed, in conjunction with other agencies to protect human life and property, and prevent damage to cultural resources or physical facilities.

A program of internal and external education regarding potential fire danger may be implemented. Visitor contacts, bulletin board materials, handouts and interpretive programs can be utilized to increase visitor and neighbor awareness of fire hazards.

During periods of extreme or prolonged fire danger area closures or emergency restrictions regarding refuge operations may become necessary. Such restrictions, when imposed, will usually be consistent with those implemented by cooperators.

Hazard Reduction for Structure Protection
Hazard reduction is conducted to prevent wildland fires from spreading onto structures owned by the FWS and adjacent structures. Vegetation around structures (metal container and shed) is cleared a minimum of two feet. Currently, this vegetation must be hauled to the dump for removal. Non-FWS structures include privately-owned residences (seven) located along all but the south boundary.

Staffing Priority Levels
No dedicated fire staff exists on the refuge. If drought conditions require additional fire preparedness and funding, addition qualified fire personnel may be assigned to the refuge.

Training
Departmental policy requires that all personnel engaged in suppression and prescribed fire duties meet the standards set by the National Wildfire Coordinating Group (NWCG), in addition to Service-specific standards. Kakahaia NWR will conform strictly to the requirements of the wildland fire management qualification and certification system and USFWS guidelines.

Basic wildland fire training refreshers are offered annually for red-carded firefighters through surrounding agencies, and records are kept in a centralized database. Additional training is available from surrounding agencies in pump and engine operation, power saws, firefighter safety, fire weather and fire behavior, helicopter safety and prescribed fire objectives and activities. On-the-job training is encouraged and will be conducted at the field level. Whenever appropriate, the use of fire qualification task books will be used to document fire experience of trainees. The Zone FMO will coordinate fire training needs with those of other nearby refuges, cooperating agencies, and the Regional Office.

The refuge supports the development of individual Incident Command System (ICS) overhead personnel from among qualified and experienced refuge staff for assignment to overhead teams at the local, regional, and national level.

Fire suppression is an arduous duty. On pile burns, personnel may be required to shift from implementation and/or monitoring activities to suppression. Poor physical condition of crew members

can endanger safety and lives during critical situations. Personnel performing fire management duties will maintain a high level of physical fitness. This requires successful completion of a fitness pack test. Personnel must complete a three mile hike with a 45 pound pack in less than 45 minutes. Employees participating in any wildland fire activities on Fish and Wildlife Service or cooperators= lands will meet fitness requirements established in PMS 310-1, except where Service-specific fitness requirements apply.

Supplies and Equipment
Currently, the refuge does not possess any fire equipment or maintain a fire cache. Equipment and supplies are available through the interagency cache system.

Detection
Fires are generally reported by the public to the Maui County Fire Department. The Fire Department notifies refuge staff of any suppression operations on the refuge.

Communications
Currently, refuge communications are limited to telephones (Appendix C). No personnel will be on-site at a wildland fire without direct communications with the suppression resources.

Pre-Attack Plan
Upon discovery of a fire, all subsequent actions will be based on the following:

- The Incident Commander (IC) will locate, size-up, and coordinate suppression actions. The IC will complete the pre-attack planning checklist.
- Provide for public safety.
- Considering the current and predicted fire conditions, the Incident Commander will assess the need for additional suppression resources and estimate the final size of the fire. The potential for spread outside of the refuge should be predicted, as well as the total suppression force required to initiate effective containment action at the beginning of each burning period.
- The Incident Commander will assess the need for law enforcement personnel for traffic control, investigations, evacuations, etc., and make the request to the FMO.
- Document decisions and complete the fire report (DI-1202).
- Should a wildland fire move into an extended attack a Delegation of Authority will be invoked. Once a Delegation of Authority has been authorized the Incident Commander will make the final decisions pertaining to the fire. A copy of the Delegation of Authority is in Appendix ?.

Fire Management Units
Fire Management Units (FMUs) are areas on a refuge which have common wildland fire management objectives and strategies, are manageable units from a wildland fire standpoint, and can be based on natural or man-made fuel breaks. Kakahaia NWR will be managed as a single FMU.

Due to staff limitations, relatively small land management parcels, long response times, valuable resources, and values at risk on neighboring lands, this plan does not authorize managing wildland fire for resource benefit. Wildland fires will be suppressed using the appropriate suppression response. Pile burning, as a limited form of prescribed burning, will be used to reduce hazardous fuels and to meet resource management objectives.

Fuels and Fire Behavior
Fuel Types and Fire Behavior

- There are two general fuel types on the refuge. These fuel types correspond to Anderson's (1982) Fuel Models 3 and 6 (Table 2). These types of fuels promote rapid spread and flame heights that

may exceed 20 feet, thus causing control problems. Steady trade winds help promote rapid fire growth.

Table 2. Habitat types and fuel models on Kakahaia NWR.

Habitat Type	Fuel Model*	Acres
Wetlands	1/3	20.5
Uplands	6	22.0
Open Water/Roads	N/A	5.0

* NFFL Fuel Model (Anderson 1982)

Fuel Model 3. The 20.5 acres of wetlands on the refuge are characteristic of Fuel Model 3. The 5.5-acre shallow water pond is maintained with a diversity of native and non-native grasses, including *Brachiaria mutica*, *Cenchrus ciliaris*, *Cynodon dactylon*, and *Leptochloa uninervia*. Depending on flooding and climatic conditions, the vegetation in some areas of this pond may be shorter and more closely resemble Fuel Model 1. The 15-acre pond contains 98% California bulrush (*Schoenoplectus californicus*). Between the two ponds, approximately 3 acres are open water and unburnable. Fires in this fuel are the most intense of the grass group and display high rates of spread under the influence of wind. Wind may drive fire into the upper heights of the grass and across standing water. Approximately one-third of the stand is considered dead or cured and maintains the fire. Table 3 shows predicted flame lengths and rates of spread in Fuel Models 1 and 3 under varying conditions from an old burn plan for the former Hawaiian Wetlands NWRC. These predictions are only for backing fires, which assumes no wind. Wind will cause heading fires and may significantly increase flame lengths and rates of spread for these fuel models.

Table 3. Backing fire behavior predictions for Kakahaia NWR in Fuel Models 1 and 3.

Parameter	Fuel Model 1		Fuel Model 3			
20-ft Windspeed	0-10 mi/hr		0-10 mi/hr			
Effective Midflame Windspeed*	0 mi/hr		0 mi/hr			
Time of Day	0800	1000	0800	0800	1000	1000
Cloud Canopy Cover (%)	Clear	Clear	Clear	Clear	Clear	Clear
Temperature (°F)	70	90	70	70	90	90
Relative Humidity (%)	65	20	65	65	20	20
Dead Fuel Moisture (%)	12	5	12	13	5	6
Slope (degrees)	Flat	Flat	Flat	Flat	Flat	Flat
Flame Length (ft)	0	1	2	2	3	3
Rate of Spread (ch/hr)	0	5	4	3	5	5

* Backing fire assumes effective mid-flame wind speed = 0.

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Fuel Model 6. The refuge's 22 acres of uplands are covered with dense stands of koa-haole (*Leucaena leucocephala*), kiawe trees (*Prosopis pallida*), and Indian marsh fleabane (*Pluchea indica*). Fires carry through the shrub layer, but this requires moderate winds. Fire will drop to the ground at low wind speeds or at openings in the stand. With winds of 5 miles/hour, dead fuel moisture content of 8%, and live fuel moisture content of 100%, predicted flame length is 6 feet, and rate of spread is 32 chains/hour (Anderson 1982).

Fire Effects

Fire can promote non-native species, but can be an effective management tool to reduce the density and complexity of these species and enhance endangered waterbird habitat. If a wildland fire were to occur on the refuge, other than short-term impacts, no negative ecological impacts would be anticipated from either suppression methods or the fire itself. A fire during peak Hawaiian stilt or coot nesting could account for some nesting failure; however, the benefits to waterbirds of reducing coverage by rank stands of non-native species would outweigh any immediate negative effects.

The ecological effect of the 1980 fire near the refuge was limited to minor erosion problems. Native vegetation quickly re-established within 6 months.

Suppression Tactics

Suppression involves a wide range of possible tactics from the initial attack to final control. To this end, all wildland fires will be suppressed in a safe, aggressive, and cost-effective manner to produce efficient action with minimal resource damage and limit smoke impacts to local communities.

Typically, initial attack suppression actions are conducted by the Maui County Fire Department. All fires will be assessed by the initial on-scene Incident Commander and attacked using minimum impact fire suppression tactics for the Refuge. Roads and natural barriers will be used as much as possible to reduce fireline construction. Fireline and mop-up through riparian areas should consider long-term damage to vegetation. Unnecessary cutting and bucking should be replaced with alternative actions whenever possible. Where wildland fires cross roads, the burned area adjacent to the road should be mopped up and dangerous snags felled.

A Resource Advisor should be assigned to the incident from the beginning to assist with on-the-ground tactical decisions and to document rehabilitation needs. There will be only one Incident Commander who will be responsible to the Refuge Project Leader. The Incident Commander will designate all overhead positions on fires requiring extended attack. Reference should be made to a Delegation of Authority (Appendix G).

Suppression Conditions

A full suppression alternative was selected for this refuge which requires containment and control of all wildland fires. Wildland fires will not be managed to achieve resource objectives, although impacts to resources may be considered in selecting suppression strategies. Suppression guidelines and restrictions (Table 4) were developed for this refuge to protect natural and cultural resources. These guidelines will be discussed annually with Maui County Fire Department to ensure their compliance. The Refuge Manager should review these guidelines annually and document any changes.

A Resource Advisor will be used to ensure impacts to natural and cultural resources are minimized. The use of heavy, ground-disturbing equipment (including bulldozers) is prohibited for normal fire suppression operations. The use of foams and retardants is also prohibited due to the presence of endangered waterbirds and extensive wetlands. Off-road travel and firelines constructed with hand tools and/or chainsaws must be approved by the Resource Advisor at all times. Low-flying aircraft and helicopter water drops must be approved by the Resource Advisor from December through August; the

Incident Commander has approval authority all other times. Hose lays from engines must be approved by the Resource Advisor from April through August due to the presence of nesting endangered waterbirds; the Incident Commander has approval authority all other times.

Table 4. Kakahaia NWR Wildland Fire Suppression Guidelines.

Kakahaia National Wildlife Refuge – Wildland Fire Suppression Guidelines	
NOTE: If human life is threatened, the Incident Commander has the authority to order any suppression strategy or tactic available to mitigate the threat.	
	FIRE MANAGEMENT UNIT – KAKAHAIA NWR
FMU Description	All lands within Kakahaia National Wildlife Refuge, Molokai, Hawaii.
Special Considerations	• Smoke/fire may cause a health hazard to neighboring communities. • Endangered waterbirds present in wetlands.
Preferred Suppression Strategies	Aggressively suppress fire, holding it to the fewest burned acres possible within safety constraints, with minimal effect on endangered species and their habitats.
TACTIC	**MUST BE APPROVED BY:**
Hand line/Chainsaws	Resource Advisor
Heavy Equipment	Prohibited
Off-road Travel	Resource Advisor
Hose Lays	Resource Advisor (April – August); Incident Commander otherwise
Foam/Retardant	Prohibited
Water Drops	Resource Advisor (December – August); Incident Commander otherwise
Helicopters, other AC	Resource Advisor (December – August); Incident Commander otherwise
Safety Considerations	High rates of fire spread, especially in windy conditions.

Wildland Fire Situation Analysis

For fires that cannot be contained in one burning period, a Wildland Fire Situation Analysis (WFSA) must be prepared. In the case of a wildland fire, the Project Leader, in conjunction with the Zone FMO, will prepare the WFSA. Approval of the WFSA resides with the Project Leader.

The purpose of the WFSA is to allow for a consideration of alternatives by which a fire may be controlled. Damages from the fire, suppression costs, safety, and the probable character of suppression actions are all important considerations.

Public safety will require coordination between all refuge staff and the IC. Notices should be posted to warn visitors, trails may be closed, traffic control will be necessary where smoke crosses roads, etc. Where wildland fires cross roads, the burned area adjacent to the road should be mopped up and dangerous snags felled. Every attempt will be made to utilize natural and constructed barriers, including changing fuel complexes, in the control of wildland fire. Rehabilitation efforts will concentrate on the damages done by suppression activities rather than on the burned area itself.

Aircraft Operations
Aircraft may be used in all phases of fire management operations. All aircraft must be Office of Aircraft Services (OAS) or Forest Service approved. An OAS Aviation Policy Department Manual will be provided by OAS. As in all fire management activities, safety is the primary consideration. Qualified aviation personnel will be assigned to all flight operations.

Helicopters may be used for reconnaissance, bucket drops and transportation of personnel and equipment. Natural helispots and parking lots are readily available in most cases. Clearing for new helispots should be avoided where possible. Improved helispots will be rehabilitated following the fire.

Burned Area Emergency Stabilization and Rehabilitation
There are three methods of repairing damage caused by wildland fires and wildland fire suppression activities – emergency stabilization, rehabilitation, and fire suppression activity damage repair.

Policy and Implementation Guidance
Departmental policy for emergency stabilization and rehabilitation (ESR) on Service lands following wildland fire, including objectives, implementation, plan submittal, monitoring, and funding, is found in the Department Manual (620 DM 3). Service ESR supplemental policy can be found in the Service Manual (095 FW 3.9), with policy implementation guidance provided in Chapter 5 of the FWS Fire Management Handbook. More detailed guidance for can be found in the Interagency Burned Area Emergency Stabilization and Rehabilitation Handbook (2002) and Technical Reference (2002). The Service maintains an internet web site (http://fire.fws.gov/ifcc/rehab/) that provides access to these and several other guidance documents.

Any treatment or activity will have an approved plan developed prior to implementation. Monitoring specifications will be included in the plan for each treatment or activity. Emergency stabilization and rehabilitation treatments and activities will be written in separate plans. The Project Leader, Biologist, and FMO will review all plans. The final plans will be submitted to the Region for review prior to submission to the Washington Office.

Compliance
Implementation activities will be conducted in a manner that is compatible with long-term goals and approved land management plans (e.g., Comprehensive Conservation Plan, Habitat Management Plan, Fire Management Plan), in compliance with applicable law and policy, including the National Environmental Policy Act, Endangered Species Act, Clean Water Act, and National Historic Preservation Act.

Required Reporting
The IC will be responsible for documenting decisions and completing the fire report (e.g., ICS-214, DI-1202). The Zone FMO will be responsible for any additional required reports.

Fire Investigation
Fire management personnel will attempt to locate and protect the probable point of origin and record pertinent information required to determine fire cause. They will be alert for possible evidence, protect the scene and report findings to the fireline supervisor.

Prompt and efficient investigation of all suspicious fires will be carried out. However, fire management personnel should not question suspects or pursue the fire investigation unless they are currently Law Enforcement Commission qualified.

Personnel and services of other agencies may be utilized to investigate wildland fire arson or fire incidents involving structures. All fire investigations should follow the guidelines outlined in the Fire Management Handbook (2004).

HAZARD FUEL REDUCTION

Hazard fuel is vegetation which presents a risk of ignition and sustaining spread of a wildland fire in relationship to a threat to some value. Hazard fuel reduction is both a fire prevention activity and a wildland fire protection measure. The objectives of this activity are:

- Reduce the hazard risk to service structures and facilities from an approaching wildland fire.
- Reduce the risk of fire spreading to the wildland from a fire originating in a Service owned structure or facility.
- Provide defensible space and safety to personnel at those facilities during a wildland fire.
- Meet federal, state and local fire hazard reduction ordinances.

Hazard Fuel Reduction Strategies
Strategies include mechanical treatment of the hazard fuels and the debris disposal. Mechanical treatment is accomplished using minimal maintenance procedures (herbicide treatment, mowing). Clearing of vegetation is primarily for wetland enhancement/restoration and to provide vehicle access to remote areas of the refuge. Vegetation clearing associated with habitat restoration occurs during summer months when water levels are low and ponds are accessible. Debris would be piled within the ponds and burned in September. These areas are open and do not have upper canopies. Trimming around the structures is completed to provide a minimum two-foot buffer. Clearing of upland vegetation was performed in 1999 to open up habitat; however, much of the vegetation (trees) has filled in. Since then, clearing of upland vegetation has not been performed.

Debris must be disposed of to complete the mitigation of the hazard. Debris disposal may be accomplished by scattering, chipping or pile burning. The quantity of vegetation, diameter size, crew availability, and logistical support will dictate the method used. If scattering of cut vegetation is used, an evaluation of the overall fuel loading needs to be considered so as to not add to the hazard fuel problem.

Pile Burning Guidelines
When planning to dispose of debris by pile burning, specific guidelines must be followed in order to provide for safety and reduce the escape potential. General guidelines for pile burning are the same as for prescribed burning. Service guidelines are found in the FWS Fire Management Handbook, Section 2. This section of the Fire Management Plan is for the purpose of outlining the steps to take when conducting pile burning only. No prescribed burning of standing vegetation will be conducted. References to a burn plan and burn boss are only for the purpose of pile burning.

Pile burning will be used to dispose of cut vegetation resulting from refuge activities such as annual hazard reduction around structures. Limbs and branches of overhanging trees and brush will annually need to be trimmed back. At times trees may have been blown down during storms which will require debris removal. The most economical and expedient method is through burning of the piled vegetation on site. Pile burning is typically rated as complexity level 3 due to the low risk of escape, limited control forces, and time of year conducted. Safety concerns are still present even at the low complexity level. Careful consideration must be given to smoke management, escape potential and resource benefit when planning and rating the pile burn. The complexity of each pile burn would be evaluated using the NWCG Prescribed Fire Complexity Rating System Guide.

Pile Burn Plan
A Burn Boss will conduct a field reconnaissance of the proposed pile burn location with the Refuge Manager to discuss objectives, special concerns, and gather all necessary information to write the burn plan. After completing the reconnaissance, a qualified Burn Boss will write the Pile Burn Plan.

All pile burning will have a Pile Burn Plan. The Pile Burn Plan is a site-specific action plan describing the purpose, objectives, prescription, and operational procedures needed to prepare and safely conduct the burn. The project area, objectives, and constraints will be clearly outlined. No piles will be ignited unless all prescriptions of the plan are met. Fires not within those parameters will be suppressed. Pile Burn Plans will follow the format found in the FWS Fire Management Handbook, Section 2.2. Pile burning is considered a complexity level 3 prescribed burn (in most cases) and should use the plan format contained in Appendix C. Each burn plan will be reviewed by the Project Leader, Refuge Manager, Refuge Biologist, Zone FMO, and Burn Boss. The Project Leader has the authority to approve the burn plan.

The Pile Burn Plan requires the following items to be completed prior to ignition:

- Contingency plan
- Complexity analysis
- Review and approval signatures
- Go/no go checklist
- Spot weather forecast

Pile Burning Strategies and Personnel

Pile burning will only be executed by qualified personnel. Pile burning requires a qualified Burn Boss. The Burn Boss will fill all required positions to conduct the burn with qualified personnel. All positions listed in the burn plan must be available for the duration of the pile burn or it will not be initiated.

Weather and fuel moisture conditions must be monitored closely in the project area to determine when the prescription criteria are met. A belt weather kit may also be utilized to augment monitoring.

When pertinent prescription criteria are within the acceptable range, the Burn Boss will select an ignition time based on current and predicted weather forecasts. A thorough briefing will be given by the Burn Boss on the day of the burn and specific assignments and placement of personnel will be discussed. An updated spot weather forecast will be obtained on the day of ignition and all prescription elements will be re-checked to determine if all elements are still within the approved ranges. If all prescription elements are met, a test fire will be ignited to determine on-site fire behavior conditions as affected by current weather. If conditions are not satisfactory, the test fire will be suppressed and the burn will be rescheduled. If conditions are satisfactory, the burn will continue as planned.

Maui County Fire Department will be made aware of any planned burn. If the burn pile escapes the predetermined burn area, all further ignition will be halted except as needed for suppression efforts. Suppression efforts will be initiated, as discussed in the pre-burn briefing. The Zone FMO will be notified immediately of any control actions on a prescribed burn. If the burn exceeds the initial suppression efforts, the burn will be declared a wildland fire and suppressed using guidelines established in the burn plan. A WFSA will be completed and additional personnel and resources ordered as determined by the Incident Commander. If the fire continues to burn out of control, additional resources based on the contingency plan will be called from the local cooperating agencies via the servicing dispatch. A management overhead team may be requested to assume command of the fire if necessary. Each Pile Burn Plan will detail the contingency plan with identified resources for suppression. This plan will serve as the incident action plan during the initial attack phase of an escape.

Monitoring and Evaluation

During pile burns, monitoring can serve as a precursor to invoking suppression action by determining if the burn is in prescription, assessing its overall potential, and determining the effects of the pile burn. Pile burning does not usually require extensive monitoring. Weather, fire behavior, and smoke

management are elements that require monitoring. The Burn Boss will assume responsibility for coordinating and implementing this section. Personnel may be assigned specific tasks such as weather monitoring to document these elements and keep the Burn Boss informed of conditions. Special situations or projects may dictate more extensive monitoring and evaluation.

Required Reports

All forms will be completed as outlined by the Pile Burn Plan. Accomplishments, costs, fire report (DI-1202), weather data, and first order fire effects monitoring are the responsibility of the Burn Boss. The Burn Boss may prepare a final report on the project for the Refuge Manager as requested. Information should include a narrative of the burn operation, a determination of whether objectives were met, weather and fire behavior data, number of work hours, and final cost of the burn.

AIR QUALITY / SMOKE MANAGEMENT GUIDELINES

An annual burn permit is required by the State of Hawaii, Department of Health for each prescribed burn. This permit process evaluates the burn in relation to emissions and local air quality standards. Typically, smoke from fires does not significantly affect air quality standards. The Refuge is required to report the schedule of each burn to the Department of Health and is also required to follow permit conditions provided by the Department of Health that are designed to minimize effects on air quality. These conditions include a specified time period when burns are permitted and attention to not burning on specified “no-burn” days for specified islands as provided on or before 1600 hr by radio broadcast through the National Weather Service, or other appropriate means, applicable for the succeeding day. The State of Hawaii, Department of Health, Agricultural Burn Permit along with an approved Prescribed Burn Plan for the refuge are maintained in the Refuge Complex office. The Agricultural Burn Permit must be renewed annually and in possession at the burn site while burning.

FIRE RESEARCH

There are no ongoing fire research projects at Kakaha’ia NWR.
rat would be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

PUBLIC SAFETY

Kakahaia NWR is dedicated to ensuring the safety of each visitor and to all residents and property adjacent to the refuge's boundary. The refuge will be closed to the public during suppression and possibly during pile burn activities.

Areas of fire activity may be clearly signed at the refuge entrance gate. Residents adjacent to the refuge (Appendix C, Table 6) will be notified in advance of any pile burn and if any fire poses a threat to burn outside the refuge boundaries.

During pile burns at least one burn team member will have first aid training. A first aid kit will be on-site for prescribed burns as well as wildland fires. The local police, fire, and emergency medical services will be notified prior to the ignition. They will also be notified of the location of any wildland fires.

PUBLIC INFORMATION AND EDUCATION

Educating the public on the value of fire as a natural process is important to increasing public understanding and support for the fire management program. The refuge will use the most appropriate and effective means to explain the overall fire and smoke management program. This may include supplemental handouts, signing, personal contacts, auto tour routes, or media releases. When deemed necessary, interpretive presentations will address the fire management program and explain the role of fire in the environment.

The public information program will be developed as follows:

- The fire management program may be incorporated into visitor contacts. Particular attention will be given when fires are conspicuous from roads or visitor use areas.
- News releases will be distributed to the media as appropriate.
- The public information outlets of neighboring and cooperating agencies and the regional office will be provided with all fire management information.
- The fire management program will be discussed in informal talks with all employees , volunteers, residents, and neighbors.

FIRE CRITIQUES AND ANNUAL PLAN REVIEW

Fire Critiques
Fire reviews will be documented and filed with the final fire report. The Refuge Manager will retain a copy for the refuge files.

Annual Fire Summary Report
The Refuge Manager will be responsible for completing an annual fire summary report. The report will contain the number of fires by type, acres burned by fuel type, cost summary (pile burns and wildland fires), personnel utilized, and fire effects.

Annual Fire Management Plan Review
The Fire Management Plan will be reviewed annually. Necessary updates or changes will be accomplished prior to the next fire season. Any additions, deletions, or changes will be reviewed by the Project Leader to determine if such alterations warrant a re-approval of the plan.

CONSULTATION AND COORDINATION

The following agencies, organizations and/or individuals were consulted in preparing this plan.

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Jerry Leinecke, Project Leader, Hawaii/Pacific Islands NWR Complex, Honolulu, HI.

Amanda McAdams, (former) Fire Ecologist, Pacific Region, USFWS, Portland, OR.

Mike Nishimoto, Wildlife Biologist, Maui NWR Complex, Kihei, HI.

James Roberts, Fire Planner, Pacific Region, USFWS, Portland, OR.

Roger Spaulding, Fire Management Officer, Pacific Region, USFWS, Portland, OR.

Linda Watters, Assistant Refuge Supervisor, USFWS, Portland, OR.

APPENDICES

Appendix A: References Cited

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Appendix B: Definitions

Agency Administrator. The appropriate level manager having organizational responsibility for management of an administrative unit. May include Director, State Director, District Manager or Field Manager (BLM); Director, Regional Director, Complex Manager or Project Leader (FWS); Director, Regional Director, Park Superintendent, or Unit Manager (NPS), or Director, Office of Trust Responsibility, Area Director, or Superintendent (BIA).

Appropriate Management Action. Specific actions taken to implement a management strategy.

Appropriate Management Response. Specific actions taken in response to a wildland fire to implement protection and fire use objectives.

Appropriate Management Strategy. A plan or direction selected by an agency administrator which guides wildland fire management actions intended to meet protection and fire use objectives.

Appropriate Suppression. Selecting and implementing a prudent suppression option to avoid unacceptable impacts and provide for cost-effective action.

Bureau. Bureaus, offices or services of the Department.

Class of Fire (as to size of wildland fires).
Class A - 3 acre or less.
Class B - more than 3 but less than 10 acres.
Class C - 10 acres to 100 acres.
Class D - 100 to 300 acres.
Class E - 300 to 1,000 acres.
Class F - 1,000 to 5,000 acres.
Class G - 5,000 acres or more.

Emergency Fire Rehabilitation/Burned Area Emergency Rehabilitation (EFR/BAER). Emergency actions taken during or after wildland fire to stabilize and prevent unacceptable resource degradation or to minimize threats to life or property resulting from the fire. The scope of EFR/BAER projects are unplanned and unpredictable requiring funding on short notice.

Energy Release Component (ERC). A number related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire. It is generated by the National Fire Danger Rating System, a computer model of fire weather and its effect on fuels. The ERC incorporates thousand hour dead fuel moistures and live fuel moistures; day to day variations are caused by changes in the moisture content of the various fuel classes. The ERC is derived from predictions of (1) the rate of heat release per unit area during flaming combustion and (2) the duration of flaming.

Extended Attack. A fire on which initial attack forces are reinforced by additional forces.

Fire Suppression Activity Damage. The damage to lands, resources and facilities directly attributable to the fire suppression effort or activities, including: dozer lines, camps and staging areas, facilities (fences, buildings, bridges, etc.), handlines, and roads.

Fire Effects. Any consequences to the vegetation or the environment resulting from fire, whether neutral, detrimental, or beneficial.

Fire Intensity. The amount of heat produced by a fire. Usually compared by reference to the length of the flames.

Fire Management. All activities related to the prudent management of people and equipment to prevent or suppress wildland fire and to use fire under prescribed conditions to achieve land and resource management objectives.

Fire Management Plan. A strategic plan that defines a program to manage wildland and prescribed fires and documents the Fire Management Program in the approved land use plan. The plan is supplemented by operational procedures such as preparedness plans, preplanned dispatch plans, prescribed fire plans and prevention plans.

Fire Prescription. A written direction for the use of fire to treat a specific piece of land, including limits and conditions of temperature, humidity, wind direction and speed, fuel moisture, soil moisture, etc., under which a fire will be allowed to burn, generally expressed as acceptable range of the various fire-related indices, and the limit of the area to be burned.

Fuels. Materials that are burned in a fire; primarily grass, surface litter, duff, logs, stumps, brush, foliage, and live trees.

Fuel Loadings. Amount of burnable fuel on a site, usually given as tons/acre.

Hazard Fuels. Those vegetative fuels which, when ignited, threaten public safety, structures and facilities, cultural resources, natural resources, natural processes, or to permit the spread of wildland fires across administrative boundaries except as authorized by agreement.

Initial Attack. An aggressive suppression action consistent with firefighter and public safety and values to be protected.

Maintenance Burn. A fire set by agency personnel to remove debris; i.e., leaves from drainage ditches or cuttings from tree pruning. Such a fire does not have a resource management objective.

Natural Fire. A fire of natural origin, caused by lightning or volcanic activity.

NFDRS Fuel Model. One of 20 mathematical models used by the National Fire Danger Rating System to predict fire danger. The models were developed by the U.S. Forest Service and are general in nature rather than site-specific.

NFFL Fuel Model. One of 13 mathematical models used to predict fire behavior within the conditions of their validity. The models were developed by US Forest Service personnel at the Northern Forest Fire Laboratory, Missoula, Montana.

Prescription. Measurable criteria which guide selection of appropriate management response and actions. Prescription criteria may include safety, public health, environmental, geographic, administrative, social, or legal considerations.

Prescribed Fire. A fire ignited by agency personnel in accord with an approved plan and under prescribed conditions, designed to achieve measurable resource management objectives. Such a fire is designed to produce the intensities and rates of spread needed to achieve one or more planned benefits to natural resources as defined in objectives. Its purpose is to employ fire scientifically to realize maximize net benefits at minimum impact and acceptable cost. A written, approved prescribed fire plan must exist

and NEPA requirements must be met prior to ignition. NEPA requirements can be met at the land use or fire management planning level.

Preparedness. Actions taken seasonally in preparation to suppress wildland fires, consisting of hiring and training personnel, making ready vehicles, equipment, and facilities, acquiring supplies, and updating agreements and contracts.

Prevention. Activities directed at reducing the number or the intensity of fires that occur, primarily by reducing the risk of human-caused fires.

Rehabilitation. Actions to (1) limit the adverse effects of suppression on soils, watershed, or other values, or (2) to mitigate adverse effects of a wildland fire on the vegetation-soil complex, watershed, and other damages.

Suppression. A management action intended to protect identified values from a fire, extinguish a fire, or alter a fire's direction of spread.

Unplanned Ignition. A natural fire that is permitted to burn under specific conditions, in certain locations, to achieve defined resource objectives.

Wildfire. An unwanted wildland fire.

Wildland Fire. Any non-structure fire, other than prescribed fire, that occurs in the wildland.

Wildland Fire Situation Analysis (WFSA). A decision-making process that evaluates alternative management strategies against selected safety, environmental, social, economical, political, and resource management objectives as selection criteria.

Wildland/Urban Interface Fire. A wildland fire that threatens or involves structures.

Appendix C: Fire Dispatch Plan

2004 Fire Dispatch Plan
Kakahaia National Wildlife Refuge

FIRE SIZE-UP

Use the following or the card, pocket guide, fireline handbook or red book guides.

Reporting party's name and phone number:_____

Time discovered:_____

Location of smoke or fire (plot on map; legal description):_____

_____

Fire Behavior: ___Smoldering ___Creeping ___Running ___Crowning ___Spotting

Estimated size (acres): ___Spot ___1/4-1/2 ___1/2-3/4 ___1 ___1-5 ___5+

Wind (midflame speed & direction):_____

Dry Bulb Temperature (°F):_____ Relative Humidity (%):_____

Fuel Type: ___Grass ___Brush ___Timber ___Slash

Adjacent Fuels: ___Grass ___Brush ___Timber ___Slash

Aspect:_____ Percent Slope:_____

Additional Resources Needed:_____

Special Considerations:_____

_____

NOTIFICATION

Upon report of a wildland fire, follow these procedures:

1. **Call Maui County Fire Department (911)** – request response, ambulance if necessary, traffic control.

2. Notify Refuge Manager/Resource Advisor, Glynnis Nakai, at the Refuge Office (808-875-1582), residence (808-878-3269), or cell phone (808-281-9698). Assignments will be made at this time to notify other personnel and agencies.

3. Notify other Refuge personnel at the Refuge Office (808-875-1582) or at their residence:

Mike Nishimoto, Wildlife Biologist/Resource Advisor	Residence:	(808) 873-9315
	Cell:	(808) 870-6461
Calvin Willis, Maintenance Worker	Residence:	(808) 873-0070
	Cell:	(808) 870-6450
Pat Savino, Admin. Support Asst.	Residence:	(808) 878-2880
Nicole Davis, Biological Technician	Residence:	(808) 875-0099

4. Notify Project Leader, Jerry Leinecke, at the Hawaiian and Pacific Islands NWRC Office in Honolulu (808-792-9540) or at his residence (808-395-6227).

5. ***Contact one of the following Regional FWS Duty Officers:***

Pam Ensley – Regional Fire Management Coordinator	Work:	(503) 231-6174
	Cell:	(503) 781-7978
	Home:	(360) 835-7004
Roger Spaulding – Regional Fire Management Officer	Work:	(503) 231-6175
	Cell:	(503) 816-7054
(vacant) – Regional Prescribed Fire Specialist	Work:	(503) 231-2075
	Cell:	
Bruce Babb – Fire Management Specialist/Regional WUI Coordinator	Work:	(503) 231-6234
	Cell:	(503) 703-5823

ESTABLISHED SUPPRESSION GUIDELINES

Suppression Conditions
A full suppression alternative was selected for this refuge which requires containment and control of all wildland fires. Wildland fires will not be managed to achieve resource objectives, although impacts to resources may be considered in selecting suppression strategies. Suppression guidelines and restrictions (see table below) were developed for this refuge to protect natural and cultural resources. These guidelines will be discussed annually with Maui County Fire Department to ensure their compliance. The Refuge Manager should review these guidelines annually and document any changes.

A Resource Advisor will be used to ensure impacts to natural and cultural resources are minimized. The use of heavy, ground-disturbing equipment (including bulldozers) is prohibited for normal fire suppression operations. The use of foams and retardants is also prohibited due to the presence of endangered waterbirds and extensive wetlands. Off-road travel and firelines constructed with hand tools and/or chainsaws must be approved by the Resource Advisor at all times. Low-flying aircraft and helicopter water drops must be approved by the Resource Advisor from December through August; the Incident Commander has approval authority all other times. Hose lays from engines must be approved by the Resource Advisor from April through August due to the presence of nesting endangered waterbirds; the Incident Commander has approval authority all other times.

Kakahaia National Wildlife Refuge – Wildland Fire Suppression Guidelines	
NOTE: If human life is threatened, the Incident Commander has the authority to order any suppression strategy or tactic available to mitigate the threat.	
	FIRE MANAGEMENT UNIT – KAKAHAIA NWR
FMU Description	All lands within Kakahaia National Wildlife Refuge, Molokai, Hawaii.
Special Considerations	• Smoke/fire may cause a health hazard to neighboring communities. • Endangered waterbirds present in wetlands.
Preferred Suppression Strategies	Aggressively suppress fire, holding it to the fewest burned acres possible within safety constraints, with minimal effect on endangered species and their habitats.
TACTIC	**MUST BE APPROVED BY:**
Hand line/Chainsaws	Resource Advisor
Heavy Equipment	Prohibited
Off-road Travel	Resource Advisor
Hose Lays	Resource Advisor (April – August); Incident Commander otherwise
Foam/Retardant	Prohibited
Water Drops	Resource Advisor (December – August); Incident Commander otherwise
Helicopters, other AC	Resource Advisor (December – August); Incident Commander otherwise
Safety Considerations	High rates of fire spread, especially in windy conditions.

COMMUNICATIONS

Currently, refuge communications are limited to telephones. No personnel will be on-site at a wildland fire without direct communications with the suppression resources.

CONTACT LIST

Table 5. Maui National Wildlife Refuge Complex Staff.

Maui NWRC	P.O. Box 1042 (Mile 6 Mokulele Hwy.) Kihei, HI 96753	Phone: (808) 875-1582 Fax: (808) 875-2945
Glynnis Nakai Refuge Complex Manager	95 Mano Drive Kula, HI 96790	Work: (808) 792-9548 Cell: (808) 753-0627 Home: (808) 395-6227
Michael Nishimoto Wildlife Biologist	Kihei, HI	Work: (808) 875-1582 Cell: (808) 870-6461 Home: (808) 873-9315
Calvin Willis Maintenance Worker	Kihei, HI	Work: (541) 867-4550 Cell: (808) 870-6450 Home:
Patricia Savino Administrative Officer	Kihei, HI	Work: (808) 875-1582 Home: (808) 878-2880
Nicole Davis Biological Science Technician	Kihei, HI	Work: (808) 875-7258 Cell: (808) 870-6457 Home: (808) 875-0099

ADJACENT LANDOWNERS

Table 6. Landowners adjacent to Kakahaia NWR.

Landowner	Address	Phone Number
Claude Sutcliffe and Brigid Mulloy	P.O. Box 280, Kaunakakai, HI 96748	(808 553-3380)
Melvin Perrells	P.O. Box 651, Kaunakakai, HI 96748	(808 553-3442)
Beth and Bob Johnson	104 Onioni Place, Kaunakakai, HI 96748	(808 553-5228)
Edwin and Diane Medeiros	249 Kamehameha V Hwy., Kaunakakai, HI 96748	(808 553-5702)
Gene and Carolyn Anderson	P.O. Box 1748, Kaunakakai, HI 96748	(808 553-5563)

Appendix D: NEPA Compliance

UNITED STATES FISH AND WILDLIFE SERVICE

ENVIRONMENTAL ACTION STATEMENT FOR CATEGORICAL EXCLUSION

Within the spirit and intent of the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act of 1969 (NEPA), and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record and determined that the action of:

Implementation of the 2004 Wildland Fire Management Plan for Kakahaia National Wildlife Refuge, which includes guidance for wildland fire suppression, hazard fuel reduction, and pile burning as a limited form of prescribed fire

Check One:

__X__ Is a categorical exclusion as provided by 516 DM 6, Appendix 1.4. No further NEPA documentation will be made.

_____ Is found not to have significant environmental effects as determined by the attached Environmental Assessment and Finding of No Significant Impact.

_____ Is found to have significant effects and, therefore, further consideration of this action will require a notice intent to be published in the *Federal Register* announcing the decision to prepare an environmental impact statement.

_____ Is not approved because of unacceptable environmental damage, or violation of Fish and Wildlife Service mandates, regulations, or procedures.

_____ Is an emergency action within the context of 40 CFR 1506.11. Only those actions necessary to control the immediate impacts of the emergency will be taken. Other related actions remain subject to NEPA review.

Proposed Action and Alternatives: Use of prescribed fire to reduce fuels, restore the natural processes and vitality of ecosystems, improve wildlife habitat, remove or reduce non-native species and noxious weeds, and/or conduct research.

Categorical Exclusions: The specific categorical exclusions from NEPA allowing for this action pursuant to 516 DM 6, Appendix 1.4 are:

B.(4) The use of prescribed burning for habitat improvement purposes, when conducted in accordance with departmental and Service procedures.

B.(5) Fire management activities, including prevention and restoration measures, when conducted in accordance with departmental and Service procedures.

Permits/Approvals: The Wildland Fire Management Plan for Kakahaia National Wildlife Refuge must be approved by the Refuge Manager, Project Leader, Regional Fire Management, and Regional Director. All prescribed fire projects require a burn plan approved by the Project Leader.

Public Involvement/Interagency Coordination: Maui County Fire Department Keonakakai Station is notified prior to any prescribed burning.

Supporting Documents:

- 2004 Wildland Fire Management Plan for Kakahaia National Wildlife Refuge.
- ESA Section 7 Biological Evaluation for pile and debris burning for refuges within the Maui National Wildlife Refuge Complex (Kealia Pond NWR and Kakahaia NWR) (Appendix E of this FMP).

Signature Approval:

Jerry Leinecke, Project Leader
Hawaiian and Pacific Islands National Wildlife Refuge Complex

9/23/04
Date

Appendix E: ESA Section 7 Compliance

INTRA-SERVICE SECTION 7 BIOLOGICAL EVALUATION

Pile and Debris Burning for refuges within the Maui National Wildlife Refuge Complex (Kealia Pond NWR and Kakahaia NWR)

Originating Person: Glynnis Nakai

Telephone Number: (808) 875-1582

Date: July 13, 2003

I. Region: Pacific (Region 1), Portland Oregon.

II. Service Activity:

Pile and debris burning as a marsh vegetation management technique at Kealia Pond National Wildlife Refuge on Maui and Kakahaia National Wildlife Refuge on Molokai.

III. Pertinent Species and Habitat:

A. Listed species and/or their critical habitat within the action area:

Hawaiian coot (*Fulica alai*) – Endangered
Hawaiian stilt (*Himantopus mexicanus knudseni*) – Endangered

B. Proposed species and/or proposed critical habitat within the action area: NONE

C. Candidate species within the action area: NONE

IV. Geographic area or station name and action:

Refuges of this Complex are located in the state of Hawaii, County of Maui: Kealia Pond NWR on the island of Maui and Kakahaia NWR on the island of Molokai.

Pile and debris burning to control and remove non-native vegetation in wetland marsh and mudflats.

V. Location (attach map):

A. County and State: Maui County, State of Hawai'i

B. Distance (miles) and direction to nearest town:

Ma'alaea is 1.5 miles southwest of Kealia Pond NWR
Kaunakakai is approximately 5.5 miles northeast of Kakahaia NWR.

VI. Action Objectives:

Pile and debris burning will be conducted on these wetland refuges as a means of controlling noxious and exotic vegetation that interferes with nesting and maintenance of endangered and migratory waterbirds. Control of the establishment and spread of these species is required to provide secure, viable, adequate habitat for endangered waterbirds, migratory waterfowl and shorebirds. Specific goals include: providing open water areas interspersed with escape, nesting, and maintenance cover; limiting predator cover and access; providing mudflat areas for nesting (Hawaiian stilts) and feeding; and promotion of desirable wetland plant species with water areas for Hawaiian coot nesting and maintenance.

VII. Explanation of Impacts of Action:

This action will result in enhanced wetlands for endangered and other species using the refuge. Undesirable plant species will be controlled encouraging growth of more beneficial species. Dense predator concealment cover will be reduced making it more difficult for predators to prey on endangered species and allow waterbirds to detect predators at a greater distance, reducing predation. Increased habitat for a diversity of species, both resident and migratory, will be made available. The ratio of open water to vegetation will be altered to provide additional habitat diversity within the wetlands.

All burns will be conducted outside major endangered species nesting seasons. Burns will normally be conducted between August and October. Burns will not be initiated when pre-fledgling birds are present. A check of each burn site will be made to determine the presence of waterbirds, young, and/or nests. If any of the above are discovered, no burning in that area of the wetlands will be undertaken. To provide necessary foraging habitat while burning, not all areas will be drawn down or dry at the same time. Wetland habitat on the refuge will continue to be provided for endangered and other waterbirds to utilize until worked ponds are re-flooded.

VIII. Effect determination and response requested: **[* = optional]**

A. Listed species/designated critical habitat:

Determination	Response requested
No effect/no adverse modification	____*Concurrence
May affect, but is not likely to adversely affect species/adversely modify critical habitat	__X__Concurrence
Hawaiian coot (*Fulica alai*) – Endangered Hawaiian stilt (*Himantopus mexicanus knudseni*) – Endangered	
May affect, and is likely to adversely affect species/adversely modify critical habitat	____Formal Consultation

B. Proposed species/proposed critical habitat: NONE

C. Candidate species: NONE

IX. Signature

_____ _____

Glynnis Nakai, Refuge Manager — Date
Maui National Wildlife Refuge Complex

X. Reviewing ESO Evaluation:

A. Concurrence _____ Nonconcurrence _____

B. Formal consultation required _____

C. Conference required _____

D. Informal conference required _____

E. Remarks (attach additional pages as needed):

_____ _____

Field Supervisor — Date
Ecological Services, Pacific Islands Field Office

Appendix F: Request for Cultural Resource Compliance

REQUEST FOR CULTURAL RESOURCE COMPLIANCE

Project Name: _____

USFWS Unit: _____

Org Code: _____

Ecoregion: _____
(By ARD; CBE, IPE, KCE, NCE)

NHPA COMPLIANCE

❑ Appendix _____ Item _____
of the Programmatic Agreement applies.

❑ 36CFR800.4 to 800.6 applies.

_____ _____
Cultural Resources Team Date

Program: _____
(Partners, WSECP, Refuges, Hatcheries, Jobs, Federal Aid, Other)

Location: _____ **County:** _____ **State:** _____
(nearest town)

Township(s): _____ **Range(s):** _____ **Section(s):** _ **Meridian:** _____

7.5' USGS Quad(s): _____
(Name, Date)

Project acres or linear meters/feet: _____

Date you want to start the project: _____ **Date of this request:** _____

USFWS Contact: _____ **Phone:** _____

Address: _____ **Fax:** _____

Directions to project (if not obvious):

Attach to this form:

- A **project (sketch) map** showing the Area of Potential Effect with locations of specific ground altering activities *(required)*.
- A **photocopy** of the **USGS quad** clearly marking the project area *(required)*.
- A **photocopy** of an **air photo** showing the project may be attached *(if available)*.

Return form and direct questions to:

USFWS Region 1 Cultural Resources Team
c/o Tualatin River NWR
20555 SW Gerda Lane
Sherwood, OR 97140
Phone: (503) 625-4377
Fax: (503) 625-4887

The Undertaking: *Describe the proposed project and means to facilitate it (e.g., provide funds to revegetate 1 mile of riparian habitat, restore 250 acres of seasonal wetlands, and construct a 5-acre permanent pond). How is the project designed (e.g., install 2 miles of fence and create approximately 25 feet of 3 foot high check dam)?*

Area of Potential Effect: *Describe where disturbance of the ground will occur. What are the dimensions of the area to be disturbed? How deep will you excavate? How long is the ditch, fence, etc? Where will fill be obtained? Where will spoil be dumped? What tools or equipment will be used? Are you replacing or repairing a structure? Are you moving dirt in a relatively undisturbed area? Will the project reach below or beyond the limits of prior land disturbance? Differentiate between areas slated for earth movement versus areas to be inundated only. Is the area to be inundated different from the area inundated today, in the recent past, or under natural conditions? Provide acres and/or linear meters or feet for all elements of the undertaking.*

Environmental Setting: *Describe the environmental setting of the Area of Potential Effect. A) What was the natural habitat prior to modifications, reclamation, agriculture, settlement? B) What is the land-use history? When was it first settled, modified? How deep has it been cultivated? Grazed? etc. C) What is the land-use and habitat today? What natural agents (e.g., sedimentation, or vegetation) or cultural agents (e.g., cultivation) might affect the ability to discover cultural resources? D) Do you (or does anybody else) know of cultural resources in or near the project area?*

Appendix G: Interagency Agreements

No interagency agreements have been developed. When completed, they will be added here.

Appendix H: Pile Burn Plan Template

REFUGE OR STATION:	**UNIT:**

Prepared By:	Prescribed Fire Specialist	Date
Reviewed By:	Refuge Biologist	Date
Reviewed By:	Prescribed Fire Burn Boss	Date
Reviewed By:	Fire Management Officer	Date
Reviewed By:	Biological Investigation Unit	Date
Reviewed By:	Refuge Manager	Date
The approved Pile Burn Plan constitutes the authority to burn, pending approval of Section 7 Consultations, Environmental Assessments or other required documents. No one has the authority to burn without an approved plan or in a manner not in compliance with the approved plan. Pile burning conditions established in the plan are firm limits. Actions taken in compliance with the approved Pile Burn Plan will be fully supported, but personnel will be held accountable for actions taken which are not in compliance with the approved plan.		
Approved By:	Project Leader	Date

PILE BURN PLAN

Note: This plan is intended for burning debris and piles (activity fuels) from refuge operations such as fuel break construction and hazard reduction. This plan format should only be used outside of declared fire season for the area considered. THIS PLAN IS FOR COMPLEXITY LEVEL 3 PILE BURNING.

Refuge:	**Refuge Burn Number:**
Substation:	**Fire Number:**
Name of Area:	**Unit Number:**
Legal Description: T_____ R_____ S_____ Meridian:_____ **Latitude:_____ Longitude:_____**	
County:	**State:**

Checklist:

1. EA optional.
2. Resource objectives.
3. Less than 1 ton per pile, completely dried.
4. Has minimum resources (equipment & personnel) required.
5. Has weather parameters been established
6. Low potential for escape. Good clearance.
7. No fire behavior prediction required
8. Can be written to be good up to 3 years per site, with annual review.
9. Burn day required.
10. Less than (<) one acre in size.
11. Complexity level should rate as level 3
12. Intended for admin sites, campgrounds, occupancy trespass, etc.

Environmental Assessment Met (where documented): _____

Estimated Cost: _____ 1202: _____ Funding Code: _____

Project Area Description (Attach Map of Burn Area)

Burn Objectives:

Number, Species, and Size of Piles:

Adjacent Fuel Description:

Weather Forecasts

The Pile Burn Boss is responsible for weather being taken every hour while burning to ensure prescription compliance. Contact the Emergency Communications Center (ECC) for weather forecasts and burn day designation. Contact ECC by radio when ignition is starting, giving legal description of area burning; and when burning is over, giving number of acres or piles burned.

Prescription: _____

Season of Burn (Fall, Spring, Summer, Winter): _____

		Acceptable Range	Desired
Air Temperature		_____	_____
Relative Humidity		_____	_____
Wind Speed		_____	_____
Fuel Moisture	1 Hour T.L.	_____	_____
	10 Hour T.L.	_____	_____
	100 Hour T.L.	_____	_____
Adjacent Live Fuel Moisture		_____	_____
Wind Direction Preferred		Acceptable: _____	Unacceptable: _____

Smoke Management

Permitting Agency:

Total Tons Per Acre Emissions:

Distance and Direction from Smoke Sensitive Area(s):

Necessary Transport Wind Direction(s):

Visibility Hazard(s) (i.e., roads, airports, etc.):

Actions to Reduce Visibility Hazard(s):

Can Residual Smoke Be a Problem?

Other Considerations:

Special Constraint(s)/Consideration(s):

Firing Technique:

Holding Force Instructions:

Mop Up Instructions

Contact Plan

Who will notify the following and when?

Key People:

Local Landowners:

Private Land Within Proposed Burn (Identify on Map):

Fire Protection Agencies:

Dispatcher:

Public Affairs Officer:

News Releases to Local Papers and News Media:

Safety Plan

All line employees involved in the actual burning of standing and/or piled fuels will have on their person and use as necessary the following protective clothing:

- Hard hat
- Goggles
- Gloves
- Fire resistant pants
- Fire resistant shirt
- Fire shelter
- Laced boots as used in fire suppression

Employees involved in a project with an assignment not related to actual burning should have with them all of the above safety equipment and be so equipped if their unplanned duties expose them to line work and/or the actual burning.

Each burning plan will designate fire safety responsibility. This designation should include the following considerations:

- Escape routes
- Safety areas
- Closest recognized burn treatment facility and specific methods of travel to burn center or hospital

Hospitals

Center Name	Address	Travel Time Air/Ground	Phone	Helipad Yes/No	Burn Yes/No

Medical Emergency Procedures

- Give First Aid at scene.
- Contact Maui County Fire Department
- Make transportation arrangements.

Comments:

Debris & Pile Burning Checklist

A "NO" response to any item means STOP!

	YES	NO
1. Are all fire prescriptions met?		
2. Has dispatch been notified?		
3. Is it a permissive burn day?		
4. Is fire weather forecast favorable?		
5. Are all personnel required in the burn plan on site?		
6. Have all personnel been briefed on the burn plan requirements?		
7. Have all personnel been briefed on safety hazards, escape routes and safety orders?		
8. Is all the required equipment in place an in working order?		
9. Are all personnel aware of mop up requirements before abandonment?		
10. Are all answers to all the above questions "Yes"?		

If all ten questions have been answered "Yes", you may proceed with lighting

Appendix I: Delegation of Authority

DELEGATION OF AUTHORITY

Region 1, U.S. Fish and Wildlife Service

Maui National Wildlife Refuge Complex

_____, you are assigned as Incident Commander of the _____ Incident on the ____ National Wildlife Refuge. You have full authority and responsibility for managing the fire suppression operation on this incident within the framework of legal statute, current policy, broad direction, and the Wildland Fire Situation Analysis (WFSA). Your primary responsibility is to achieve complete control of the fire by organizing and directing the fire suppression organization in an effective, efficient, economical and most importantly, safe manner.

You should be guided in your duties by the fire job descriptions relating to Incident Commander, as found in the Fireline Handbook. Strongly consider long-term ecosystem health, and the effects of suppression actions in the development of appropriate suppression responses. These issues are to be addressed and documented in the WFSA.

You are accountable to the Refuge Manager, _____ of the Maui National Wildlife Refuge Complex, who is the Line Officer. _____ may serve as the Line Officer Designee for this incident.

You will immediately notify me in person in the event of:

(1) a serious injury or fatality,
(2) threat to private property,
(3) if the incident exceeds the limits of the selected alternative of the WFSA.

Much of the Refuge Complex is home to endangered species. Your job as Incident Commander is critical, as you must minimize damage to the habitats, as well as provide for firefighter safety. Minimum environmental suppression tactics shall be used, commensurate with forecasted and threatened resource values.

You are to be guided by the Wildland Fire Situation Analysis, approved by _____, Project Leader.

The Resource Advisor assigned to your incident will be _____.

_____ _____

Glynnis Nakai, Refuge Manager Date
Maui National Wildlife Refuge Complex

Appendix J: Wildland Fire Situation Analysis

WILDLAND FIRE

SITUATION ANALYSIS

Incident Name: _____

Jurisdiction: _____

Date and Time Completed: _____

I. WILDLAND FIRE SITUATION ANALYSIS

A. Jurisdiction(s)	**B. Geographic Area**
C. Unit(s)	**D. WSFA #**
E. Fire Name	**F. Incident #**

G. Accounting Code: _____

H. Date/Time Prepared: _____ @ _____

I. Attachments: _____

Complexity Matrix/Analysis * _____

Risk Assessment/Analysis * _____

Probability of Success * _____

Consequences of Failure * _____

Maps * _____

Decision Tree ** _____

Fire Behavior Projections * _____

Calculations of Resource Requirements * _____

Other (specify) _____

* Required

** Required by FWS

This page is completed by the Agency Administrator(s)

II. OBJECTIVES AND CONSTRAINTS

A. Objectives (must be specific and measurable)

1. Safety

   - Public

   - Firefighter

2. Economic

3. Environmental

4. Social

5. Other

B. Constraints

This page is completed by the Agency Administrator(s)

III.	ALTERNATIVES		
	A	**B**	**C**
A. Wildland Fire Strategy			
B. Narrative			
C. Resources Needed Handcrews Engines Dozers Airtankers Helicopters			
D. Final Size			
E. Estimated Contain/ Control Date			
F. Costs			
G. Risk Assessment Probability of Success Consequences of Failure			
H. Complexity			
I.	**Attach maps for each alternative**		

This page is completed by the Agency Administrator(s) and FMO/Incident Commander

IV. EVALUATION OF ALTERNATIVES			
A. Evaluation Process	**A**	**B**	**C**
Safety			
Firefighter	_____	_____	_____
Aviation	_____	_____	_____
Public	_____	_____	_____
Sum of Safety Values			
Economic			
Forage	_____	_____	_____
Improvements	_____	_____	_____
Recreation	_____	_____	_____
Timber	_____	_____	_____
Water	_____	_____	_____
Wilderness	_____	_____	_____
Wildlife	_____	_____	_____
Other (specify)	_____	_____	_____
Sum of Economic Values			
Environmental			
Air	_____	_____	_____
Visual	_____	_____	_____
Fuels	_____	_____	_____
T & E Species	_____	_____	_____
Other (specify)	_____	_____	_____
Sum of Environmental Values			
Social			
Employment	_____	_____	_____
Public Concern	_____	_____	_____
Cultural	_____	_____	_____
Other (specify)	_____	_____	_____
Sum of Social Values			

Other			
This page is completed by the Agency Administrator(s) and FMO/Incident Commander			

V. ANALYSIS SUMMARY

Alternatives	A	B	C
A. Compliance with Objectives			
Safety	_____	_____	_____
Economic	_____	_____	_____
Environmental	_____	_____	_____
Social	_____	_____	_____
Other (specify)	_____	_____	_____
B. Pertinent Data			
Final Fire Size	_____	_____	_____
Complexity	_____	_____	_____
Suppression Cost	_____	_____	_____
Resource Values	_____	_____	_____
Probability of Success	_____	_____	_____
Consequences of Failure	_____	_____	_____

C. External/Internal Influences

National & Geographic Preparedness Level: _____

Incident Priority: _____

Resource Availability: _____

Weather Forecast (long range): _____

Fire Behavior Projections: _____

This page is completed by the Agency Administrator(s) and FMO/Incident Commander

VI. DECISION

The Selected Alternative is: _____

Rationale: _____

_____ _____

Agency Administrator's Signature **Date/Time**

This page is completed by the Agency Administrator(s) or designate

VII. DAILY REVIEW

To be reviewed daily to determine if still valid until containment or control

			PREPAREDNESS LEVEL	INCIDENT PRIORITY	RESOURCE AVAILABILITY	WEATHER FORECAST	FIRE BEHAVIOR PROJECTIONS	WFSA VALID
Date	**Time**	**By**						

IF WFSA IS NO LONGER VALID, A NEW WFSA WILL BE COMPLETED!

This page is completed by the Agency Administrator(s) or designate

VIII.	FINAL REVIEW	
The elements of the selected alternative were met on:	Date	Time
By: Agency Administrator(s)		

INSTRUCTIONS

Section I. WFSA Information Page

A. Jurisdiction(s): Assign the agency or agencies that have or could have fire protection responsibility, e.g., USFWS, BLM, etc.

B. Geographic Area: Assign the recognized "Geographic Coordination Area" the fire is located in, e.g., Northwest, Northern Rockies, etc.

C. Unit(s): Designate the local administrative unit(s), e.g., Hart Mountain Refuge Area, Flathead Indian Reservation, etc.

D. WFSA #: Identify the number assigned to the most recent WFSA for this fire.

E. Fire Name: Self-explanatory.

F. Incident #: Identify the incident number assigned to the fire.

G. Accounting Code: Insert the local unit's accounting code.

H. Date/Time Prepared: Self-explanatory.

I. Attachments: Check here to designate items used to complete the WFSA. "Other could include data or models used in the development of the WFSA. Briefly describe the "other" items used.

Section II. Objectives and Constraints

A. Objectives: Specify objectives that must be considered in the development of alternatives. Safety objectives for firefighter, aviation, and public must receive the highest priority. Suppression objectives must relate to resource management objectives in the unit resource management plan.

Economic objectives could include closure of all or portions of an area, thus impacting the public, or impacts to transportation, communication, and resource values.

Environmental objectives could include management objectives for airshed, water quality, wildlife, etc.

Social objectives could include any local attitudes toward fire or smoke that might affect decisions on the fire.

Other objectives might include legal or administrative constraints which would have to be considered in the analysis of the fire situation, such as the need to keep the fire off other agency lands, etc.

B. Constraints: List constraints on wildland fire action. These could include constraints to designated wilderness, wilderness study areas, environmentally or culturally sensitive areas, irreparable damage to resources or smoke management/air quality concerns. Economic constraints, such as public and agency cost, could be considered here.

Section III. Alternatives

A. Wildland Fire Management Strategy: Briefly describe the general wildland fire strategies for each alternative. Alternatives must meet resource management plan objectives.

B. Narrative: Briefly describe each alternative with geographic names, locations, etc., that would be used when implementing a wildland fire strategy. For example: "Contain within the Starvation Meadows' watershed by the first burning period."

C. Resources Needed: Resources described must be reasonable to accomplish the tasks described in Section III.B. It is critical to also look at the reality of the availability of these needed resources.

D. Final Fire Size: Estimated final fire size for each alternative at time of containment.

E. Estimated Contain/Control Date: Estimates of each alternative shall be made based on predicted weather, fire behavior, resource availability, and the effects of suppression efforts.

F. Cost: Estimate all incident costs for each alternative. Consider mop-up, rehabilitation, and other costs as necessary.

G. Risk Assessment - Probability of Success/Consequences of Failure: Describe probability as a percentage and list associated consequences for success and failure. Develop this information from models, practical experience, or other acceptable means. Consequences described will include fire size, days to contain, days to control, costs, and other information such as park closures and effect on critical habitat. Include fire behavior and long-term fire weather forecasts to derive this information.

H. Complexity: Assign the complexity rating calculated in "Fire Complexity Analysis" for each alternative, e.g., Type II, Type I.

I. A map for each alternative should be prepared. The map will be based on the "Probability of Success/Consequences of Failure" and include other relative information.

Section IV. Evaluation of Alternatives

A. Evaluation Process: Conduct an analysis for each element of each objective and each alternative. Objectives shall match those identified in Section II.A. Use the best estimates available and quantify whenever possible. Provide ratings for each alternative and corresponding objective element. Fire effects may be negative, cause no change, or may be positive. Examples are: 1) a system which employs a "-" for negative effect, a "0" for no change, and a "+" for positive effect; 2) a system which uses a numeric factor for importance of the consideration (soils, watershed, political, etc.) and assigns values (such as -1 to +1, -100 to +100, etc.) to each consideration, then arrives at a weighted average. If you have the ability to estimate dollar amounts for natural resource and cultural values, this data is preferred. Use those methods which are most useful to managers and most appropriate for the situation and agency. To be able to evaluate positive fire effects, the area must be included in the resource management plan and consistent with prescriptions and objectives of the Fire Management Plan.

Sum of Economic Values: Calculate for each element the net effect of the rating system used for each alternative. This could include the balance of pluses (+) and minuses (-), numerical rating (-3 and +3), or natural and cultural resource values in dollar amounts. (Again, resource benefits may be used as part of the analysis process when the wildland fire is within a prescription consistent with approved Fire Management Plans and in support of the unit's Resource Management Plan.)

Section V. Analysis Summary

A. Compliance with Objectives: Prepare narratives that summarize each alternative's effectiveness in meeting each objective. Alternatives that do not comply with objectives are not acceptable. Narrative could be based on effectiveness and efficiency. For example: "most effective and least efficient," "least effective and most efficient," or "effective and efficient." Or answers could be based on a two-tiered rating system such as "complies with objective" and "fully complies with or exceeds objective." Use a system that best fits the manager's needs.

B. Pertinent Data: Data for this Section has already been presented, and is duplicated here to help the Agency Administrator(s) confirm their selection of an alternative. Final Fire Size is displayed in Section III.D. Complexity is calculated in the attachments and displayed in Section III.H. Costs are displayed on page 4. Probability of Success/Consequences of Failure is calculated in the attachments and displayed in Section III.G.

C. External and Internal Influences: Assign information and data occurring at the time the WFSA is signed. Identify the Preparedness Index (1 through 5) for the National and Geographic levels. If available, indicate the Incident Priority assigned by the MAC Group. Designate the Resource Availability status. This information is available at the Geographic Coordination Center, and is needed to select a viable alternative. Designate "yes," indicating an up-to-date weather forecast has been provided to, and used by, the Agency Administrator(s) to evaluate each alternative. Assign information to the "Other" category as needed by the Agency Administrator(s).

Section IV. Decision

Identify the alternative selected. Must have clear and concise rationale for the decision, and a signature with date and time. Agency Administrator(s) is mandatory.

Section VII. Daily Review

The date, time, and signature of reviewing officials are reported in each column for each day of the incident. The status of Preparedness Level, Incident Priority, Resource Availability, Weather Forecast, and WFSA validity is completed for each day reviewed. Ratings for the Preparedness Level, Incident Priority, Resource Availability, Fire Behavior, and Weather Forecast are addressed in Section V.C. Assign a “yes” under "WFSA Valid" to continue use of this WFSA. A "no" indicates this WFSA is no longer valid and another WFSA must be prepared or the original revised.

Section VIII. Final Review

This Section is completed by the Agency Administrator(s). A signature, date, and time are provided once all conditions of the WFSA are met.

A GUIDE FOR ASSESSING FIRE COMPLEXITY

The following questions are presented as a guide to assist the Agency Administrator(s) and staff in analyzing the complexity or predicted complexity of a wildland fire situation. Because of the time required to assemble or move an Incident Management Team to wildland fire, this checklist should be completed when a wildland fire escapes initial attack and be kept as a part of the fire records. This document is prepared concurrently with the preparation of (and attached to) a new or revised Wildland Fire Situation Analysis. It must be emphasized this analysis should, where possible, be based on predictions to allow adequate time for assembling and transporting the ordered resources.

Use of the Guide:

1. Analyze each element and check the response "yes" or "no."

2. If positive responses exceed, or are equal to, negative responses within any primary factor (A through G), the primary factor should be considered as a positive response.

3. If any three of the primary factors (A through G) are positive responses, this indicates the fire situation is, or is predicted to be, Type I.

4. Factor H should be considered after all the above steps. If more than two of these items are answered "yes," and three or more of the other primary factors are positive responses, a Type I team should be considered. If the composites of H are negative, and there are fewer than three positive responses in the primary factors (A-G), a Type II team should be considered. If the answers to all questions in H are negative, it may be advisable to allow the existing overhead to continue action on the fire.

GLOSSARY OF TERMS

Potential for blow-up conditions - Any combination of fuels, weather, and topography excessively endangering personnel.

Rate or endangered species - Threat to habitat of such species or, in the case of flora, threat to the species itself.

Smoke management - Any situation which creates a significant public response, such as smoke in a metropolitan area or visual pollution in high-use scenic areas.

Extended exposure to unusually hazardous line conditions - Extended burnout or backfire situations, rock slide, cliffs, extremely steep terrain, abnormal fuel situation such as frost killed foliage, etc.

Disputed fire management responsibility - Any wildland fire where responsibility for management is not agreed upon due to lack of agreements or different interpretations, etc.

Disputed fire policy - Differing fire policies between suppression agencies when the fire involves multiple ownership is an example.

Pre-existing controversies - These may or may not be fire management related. Any controversy drawing public attention to an area may present unusual problems to the fire overhead and local management.

Have overhead overextended themselves mentally or physically - This is a critical item that requires judgment by the responsible agency. It is difficult to write guidelines for this judgment because of the wide differences between individuals. If, however, the Agency Administrator feels the existing overhead cannot continue to function efficiently and take safe and aggressive action due to mental or physical reasons, assistance is mandatory

FIRE COMPLEXITY ANALYSIS

A. FIRE BEHAVIOR: Observed or Predicted	YES/NO
1. Burning Index (from on-site measurement of weather conditions) predicted to be above the 90% level using the major fuel model in which the fire is burning.	_____
2. Potential exists for "blowup" conditions (fuel moisture, winds, etc.).	_____
3. Crowning, profuse or long-range spotting.	_____
4. Weather forecast indicating no significant relief or worsening conditions.	_____
Total	_____

B. RESOURCES COMMITTED	
1. 200 or more personnel assigned.	_____
2. Three or more divisions.	_____
3. Wide variety of special support personnel.	_____
4. Substantial air operation which is not properly staffed.	_____
5. Majority of initial attack resources committed.	_____
Total	_____

C. RESOURCES THREATENED	
1. Urban interface.	_____
2. Developments and facilities.	_____
3. Restricted, threatened, or endangered species habitat.	_____
4. Cultural Sites.	_____
5. Unique natural resources, special designation zones, or wilderness.	_____
6. Other special resources.	_____
Total	_____

D. SAFETY **YES/NO**

1. Unusually hazardous fire line conditions. _____
2. Serious accidents or fatalities. _____
3. Threat to safety of visitors from fire and related operations. _____
4. Restricted and/or closures in effect or being considered. _____
5. No night operations in place for safety reasons. _____

Total _____

E. OWNERSHIP

1. Fire burning or threatening more than one jurisdiction. _____
2. Potential for claims (damages). _____
3. Conflicting management objectives. _____
4. Disputes over fire management responsibility. _____
5. Potential for unified command. _____

Total _____

F. EXTERNAL INFLUENCES

1. Controversial wildland fire management policy. _____
2. Pre-existing controversies/relationships. _____
3. Sensitive media relationships. _____
4. Smoke management problems. _____
5. Sensitive political interests. _____
6. Other external influences. _____

Total _____

G. CHANGE **YES/NO**

1. Change in strategy to confine/contain to control. _____
2. Large amount of unburned fuel within planned perimeter. _____
3. WFSA invalid or requires updating. _____

Total _____

H. EXISTING OVERHEAD

Worked two operational periods without achieving initial objectives. _____

Existing management organization ineffective. _____

IMT overextended themselves mentally and/or physically. _____

Incident action plans, briefings, etc. missing or poorly prepared. _____

Total _____

I. SIGNATURE

_____ _____

Name and Title **Date and Time**

Appendix G. STATEMENT OF COMPLIANCE for Implementation of the Kakahai‘a National Wildlife Refuge, Maui County, Hawai‘i Comprehensive Conservation Plan

The following Executive orders and legislative acts have been reviewed as they apply to implementation of the Kakahai‘a NWR CCP.

National Environmental Policy Act (1969). The planning process has been conducted in accordance with NEPA Implementing Procedures, Department of the Interior and Service procedures, and has been performed in coordination with the affected public.

The CCP is programmatic in many respects and specific details of certain projects and actions cannot be determined until a later date depending on funding and implementation schedules. Certain projects or actions may require additional NEPA compliance.

National Historic Preservation Act (1966). The implementation of the CCP should not affect cultural resources. The proposed action does not meet the criteria of an effect or adverse effect as an undertaking defined in 36 CFR 800.9 and 614 FW 2. The Service will comply with the National Historic Preservation Act if any management actions have the potential to affect any historic properties which may be present.

Executive Order 12372. Intergovernmental Review. Coordination and consultation with affected Tribal, local, and State governments, other Federal agencies, and the landowners has been completed through personal contact by Service planners, refuge managers, and supervisors.

Executive Order 12898. Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. All Federal actions must address and identify, as appropriate, disproportionally high and adverse human health or environmental effects of its programs, policies, and activities on minority populations, low-income populations, and Indian Tribes in the United States. The CCP was evaluated and no adverse human health or environmental effects were identified for minority or low-income populations, Indian Tribes, or anyone else.

Wilderness Preservation Act of 1964. The Service has evaluated the suitability of the Refuge for wilderness designation and determined it does not qualify.

National Wildlife Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-668ee). Appropriate Use findings and Compatibility Determinations have been prepared for the following uses: Wildlife Observation, Interpretation and Photography; Environmental Education; and Research.

Executive Order 13186. Responsibilities of Federal Agencies to Protect Migratory Birds. The CCP is consistent with Executive Order 13186 because the CCP and NEPA analyses evaluate the effects of agency actions on migratory birds.

Endangered Species Act of 1973. The Service will conduct consultations under Section 7 of the ESA for any refuge management program actions that have the potential to affect listed species.

Coastal Zone Management Act, Section 307. Section 307(c)(1) of the Coastal Zone Management Act of 1972, as amended, requires each Federal agency conducting or supporting activities directly affecting the coastal zone, to conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with approved state coastal management programs. The CCP is consistent with Coastal Zone Management Act because CCP implementation would protect the coastal zone from adverse impacts as a result of modification or destruction.

Executive Order 11990. Protection of Wetlands. The CCP is consistent with Executive Order 11990 because CCP implementation would protect and enhance existing wetlands.

Executive Order 11988. Floodplain Management. Under this order Federal agencies "shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by flood plains." The CCP is consistent with Executive Order 11988 because CCP implementation would protect floodplains from adverse impacts as a result of modification or destruction.

Integrated Pest Management (IPM), 517 DM 1 and 569 FW 1. In accordance with 517 DM 1, an integrated pest management (IPM) approach has been adopted to eradicate, control, or contain pest and invasive species on the refuge. In accordance with 517 DM 1, only pesticides registered with the USEPA in full compliance with FIFRA and as provided in regulations, orders, or permits issued by USEPA may be applied on lands and waters under Refuge jurisdiction.

Chief, Division of Refuge Planning

9-27-2011
Date

Appendix H. Common Acronyms and Abbreviations

ac	acre(s)
Administration Act	National Wildlife Refuge System Administration Act of 1966
BCE	Before Common Era
BIDEH	Biological Integrity, Diversity, and Environmental Health
BMPs	Best Management Practices
CCP	Comprehensive Conservation Plan
CD	Compatibility Determination
CE	Common Era
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO_2	carbon dioxide
Complex	Maui National Wildlife Refuge Complex
CWRM	Commission on Water Resource Management
DBEDT	Hawaiʻi Department of Business, Economic Development, and Tourism
DIN	dissolved inorganic N concentration
DLNR	Hawaiʻi Department of Land and Natural Resources
DM	Department Manual
DO	dissolved oxygen
DOA	Hawaiʻi Department of Agriculture
DOCARE	Hawaiʻi Division of Conservation and Resource Enforcement
DOE	Hawaiʻi Department of Education
DOFAW	Hawaiʻi Division of Forestry and Wildlife
DOH	Hawaiʻi Department of Health
DOI	U. S. Department of the Interior
EA	Environmental Assessment
EE	environmental education
e.g.	exempli gratia, "for example"
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FONSI	Finding of No Significant Impact
ft	Feet (Foot)
GAO	Government Accountability Office
GHG	greenhouse gas(es)
gpm	gallon (U.S. fluid) per minute
HDOT	Hawaiʻi Department of Transportation
Improvement Act	National Wildlife Refuge System Improvement Act of 1997
I&M	inventory and monitoring
in	inch(es)
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
lb(s)	pound(s)
LCA	Land Commission Awards
MCPD	Maui County Planning Department

mgd	million gallons per day
mi	mile(s)
MLLW	mean lower low water
mm	millimeter(s)
MOA	Memorandum of Agreement
N	Nitrogen
NAGPRA	Native American Graves Repatriation Act
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NRCS	Natural Resources Conservation Service
NWHI	Northwestern Hawaiian Islands
NWR	National Wildlife Refuge
OPIC	Overseas Private Investment Corporation
PCJV	Pacific Coast Joint Venture
PDO	Pacific Decadal Oscillation
PICCC	Pacific Islands Climate Change Cooperative
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PVC	polymerizing vinyl chloride
Refuge System	National Wildlife Refuge System
RHPO	Regional Historic Preservation Officer
Service, USFWS	U.S. Fish and Wildlife Service
SHPO	State Historic Preservation Officer
SLAMM	Sea Levels Affecting Marshes Model
SLR	Sea Level Rise
SUP	Special Use Permit
T&E	Threatened and Endangered
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WWII	World War II
YCC	Youth Conservation Corps
yd(s)	yard(s)

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Appendix J. Planning Team Members

The following members of the core planning team were responsible for preparing the CCP.

Glynnis Nakai	**Project Leader, Maui NWRC**
Michael Nishimoto	**Wildlife Biologist, Maui NWRC**
Laura Beauregard	**Refuge Planner, Hawaiian and Pacific Islands NWRC**
Tim Mayer	**Hydrologist, Region 1**

The following members of the extended planning team provided assistance and analysis to the core planning team of the CCP.

Arleone Dibben-Young	Nēnē o Molokaʻi
Sandra Hall	External Affairs Specialist, Hawaiian and Pacific Islands NWRC
Ben Harrison	Deputy Regional Chief, Region 1
David Hoy	GIS Specialist, Region 1
Kevin Kilbride	Wildlife Biologist, Refuge Biology, Region 1
Mike Marxen	Chief, Visitor Services and Communications Division, Region 1
Barbara Maxfield	(former) External Affairs Specialist, Hawaiian and Pacific Islands NWRC
Scott McCarthy	Chief, Planning Division, Region 1
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Fred Paveglio	(former) Chief, Branch of Refuge Biology, Region 1
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Calvin Willis	Maintenance Worker, Maui NWRC

Maps were prepared by David Hoy.

Graphic design of cover by Patrick Stark.

Graphic design of Readers Guide by Sandra Hall.

Appendix K. Public Comments and Service Responses

In this appendix the Service responds to comments that were received on the Keālia Pond NWR Draft CCP/EA, August 2011) during the official public comment period from August 19-September 19, 2011. Comments were received via letter, comment card, and e-mail. All substantial comments regarding the Draft CCP/EA are presented below. Some comments have had formatting changes and other minor edits to correct spelling or punctuation, but the majority of comments are as received. Service responses indicate where changes were made to the CCP based on specific comments.

Index

Comments and Responses

1. Claud Sutcliff, Ph.D.

Comment:

I have read the draft CCP and love the Vision (and that it is in Hawaiian first) and preferred alternative for Kakahai'a, but understand the realities you face financially, particularly if Fish and Wildlife succeeds in getting stewardship for Molokini (which sounds like a good idea). For the record, I very much would like to see USFW get the funding necessary to implement the preferred alternative for Kakahai'a! p. 3-1 (and the pages that follow) says that Wailau is the East Molokaʻi volcano; that's wrong, Kamakou is the volcano, and Wailau is the main valley on the north shore...

Service Response:

We appreciate the support expressed by these comments. While there is also a "Wailau Valley" on this shield volcano, the entire East Molokaʻi volcano is named "Wailau," according to the U.S. Geological Survey (Fields et al. 2008). The place name "Kamakou" is officially designated as the summit of Wailau, the highest peak on the southern rim. Please see the following references:

Feature Detail Report for: Kamakou [http://geonames.usgs.gov/pls/gnispublic]

Field, Michael E., Cochran, Susan A., Logan, Joshua B., and Storlazzi, Curt D., 2008, The south Molokaʻi reef; origin, history and status, U.S. Geological Survey Scientific Investigations Report 2007-5101, p. 3-10 [http://pubs.usgs.gov/sir/2007/5101/sir2007-5101_intro.pdf]

Comment:
p. 3-10 says that Molokaʻi "was first settled in approximately 600 BCE;" some families may claim that (and it may even be right), but the earliest date I've ever read in the archeological literature says 450 CE...

Service Response:
We apologize for the typographical error in the Draft CCP/EA. It should have read "600 CE." The text has been revised to "…450-650 CE."

2. Gene Anderson
Comment:
Prefers Alternative C and suggests adding Pueo to species list.

Service Response:
We appreciate the support expressed for our preferred alternative. Pueo has been added to our species list.

3. Arleone Dibben-Young
Comment:
Pg 2-17 Correct the use of ʻokina for ʻAlae keʻokeʻo
Pg 5-1 Yuen family, not Ewing.
Pg 6-7 Estioko-Griffin (1987) reference is missing from Literature Cited

The commenter also provided substantial historical information on the area.

Service Response:
Thank you, typographical corrections have been made. Preliminary investigation of the cultural history of the Kakahaiʻa NWR area will be verified and augmented in a formal archaeological and cultural investigation.

Comment:
Regarding Alternative C as proposed, I ask that reconfiguring the pond to its pre-1900 shape and size be investigated, not only to increase year round habitat, but to reduce refuge operation costs (pumping = costly electricity), perhaps thereby freeing funds for a full-time on-island refuge staff. The current practice of managing the water levels of the existing two pond system is to pump water year round from the well *into* the impoundments. In this way, the water levels can be managed when necessary, such as during an avian botulism outbreak or to kill vegetation that has regenerated when the ponds have dried by flooding. Water level management, however, could also be done by pumping water *out*, when required, to an upland containment pond. Re-exposing the fresh water lens floating atop the water table would provide year round habitat, and although a botulism outbreak can occur with permanently open water, an outbreak could be managed quickly by carcass salvage and without altering the water level.

Service Response:
The Refuge plans to collect as much data (soils, water resources, etc.) as possible to evaluate and design the restoration plan. These data will identify the feasibility of retaining the existing pond configurations.

Comment:
Although there is the Molokaʻi Human Society on island, their policy is to spay/neuter/release feral cats. I suggest a written agreement with the MHS to euthanize predators captured at the refuge or to dispatch any such predators on premises.

Service Response:
Feral animals will be euthanized upon capture on the Refuge. As identified in this CCP, establishing fences to reduce predators (including cats) will be a critical management strategy.

4. Bill Feeter
Comment:
It is not coordinated with other agencies to the fullest and is not holistically planned. Since there is no hope for funding I suggest that the USFWS consider private enterprise to operate the reserve.

Service Response:
*In section **2.3.2 Interagency Coordination and Collaboration** we highlighted ecosystem planning efforts involve collaboration among Federal, State, and local agencies. We recognize that implementation of some strategies in the plan will require this same type of broad collaboration with others. We have revised this section to acknowledge that we will strive to collaborate with other public and private organizations, as appropriate, to achieve the goals identified in the plan.*

5. Skippy Hau
Comment:
I support Alternative C. 5-4. I strongly support maintaining shoreline access to fish and picnic. Involving the local community in implementing the proposed plan could be a win-win situation. I suggest the predator-proof fencing and its effectiveness in reducing predation could help with educating the public. I suggest stressing that visitors will be made up of local classes, teachers, and students.

Service Response:
More detailed information on interpretation, EE, and target groups will be included in the VSP. Chapter 5 has language regarding interpretation, EE, volunteering, and other opportunities for island residents.

Comment:
Having clear guidelines for flash photography and video cameras would be helpful to explain why we prohibit them during turtle nest excavations and their distraction for emerging hatchlings.

Service Response:
There is no documented evidence of turtles nesting along the Refuge shoreline but if there should be, we would develop guidelines to minimize impacts to adult nesting females and hatchlings at that time.

5. Ken Fiske

Comment:
This bird list, along with the latter one, includes birds not found on Darlene Fiske's bird survey. I was surprised to see the area along the beach now included as part of the Refuge. Thus, different birds not found within the Refuge are included. At one time, site was home to moorhens and they need to be reintroduced.

Service Response:
The Appendix A Species List is a compilation of species found on the Refuge at various times by multiple individuals, dating back to 1981. As such, it is likely to include more species than those identified by any one individual.

The coastal area was included with the acquisition in 1976 and has always been part of the Refuge. The direction of this first 15 year plan is to restore the wetlands. Once restored and managed, moorhens can be evaluated for repatriation to the Refuge – if they don't voluntarily return. This would likely be included in the next 15-year plan.

Comment:
Alternate C is the best plan. Forest habitat should be all native trees.

Service Response:
All native species would be ideal; however, restoration of the wetlands is a priority. The forest habitat is essential for protecting the wetland from sedimentation from the upper watershed. The Refuge will strategically plan the replacement of the invasive pest species with native species while preparing the wetland restoration plan and ensure impacts to the wetlands are not exacerbated.

Comment:
Restoration of wetland is of first importance, along with a need for permanent staff presence on the site. There is a need to involve the Natural Resource Conservation Service and the Molokaʻi-Lanaʻi Soil and Water Conservation District, which can address the alternate components not within the scope of the Fish and Wildlife Service.

Service Response:
An onsite employee is a need identified in the preferred alternative, Alt. C., and similar to other strategies, is dependent upon future funding. Both agencies identified by the commenter are partners within the East Molokaʻi Watershed Committee and the Sedimentation Committee, partners have been identified in ***2.2.2 Interagency Coordination and Collaboration.***

Comment:
Information from the airport does not transpose to the Refuge.

Service Response:
The weather data from the airport is of importance even though the distance is away from the Refuge. The weather station at the airport is the closest monitoring system and we need to know how it differs from the Refuge. This information will remain in the final CCP as a future reference. The Refuge used to have a weather station and it will need to be reinstalled as the wetlands are restored.

Comment:
Herbicides were once applied to the bulrush and were ineffective. Any pesticide application should have assurance of working and a label which will not endanger the birds for which the Refuge is being created.

Service Response:
The Refuge is cognizant of label restrictions and proper applications. The plan is to remove California bulrush as completely as possible. Herbicides would be used to hold back and prevent re-establishment of invasive pest species.