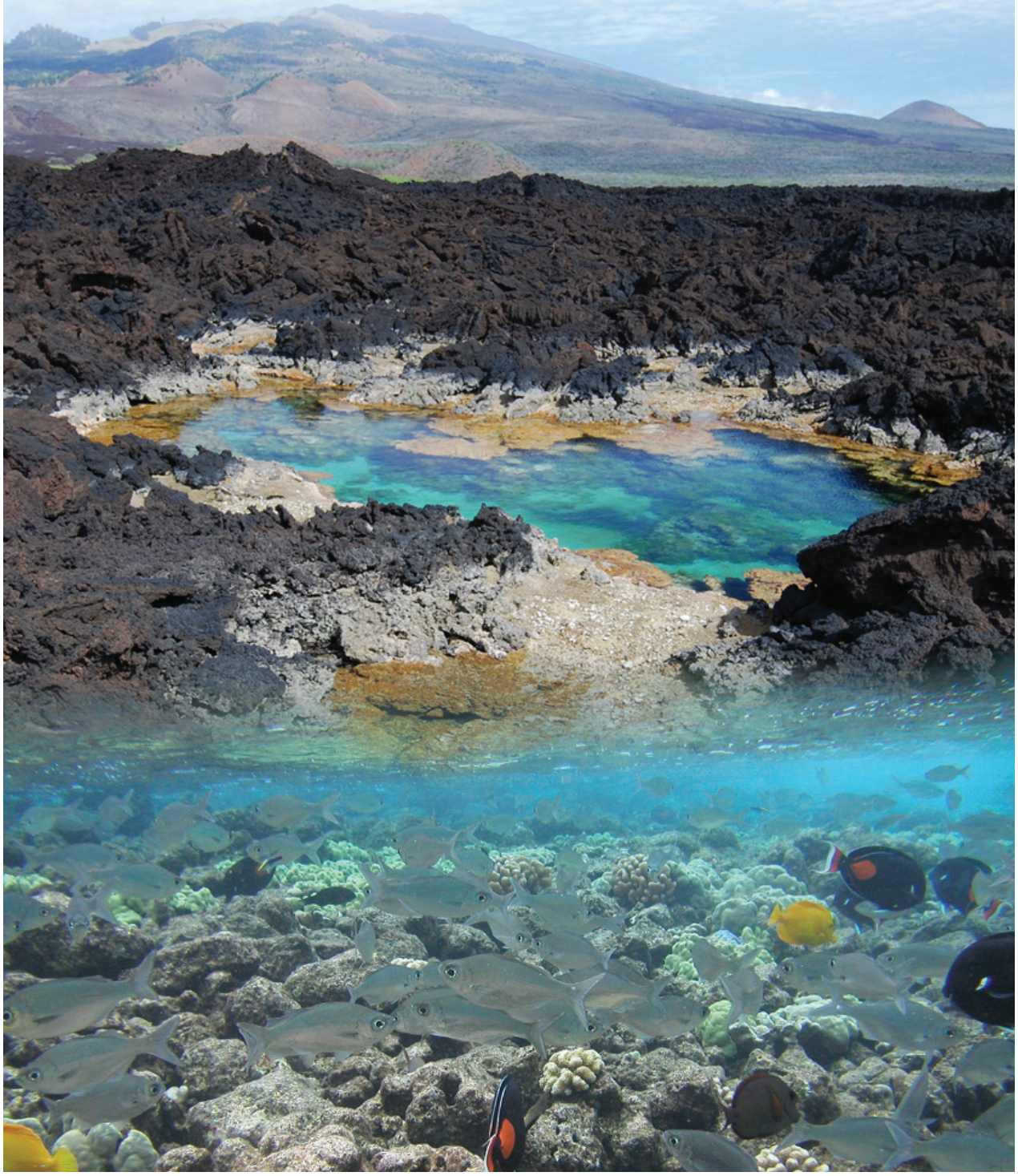
ʻĀhihi-Kīnaʻu Natural Area Reserve
Draft Management Plan



Department of Land and Natural Resources

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The Department of Land and Natural Resources Division of Forestry and Wildlife's mission is to enhance, protect, conserve and manage Hawaiʻi's unique and limited natural, cultural and historic resources held in public trust for current and future generations of visitors and the people of Hawaiʻi nei in partnership with others from the public and private sectors.

Forward

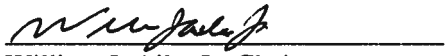
We invite you to join us in learning about ʻĀhihi-Kinaʻu Natural Area Reserve (NAR). The Natural Area Reserves System (NARS) was established by the Legislature in 1970 for the protection of Native Hawaiian ecosystems and geological features in as unmodified a manner as possible. ʻĀhihi-Kinaʻu NAR was the first to be established, in 1973, and the only one currently including the ocean (*moana*) and coral reefs. Inspired by the area's stark beauty and natural and cultural resources, residents and visitors have invested countless hours of volunteer time and community action to help care for the Reserve. This plan extends this legacy of public investment to better protect and manage this Reserve.

In 2008, the Hawai'i Department of Land and Natural Resources (DLNR) and the ʻĀhihi-Kinaʻu Natural Area Reserve/Keoneʻōʻio Advisory Group (Advisory Group) began a planning process with assistance from The Nature Conservancy. These partners convened a diverse working group who met together in more than fifteen meetings between 2008 and 2010 to establish the vision, priority resources, threats, goals, objectives and strategic actions for preserving the Reserve.

The purpose of the Management Plan is to describe management actions needed to preserve, protect, and enhance the biological and cultural resources of the Reserve for current and future generations. It also acts as an institutional memory of past actions and a description of the status of resources and management today that can serve as a baseline of knowledge and comparison in the future.

Mahalo to the Management Plan Working Group, the Advisory Group and the people of Maui for their involvement and interest in the Reserve and this Management Plan. I fully support your vision for the Reserve which includes nature, culture and people. Through *kōkua* and *mālama*, the natural and cultural resources of ʻĀhihi-Kinaʻu Natural Area Reserve are respected and protected as a living legacy of *aloha ʻāina* and *aloha moana.*

I encourage you to stay involved if you already are, or get involved, in the plan review process and in supporting its implementation in the years to come. In today's economic climate, the strategies outlined in this plan - government and community partnerships, creative finance and measures of success - are essential to protecting and preserving the unique and irreplaceable place that is ʻĀhihi-Kinaʻu Natural Area Reserve.



William J. Aila, Jr. Chairperson
Board of Land and Natural Resources

Acknowledgements

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This plan is the culmination of years of efforts by many individuals. Mahalo to the ʻĀhihi-Kīnaʻu Natural Area Reserve/Keoneʻōʻio Advisory Group: Ann Fielding, Charles Maxwell Sr., Cheryl King, Declan McCarthy, Dino Ventura (Mākena Resident), Erik Frederickson (Archeology), Gary Hashizaki (Ocean Recreation), Hannah Bernard, Jeff Bagshaw, Ken Kawahara, Kuhea Paracuelles, Mona Kapaku, Nicole Davis, Pat Borge, Robert Luʻuwai, and Sumner Erdman (Adjacent landowner). Mahalo also to previous Advisory Group members.

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Mahalo to the dedicated volunteers and members of the public who steadfastly advocate for the ʻĀhihi-Kīnaʻu Natural Area Reserve.

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Acronyms

BLNR	Board of Land and Natural Resources
BMP.....	Best Management Practices
CAP.....	Conservation Action Plan
CRAMP	Coral Reef Assessment and Monitoring Program
CRMP	Cultural Resource Management Plan
CMP	Conservation Measures Partnership
DLNR	Department of Land and Natural Resources
DAR	Division of Aquatic Resources
DOCARE	Division of Conservation and Resources Enforcement
DOFAW	Division of Forestry and Wildlife
EA.....	Environmental Assessment
ESA.....	Endangered Species Act
HAR.....	Hawaiʻi Administrative Rules
HIHWNMS.....	Hawaiian Islands Humpback Whale National Marine Sanctuary
HIMB	Hawaiʻi Institute of Marine Biology
HTA	Hawaiʻi Tourism Authority
HWF	Hawaiʻi Wildlife Fund
HRS	Hawaiʻi Revised Statute
MLCD	Marine Life Conservation District
MOA.....	Memorandum of Agreement
MPD	Maui Police Department
NOAA	National Oceanic Atmospheric Administration
NPS	National Park Service
NAR.....	Natural Area Reserve
NARS	Natural Area Reserves System
TNC	The Nature Conservancy
US.....	United States

How to Read This Plan

This document is written for many audiences, and it can be read front to back, or in sections. It captures historical and biological information and suggestions from a citizen-government Working Group on how to comprehensively protect and preserve ʻĀhihi-Kīnaʻu Natural Area Reserve (Reserve).

Section 1 has detailed information about the Reserve's setting and history. **Section 1** also describes the cultural and biological resources within the Reserve and the major threats to these resources.

In **Section 2**, readers can learn about a comprehensive set of prioritized management actions for the Reserve; as well as measures of success and a sustainable finance plan. Together, these components form a framework for effective management.

Section 1.3 Legacy of Protection allows the reader to learn about the history of management actions and how the Reserve is managed today. In that section, **Table 2** summarizes management recommendations from 30 years of plans and reports. To compare those with the actions recommended in this plan, see **Table 21**.

To learn about what makes this Reserve so unique, read about target resources in **Section 1.4 What We're Protecting**. This section describes the seven primary resources in the Reserve, their current status, and what level of threat they currently face. For more detailed information about threats, go to **Section 1.5 Critical Threats.** Nineteen direct threats are grouped into four categories and are ranked from high to low.

For information about how to address threats and care for the Reserve, see **Section 2.3 Goals, Objectives, and Strategic Actions.** This section describes strategic actions that address critical threats to resources, with a focus on human use, zoning, education, enforcement, and alien species removal. This section also lists the top twelve actions to be implemented first.

To learn how the Reserve plans to finance the programs in the plan, see **Section 2.5 Sustainable Finance.** In this section you can learn about the basic operating costs of the Reserve, the source of its current revenue, and how the Working Group suggests filling the funding gap.

Plan Overview

This draft management plan captures the best thinking of a citizen-government Working Group on how to comprehensively protect and preserve ʻĀhihi-Kīnaʻu Natural Area Reserve (Reserve). Though unintentional, people's love for this place has had serious impacts on Reserve resources. This plan documents the history of the Reserve, outlines its current condition, and recommends management actions to protect the Reserve.

This plan seeks to fulfill the mandate from the Hawaiʻi Legislature, which in 1970 created the Natural Area Reserves System (HRS 195-1) to protect and preserve Hawaiʻi's "unique geological and volcanological features and distinctive marine and terrestrial plants and animals…both for the enjoyment of future generations, and to provide baselines against which changes being made in the environments of Hawaiʻi can be measured."

Why is this plan needed?

The Reserve is highly protected and heavily visited. Popular among residents and visitors, damage has occurred to natural and cultural resources throughout the Reserve. Examples include:

- impacts to cultural sites
- illegal fishing harvest/poaching
- human waste in anchialine pools
- harassment of endangered marine mammals, and
- graffiti

Resource damage, as well as crowding, safety issues, and the lack of a management plan led the state to restrict access to areas of the Reserve in 2008 and again in 2010. Public safety issues have included:

- injuries from lava and coral
- drowning
- heat stroke
- car stranding and theft

This plan provides recommendations, including managing access, to balance the needs of human use with the need to protect the natural and cultural resources within the Reserve. Protecting resources also includes addressing the threats of development, alien invasive species, and climate change.

How will people benefit from this plan?

Management actions outlined in the plan provide for development of interpretive and volunteer programs that enhance educational, hiking and nature study activities, and help provide more funding for Reserve management. The plan provides a comprehensive description of the Reserve and will aid decision makers and the public in understanding and protecting the area and people.

ʻĀhihi-Kīnaʻu was designated as the first Natural Area Reserve (NAR) in Hawaiʻi in 1973. It is the only NAR that includes marine resources. NARs were established by the State of Hawaʻi to protect the best representative samples of intact ecological and geological systems in the state. The NAR designation exists to preserve these areas in perpetuity as safe havens for natural and cultural resources – the primary goal of NAR management.

What resources are inside the Reserve?
A young lava flow, healthy marine life, Hawaiian cultural sites, endemic plants and arthropods, and anchialine pools (surface brackish water pools fed by underground fresh and ocean water). The resources within the Reserve are an important heritage to the people of Hawaiʻi, as well as the broader community, because many are unique, either in Hawaiʻi or in the world, and all are threatened to some degree.

The table below shows how significant Reserve resources are on a local, national and global level based on endemism (e.g. found only in Hawaiʻi or only on Maui), and presence in other places in the world (e.g. anchialine pools are globally rare).

Natural and Cultural Resources of ʻĀhihi-Kīnaʻu Natural Area Reserve	State Significance	National Significance	Global Significance
Anchialine pools	•	•	•
Coral reefs	•	•	
Coastal marine habitats	•		
Lava flow formations and habitats	•	•	
Cultural landscape	•		
Native leeward shrublands and forests	•		
Wilderness qualities	•		

How do we know how Reserve resources are doing?
The plan describes the current status of resource health. Measures are designed and set to show managers how resources are doing over time or in response to a management action. Examples of measures include marine life abundance, cessation of geologic and cultural site trampling, nesting success of native water birds, percent coral cover, and water quality.

What kinds of things are damaging or threatening the resources inside the Reserve?
Many things have damaged, can damage or could further erode the resources inside the Reserve. There are four major threats:

1) Human Use
   Some of the highest threats include:
   - illegal marine harvest/poaching
   - trampling of marine life, geology, and cultural sites
   - damage to formations and structures
   - rock removal
   - spray paint graffiti
   - public safety

2) Alien Species and Other Biological Threats
   Some of the highest threats include:
   - introduced non-native species including algae, fish, cats, rats, mongoose, goats and deer
   - pathogens or diseases that affect species like plants, coral and fish such as the *Erythrina* gall wasp and *Montipora* coral disease

3) Land-based Impacts
   Some of the highest threats include:
   - land-based pollution, nutrients and resulting alien algae growth
   - altered wilderness qualities and scenic resources
   - light pollution (affects native birds, bats and insects)

4) Global Impacts
   Some of the highest threats include:
   - climate change
   - resilience to climate change
   - marine debris

What is in the plan?

Section 1 describes the setting and history of the Reserve. It documents what natural and cultural resources are found there, their biological and cultural significance and their current condition. It summarizes the social, regulatory and management history of the Reserve and it delineates what threats need the most attention.

Section 2 specifies recommended actions to protect and preserve the Reserve based on a framework designed to reduce threats and improve the resource status where it is most needed. It also suggests ways to finance this management and outlines measures of success.

What does the draft management plan recommend?

The draft management plan identifies goals, objectives, and strategic actions to protect, preserve, and improve resource status. The four goals are:

1. Manage Human Use
2. Build and Maintain the Reserve's Management Capacity
3. Control Alien Species and Other Biological Threats
4. Prevent Land-based Impacts

The actions outlined in the draft management plan address the protection and preservation needs of each unique resource. The top priority actions selected to be implemented first are:

- Hire a full-time Reserve manager
- Build and maintain staff capacity to meet Reserve needs
- Implement a Reserve sustainable financing plan
- Minimize the impact of unexploded ordnance
- Improve and maintain on-site facilities
- Recruit partners in support of the plan's implementation
- Manage visitors and access points
- Establish and maintain trails and boundaries
- Establish an interpretative program
- Implement and operate a volunteer program
- Protect and stabilize high priority cultural resource sites
- Deter and remove ungulates out of the Reserve

Who wrote the plan?
The ʻĀhihi-Kīnaʻu Natural Area Reserve / Keoneʻōʻio Advisory Group was created in 2004 to advise the Department of Land and Natural Resources (DLNR). The group includes local residents, government employees, cultural practitioners, volunteers, scientists, and others. In 2008, the Advisory Group formed a Working Group to develop the management plan which included Advisory Group members, DLNR staff, local and federal government staff, subject matter experts, and other individuals. This working group met together in more than 15 meetings between 2008 and 2010 to write this plan. The Working Group process and draft plan production was facilitated by The Nature Conservancy.

Where does the information in the plan come from?
The background information comes from dozens of historical, government, and human use reports, previous draft management plans, cultural assessments, and scientific papers, as well as input from volunteers, local business owners, on-site data, stakeholders, and residents.

How will the draft management plan be used?
DLNR will use this draft plan to help determine priorities and actions to include in the final plan. Each action from the plan that DLNR decides to implement will likely involve a work plan, budget with internal review and approval, as well as securing the necessary funding prior to implementation.

What the draft management plan is:
Overall guidance and recommendations to DLNR from an advisory/stakeholder group
Prioritized recommendations on how to protect and preserve the area, and allow for human use
A living, growing, adaptive document to be revised periodically as conditions in the Reserve change
A compilation of natural and cultural history and resources of the area
Documentation of the current top threats to the area – recognizing that threats change
A planning and management tool for DLNR to use to determine priorities, work plans, staffing requirements, budget requests, and more
Funding guidance and request document that enables DLNR to ask for the resources necessary to protect the Reserve

1.0 Reserve Status

The natural and cultural resources of ʻĀhihi-Kīnaʻu Natural Area Reserve (Reserve) are unique in Hawaiʻi, and thus were protected from development and extractive uses more than 30 years ago. Today, threats to these sensitive resources have increased and additional threats include: visitors by the thousands, introduced species and other biological threats, additional nearby development, and impacts of climate change. The type and intensity of change in today's world require that protected natural areas not just be set aside but also that they be managed. Effective management requires reliable human and financial resources and a landscape scale view of threats and opportunities to ensure that the natural and cultural landscape itself is cared for, and not hemmed in by human structures and activities and thus change the inherent integrity that defines it as a unique Hawaiian place.

This section lays out the basic understanding of the Reserve, what makes it unique and why it needs to be managed. First, it describes the purpose and need for this plan, then the geographical, geological, biological, social, economic, cultural, and physical infrastructure setting of the Reserve. This is followed by a description of the management framework under the State of Hawaiʻi, Department of Land and Natural Resources (DLNR), and an accounting of the management history of the Reserve from its inception in 1973 to the present day. A discussion of the natural and cultural resources targeted for protection under this plan, is followed by a categorization and description of how Reserve resources are being impacted by four types of threats.

1.1 Purpose and Need

The purpose of this management plan is to provide direction for future management of the Reserve, particularly regarding human use, utilizing input from the Advisory Group and the general public. With visitation numbers at 250,000 visitors per year and a state mandate to "protect and preserve" Reserve resources as relatively unmodified as possible, this plan addresses the need to manage human access and use and natural resource protection in the once remote, increasingly popular part of Maui. Human use has been the defining issue at the Reserve for nearly two decades, one that requires appropriate levels of resources and staff.

1.2 Reserve Description and Setting

The state's Natural Area Reserves System (NARS) was established in 1970 to protect the best examples of Hawaiʻi's remaining ecology and geology. Each reserve in the state protects unique examples of community types found on each island. The Reserve is the most heavily used of the nineteen NARS. It is aesthetically beautiful, biologically and geologically unique, and culturally important. The area affords sweeping views of Haleakalā volcano's southwest rift zone, Kahoʻolawe, Molokini, Lānaʻi, Mauna Kahalawai (West Maui Mountain), and the surrounding ocean. Here, one can consider the continuation of geologic history from one of the youngest flows on Maui, to the older Maui Nui complex islands (Kahoʻolawe, Lānaʻi, and Molokaʻi), and the regenerative and erosional forces of nature on the landscape. Native Hawaiian mythology describes many events through the features of this landscape. Some of the most well-preserved examples of Hawaiian endemic ecosystems associated with recent lava

flows occur in the Reserve, both in the water and on land.

1.2.1 Geographic Setting

The Reserve is situated on the southern shoreline of the Hawaiian Island of Maui, in the *moku* (traditional land district) of Honuaʻula[1], on the southwest flank of the 3,055 meters (10,023 feet) volcano of Haleakalā (**Figure 1**). It is within the County of Maui administrative district of Makawao near the town of Kīhei and resort areas of Wailea and Mākena. From north to south, the Reserve spans four *ahupuaʻa* (land division extending from the uplands into the sea): Onau, Kanahena, Kualapa, and Kalihi. The Reserve was named so because it includes both the land and sea around the lava flow named Cape Kīnaʻu[2], situated at the southern end of ʻĀhihi Bay. The Reserve's geographic boundaries were drawn to encompass the entirety of the lava flow at Cape Kīnaʻu including its source vent at Kālua O Lapa, and includes portions of other, older lava flows. The purpose and intent of the Reserve is to preserve and protect three unique components: the geologic setting of the most recent lava flow on Maui; unique assemblages of nearshore coral reef ecosystems; and the anchialine ponds found there.

The 828 ha (2,045 acres or 8.3 km^2) Reserve consists of 327 ha (807 acres / 6.3 km^2) of submerged lands and 501 ha (1,238 acres or 5 km^2) of terrestrial area along 4.8 km (3 miles) of the southern coastline of Maui. The Reserve was created in 1973 and has the unique distinction of being the first in the statewide NARS, the only Reserve to encompass marine ecosystems, and is one of few areas on state lands where an entire lava flow is protected from its source to the sea. The size of ʻĀhihi-Kīnaʻu is average when compared to other Reserves in the NARS which vary greatly in size from the smallest at Kaʻena Point on Oʻahu (59 acres) to the largest at Manuka on Hawaiʻi island (25,550 acres). Compared to the 11 state Marine Life Conservation Districts (MLCDs) which offer similar protections, the Reserve's marine portion is nearly three times as large as the largest MLCD at Kealakekua Bay, Hawaiʻi.

Rainfall in the Reserve ranges from 400 mm (15 inches) along the coastline, to 600 mm (24 inches) per year along the *mauka* (upland) boundary. There is distinct seasonal variability in rainfall, with much of the precipitation from winter storms. The highest point in the Reserve is Kālua O Lapa at 158 meters (520 feet) elevation. Below sea level the lowest point is -35 meters (-115 feet). Solar radiation here is among the highest in the state. The dark color of the lava absorbs solar radiation, which creates warmer conditions in the Reserve than the surrounding areas (500 calories/m^2/day) (Rodgers et al. 2008).

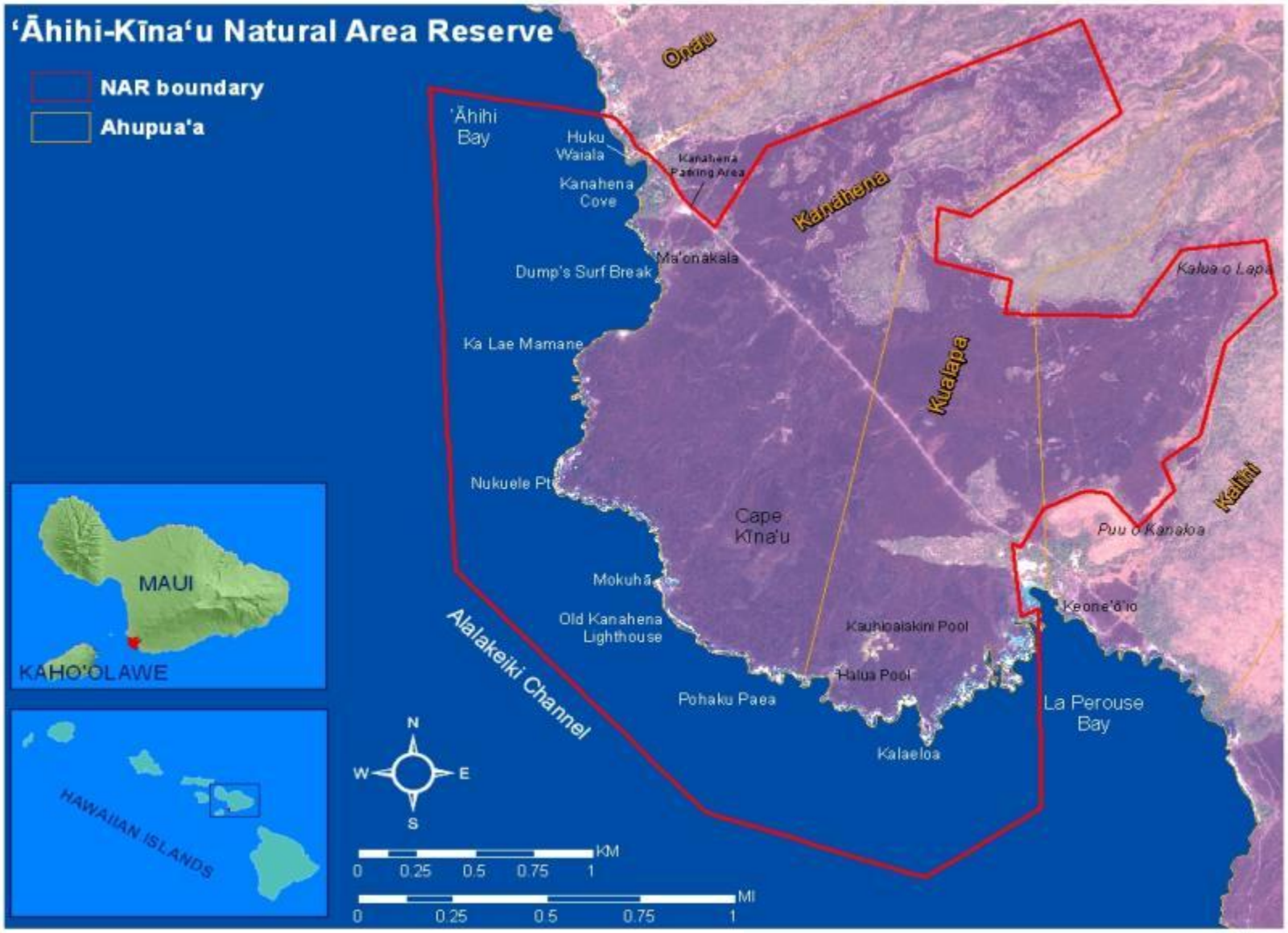

Figure 1. 'Āhihi-Kīna'u Reserve boundary and *ahupua'a* (map by Stephanie Tom).

1.2.2 Geologic Setting

The geology of the Reserve is among the youngest on the island and is home to a wide variety of unique ecosystems and creatures. Much like its neighbor, Haleakalā National Park, the Reserve landscape allows for a glimpse into the geologic history of Maui and the processes of volcanic islands.

The Reserve encompasses young rugged lava flows on Haleakalā volcano's southwest rift zone (**Figure 2**), where *ʻaʻā* (rough, slow moving lava) lava fed the Kālua O Lapa cinder cone. These lava flows reach seaward, forming Cape Kīnaʻu and coating the adjacent offshore sea floor. Also within the Reserve is the coastal part of an older, similar sequence of lava flows that lies to the northwest of the Kālua O Lapa lava. This older sequence, the Kanahena flows, had erupted from an unnamed fissure at about 430 meters altitude (1,400 feet) on the southwest rift zone. Since the Reserve boundary on land was specifically designed to encompass the entirety of the lava flows, 83% of the Reserve is unvegetated lava, primarily very rough and jagged *aʻā* lava with some *pāhoehoe* (smooth, fast moving lava) lava. Because of the extreme roughness and fractured nature of the lava itself, the area is extremely difficult to traverse on foot. However, because it is easily accessed and viewed, the Reserve functions as an outdoor, natural history classroom; it provides many opportunities to educate and create awareness that the landscape found here is a representative example of the geologic forces that created the Hawaiian archipelago.

Two radiocarbon ages have been determined from charcoal collected beneath Kālua O Lapa lava flows and spatter deposits (Sherrod et al. 2006). The average age indicated the lava flows were emplaced sometime between A.D. 1419 and 1621. This range of calendar ages is a calibrated age, adjusted to account for the varying abundance of the carbon-14 isotope over time.[3]

Five other eruptive sequences younger than about 500 years in age are known from East Maui (Sherrod et al. 2006). The Kālua O Lapa sequence may not be the youngest of Maui's volcanic events, but it certainly is among them. Two radiocarbon ages from charcoal beneath the Kanahena lava flows leave its age unresolved. Of these, the older age is more likely correct, corresponding to an eruption between A.D. 1024 and 1183, about 800–900 years ago (Sherrod et al. 2006). In instances like this, the younger age commonly is too young, a result of younger roots penetrating through or along the margins of a lava flow and then being burned by range fires that are unrelated to the volcanic event in question. (More information on the geologic history of the Reserve can be found in **Section 1.4.5**).

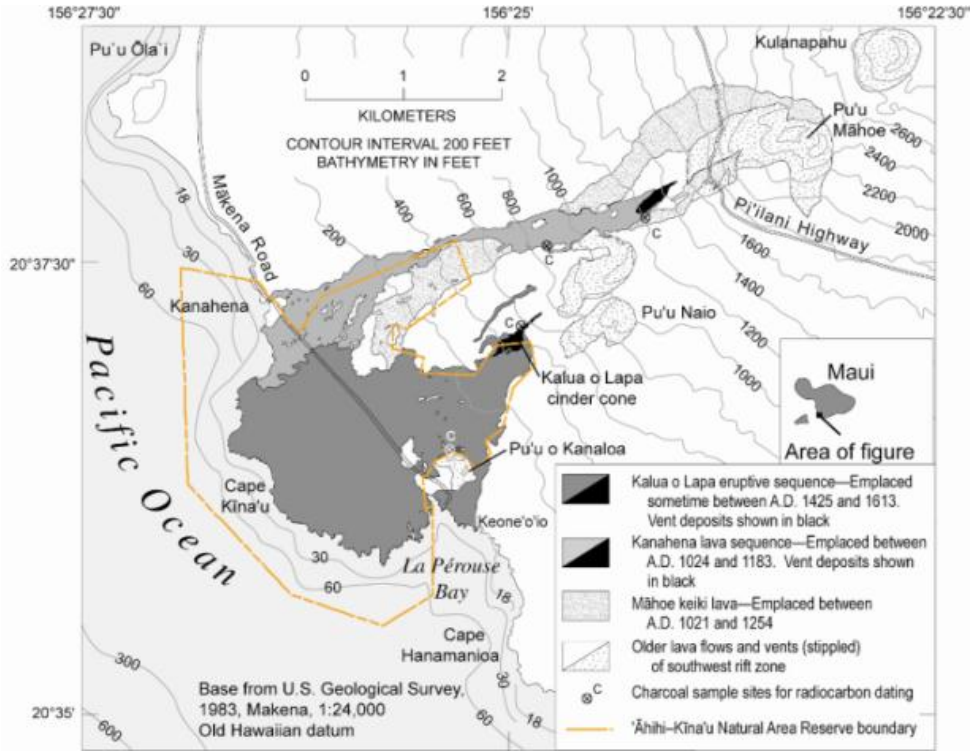

Figure 2. Generalized geologic map showing young lava flows on the lower southwest rift zone of Haleakalā volcano (map by Dave Sherrod).

1.2.3 Biological Setting

On a worldwide scale, the oceanic islands of Hawai'i are biologically significant because of extremely high levels of endemism. More than 90% of Hawai'i's native plants and animals, an estimated 15,000 species, are found only in Hawai'i. Hawai'i's coral reefs and nearshore waters are home to more than 7,000 species, a quarter of them found nowhere else in the world. Today, more than 25% of Hawai'i's plants, animals, forest birds, and land snails are now rare and Hawai'i is home to more endangered species than any other state in the United States (U.S.) (TNC 1998).

Some of the most pristine examples of Hawaiian endemic ecosystems associated with recent lava flows occur in the Reserve. Biological resources include anchialine pools, coastal marine habitats, coral reef ecosystems, lava flow formations and habitats, remnant native leeward shrublands and forests, and connections between these used by native wildlife. (Each of these resources is described further in **Section 1.4**.)

Anchialine pools are surface brackish-water pools, fed underground from both marine and fresh water sources, and lack a surface connection to the sea. The word anchialine is derived from the Greek word *anchialos* meaning near the sea. **Anchialine pools are globally rare and Hawai'i is home to the only natural representatives in the U.S. as well as the largest concentration of them on the planet** (Santos 2010). The Kālua O Lapa flow created lava tubes and depressions near the shoreline. Some of these depressions along the coastal stretch have floors that lie below sea level, allowing ocean water to infiltrate and form shallow ponds (such

as the anchialine pools). There are 12 groupings of the unique pools at Cape Kīnaʻu, including the largest in the state. The diversity of shrimp in the pools is the greatest known in the Indo-Pacific, and five of the ten species are listed as candidate species under the Endangered Species Act (ESA). The pools also provide habitat for waterbirds, shorebirds, migratory birds, native herblands and algae. The endangered *ae`o* or Hawaiian stilt (*Himantopus mexicanus knudseni*) is known to forage and nest in at least one of the anchialine pool complexes.

The complexity and low relief of the young lava shoreline provides distinctive coastal habitat types - sheltered bays, tide pools*, loko iʻa* (fishponds), and basaltic intertidal - each hosting unique assemblages of species. Deep inlets on the shore and anchialine pools were modified into distinctive *loko iʻa* by Native Hawaiians in ancient and modern times. The intertidal areas of the Reserve are notable for a diversity of native algae and healthy populations of intertidal invertebrates such as urchins, limpets, and snails.

The coral reefs of the Reserve are among the most robust in the main Hawaiian Islands. A long-term study of nine Maui reefs by the Hawaiʻi Institute of Marine Biology's (HIMB) Coral Reef Assessment and Monitoring Program (CRAMP) indicated that the reefs off of Kanahena were the only Maui reefs to increase coral cover in recent years (17%-30% 1999-2006). At least 33 species of coral, 53 species of subtidal invertebrate, and 75 species of fish (17 endemic) were accounted for in the Reserve. Five marine species with protected status frequent the Reserve: Hawaiian Monk seal or *'Ilio-holo-i-ka-uaua* (*Monachus schauinslandi*); Hawksbill turtle or *ʻea* (*Eretmochelys imbricata*); Green Sea turtle or *honu* (*Chelonia mydas*); Spinner dolphin or *naiʻa* (*Stenella longirostris longirostri*s); and Humpback whale or *kohalā* (*Megaptera novaeangliae*). The Hawaiian Monk seal, Hawksbill turtle, Green Sea turtle, and Humpback whale are all listed as endangered or threatened under the ESA. The entire marine portion of the Reserve is encompassed by the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS).

In addition to aquatic habitats, these geologic characteristics created at least four unique native terrestrial habitats: aeolian (wind-supported) ecosystems on un-vegetated lava; lava tube cave and associated subterranean voids; littoral (associated with the marine coast) habitats; and seabird nesting habitats.

Botanically, the Reserve is part of the lowland dry ecotype. Although comprised almost entirely of un-vegetated lava, there are *kīpuka* (vegetated oasis within lava beds) where remnant native plants are found among the dominant non-native trees. Compared to the historical extent of this ecotype for the island of Maui, **less than 2% of this native lowland vegetation is left today.** The life cycles of plants here are keyed to a very severe and prolonged dry season and variable wet season. The endemic *wiliwili* (*Erythrina sandwicensis)* is the dominant tree of the remnant native dry forest zone and in the Reserve. The Reserve contains 21 native plant species, several of which are now rare (Hawaiʻi Heritage 1989). One of the native insects found there is the Blackburn's Sphinx Moth (*Manduca blackburni),* **the first Hawaiian insect to be listed as endangered under the ESA**. The Reserve acts as critical habitat for the Moth, designated by the U.S Fish & Wildlife Services in 2003.

Biologically, this connectivity is essential for wildlife that travel throughout the slopes of Haleakalā and along the shoreline. Some species like the Hawaiian Petrel or *ʻuaʻu* (*Pterodroma sandwichensis*), fly from the upper elevations to the open sea. This land and seascape, relatively

free of structures and lights, along with low noise levels, and clear air and sea space, all contribute to providing the high quality wildlife habitat found in the Reserve.

Each one of the resources mentioned in the table below is significant, and represents an outstanding example of its type on either the state, national, or global level.

Table 1. The significance of the natural and cultural resources of the Reserve.

Natural and Cultural Resources of ʻĀhihi-Kīnaʻu Natural Area Reserve[4]	State Significance	National Significance	Global Significance
Anchialine pools	●	●	●
Coral reefs	●	●	
Coastal marine habitats	●		
Lava flow formations and habitats	●	●	
Cultural Landscape	●		
Native leeward shrublands and forests	●		
Wilderness qualities	●		

1.2.4 Social, Economic and Cultural Setting

The Reserve has numerous archeological features and cultural landscapes in Maui. The cultural landscape of the Reserve includes both pre-European contact and post-contact Native Hawaiian village sites, *heiau* (religious sites), burials, trails, shelters, caves, *loko iʻa* complexes, ranching walls, and a lighthouse site. It also includes traditional place names, genealogies, records of travel, oral histories, ecological knowledge, and mythology of Hawaiian deities. The cultural landscape includes the entirety of the landscape itself, the physical history, and living connections to the place and the past. Cultural and historic sites are protected within the boundaries of the Reserve by Hawaiʻi Administrative Rules (HAR) § 13-209-4. Nine site complexes in the Reserve are on the Hawaiʻi Register of Historic Places, including the Maʻonakala Village Complex, Kualapa Cluster, Kauhuoaiakini and Hālua Pool Complex (Desilets et al. 2007).

Early Polynesian settlement is thought to have begun from the Marquesas and Society Islands ca 400 A.D., with long distance canoe voyages occurring regularly through at least the 13th century (Maly and Maly 2005). Permanent settlements of the dry coastal areas of Keoneʻōʻio and ʻĀhihi are thought to have occurred between 1000 and 1400 A.D (Deslits 2007; Maly and Maly 2005). Permanent Hawaiian occupation was based on use of marine resources and dry-land crops, dominated by *ʻuala* (sweet potato) cultivation in *mauka* areas. Fish and other marine resources were and are important staples. The name Keoneʻōʻio refers to the *ʻōʻio* or bonefish (*Albula glossondonta*) which were once abundant. In 1786, La Pérouse noted as many as five villages within what is now in the area. These included Maʻonakala Village at the far northern end of the Reserve in ʻĀhihi Bay, and four small villages in Keoneʻōʻio, each with 10 to 12 thatched houses. Those living at the shore focused primarily on fishing and had comparatively easy access to potable water at shoreline springs (Maly and Maly 2005). The residents traveled between the uplands and the coast to trade products.[5]

As European and American merchants, whalers, and missionaries found more influence in the Hawaiian Islands in the 1800s, traditional society was drawn into the global market economy. Migration and disease contributed to rapid Native Hawaiian population decline in rural areas. In Honuaʻula, census data showed a decline between 1831-1836 from 3,340 residents to 1,911 residents (Schmitt 1973). By the mid-1840s land use in Honuaʻula transitioned from primarily traditional subsistence to agricultural business activities (Maly and Maly 2005). An estimated 150 people were living in or very near to the Reserve and Keoneʻōʻio in 1853 (Coulter 1931). These changes in use were also associated with changes in land tenure during the Mahele, which eventually allowed government lands to become acquired as a Reserve.[6]

Of the Hawaiian government's improvements in this region in the 1800s, the most prominent and lasting was the government road built under the direction of Hoapili, Governor of Maui from 1823-1840. While he held this position, he had a road constructed from Honuaʻula to Kaupō, running along the shore (Maly and Maly 2005). The Hoapili Road traversed the Reserve, and it is assumed that the current government road was built upon the Hoapili Road, obscuring its original construction. Today the historic road can be seen along the shoreline beginning in Keoneʻōʻio through Kahikinui. The Kanahena Lighthouse was installed on Kanahena Point in 1884 and tended by light keepers until a new light was built at nearby Cape Hanamanioa in 1918 under the Territorial government. Remnant stone walls or fence-lines and cattle trails from the years that the Reserve was leased by Rose Ranch and ʻUlupalakua Ranch are still visible in the *mauka* portion of the Reserve.

With the onset of World War II, the U.S. Military began conducting maneuvers in south Maui. Coastal areas were fortified with bunkers and amphibious landings were made at Mākena (Desilets et al. 2007). Some of the structures can still be seen at Oneloa Beach in Mākena State Park, including a concrete ramp at Keoneʻōʻio. Following World War II, Cape Kīnaʻu was used for bombing target practice by the Navy from 1945-1946 (Parsons 2008) and unexploded ordnance are still present on Cape Kīnaʻu (the nature and extent of the ordnance are underway and surveyed by U.S. Army Corps of Engineers, 2011-2012). The Reserve's current Kanahena Parking Area (also known as "Dumps") was used as a dump site for metal debris, such as barbed wire, from the coastline during and after the war (Luʻuwai pers. comm. 2009). Today the name "Dumps" is still used for the popular surf spot.

Beginning in the 1970s, Maui, more than any other Hawaiian Island, experienced dramatic population growth, doubling between 1980 (63,000 residents) and 2000 (128,000 residents) (Maui County 2006). The defacto island population (residents plus visitors) can be 30-50,000 people greater, depending on the time of year. Nowhere else is this growth more apparent than the communities within 10 miles of the Reserve. In 1980, from Kīhei to Mākena, a population of 7,263 people lived in a quiet rural area with miles of uncrowded beaches and a few small hotels. Today, Kīhei to Mākena is the second largest tourism area on Maui, with a population of more than 22,400 people, in a 10 mile stretch of urban development (Maui County 2006). With more new residents and visitors in southwest Maui, and the paving of the government road to La Pérouse Bay/Keoneʻōʻio in the 1990s, the Reserve and adjacent areas became an increasingly popular recreation destination. As early as 2001, visitor counts by "Friends of Keoneʻōʻio" recorded 805 people per day and as many as 339 vehicles per day (CSV Consultants and HWF 2007). In recent years the Reserve received an average of 700 visitors per day or 250,000 visitors per year (Vann et al. 2006; CSV Consultants and HWF 2007; HWF 2008).

1.2.5 Physical Infrastructure Setting

There are few infrastructural improvements in the Reserve and adjacent areas. A large sign was placed at the coastal entry on the Mākena-Keoneʻōʻio government road. About 100 meters further down the coast is an unpaved parking area adjacent to a privately-owned home. Within the parking area is a temporary Ranger office. Signs stating Reserve restrictions and the 2010-2012 access restrictions are located along the road, at the Maʻonakala parking area, at restricted access trail heads, and at La Pérouse Bay/Keoneʻōʻio, which is outside of the Reserve. Portable toilets are provided at both Maʻonakala and La Pérouse Bay/Keoneʻōʻio parking areas. Overhead power lines and a water pipeline run parallel of the road that traverses the Reserve, serving the single household at the end of the government road in La Pérouse Bay/Keoneʻōʻio.

1.3 Legacy of Protection

1.3.1 Management Context

a) Conserving biodiversity through protected areas

The loss of biodiversity is of great concern worldwide. Numerous international, national and local programs have been adopted to slow the loss of life forms on earth (Convention on Biological Diversity 1993). Prime among them is the designation of place-based conservation and/or protected area management. To sustain biodiversity, most countries have developed a system of protected areas, which in 2008 covered about 12% of the Earth's land surface (Chape et al. 2008). **Less than 1% of this is marine** (World Database on Marine Protected Areas 2009). Protected areas are of crucial and growing importance because they:

1. Safeguard many of the world's outstanding areas of living richness, natural beauty, cultural significance, and are a source of inspiration and an irreplaceable asset of the country to which they belong;
2. Help to maintain the diversity of ecosystems, species and genetic varieties, and ecological processes (including regulation of water flow and climate) which are vital for the support of all life on earth and for the improvement of human social and economic conditions;
3. Protect genetic varieties and species which are vital in meeting human needs, for example in agriculture and medicine, and are the basis for human social and cultural adaptation in an uncertain and changing world; and
4. Often are home to communities of people with traditional cultures and irreplaceable knowledge of nature. (McNeely 1994)

b) Statutory authority under the Natural Area Reserves System

Hawaiʻi was among the first states to set up a representative network of reserves (NARS 1992). The NARS was established by the State of Hawaiʻi in 1970 to preserve and protect representative samples of Hawaiian biological ecosystems and geological formations. The biological wealth of Hawaiʻi was being depleted rapidly by land use changes and the designation of a representative system of protected areas sought to protect the Hawaiian ecology and geology.

Since the enactment of legislation that established the NARS, representative samples of Hawaiian biological ecosystems and geological formations have been set aside for the enjoyment of future generations and to provide baseline examples against which changes in other areas could be measured (HRS §195-1). There are nineteen reserves (see **Figure 3**) on five islands, encompassing 115,446 acres. These reserves were established and/or expanded between 1973-2010 (NARS website).

The NARS provides permanent legal protection for conservation of resource values, one of the highest levels of legal protection for state managed natural areas in Hawaiʻi. NARS make up 11% of the 1 million acres under DLNR jurisdiction. Other types of DLNR conservation designation include Wildlife Sanctuary and Forest Reserve. The NARS mission is: "The Natural Area Reserves System exists to ensure the stewardship for Hawaiʻi's unique natural resources

through acquisition, active management, and other strategies." Under its mandate, the Natural Area Reserves System Commission (NARS Commission) and staff continue to strengthen and enhance the NARS by considering nominations to add representative areas. Many of the Reserves are located in remote mountainous areas and have few visitors. Conversely, reserves located on the coast are more accessible and can be heavily used by the public as is the case for Kaʻena Point NAR on Oʻahu and ʻĀhihi-Kīnaʻu NAR.

Figure 3. Map of the State of Hawai'i's Natural Area Reserves System.

Natural Area Reserves are managed and administered by the DLNR, Division of Forestry and Wildlife (DOFAW), through their District Branch offices and program administration in Honolulu. The NARS program (within the Native Ecosystem Protection and Management) is one of the many programs administered by DOFAW. The system is overseen by the NARS Commission, which advises the Board of Land and Natural Resources (BLNR) and the Governor. NARS Commission guidance to DOFAW occurs within a set of policies (NARSC 1997), a strategic plan (New Fields Companies, LLC 2008), and DLNR policy. A DLNR hierarchy of use states that the department must protect natural resources first, and may allow compatible public uses if resources are not affected, and then only when the first two criteria are met, may they allow for compatible commercial use (DLNR 1997).

c) Reserve management

The DOFAW NARS Maui District Branch Program staff is responsible for the day-to-day operation of the Reserve. The Maui District NAR Program manager oversees the management and staff for nine Reserves on Maui and Molokaʻi. Staff in the Reserve are referred to as Rangers, and a supervisory Ranger attends to day-to-day management concerns. The number of Ranger positions dedicated to the Reserve, has varied over the years from six in 2010 to two in 2012. Rangers typically operate in two daily shifts, 365 days per year. The only other NAR that has regular on-site presence is the Kaena Point NAR.

Reserve budgets and staffing grew to meet the demand for greater presence and attention to human use pressures and resource management. Funds peaked with a four year HTA grant from 2004-2008, but has since declined; 2010 state funding dropped to nearly 2005 levels. Even at peak levels, funding has been insufficient to meet Reserve management needs.

DLNR's Division of Conservation and Resources Enforcement (DOCARE) is responsible to enforce all laws, rules and regulations in the Reserve. Rules specific to the NARS are found in HAR 13-209. DOCARE's statutory mandate (HRS Chapter 199) encompasses a wide range of law enforcement responsibilities that service all of DLNR.

State Historic Preservation Division has a regulatory and support function in addressing management of the Reserve's cultural and historic resources. The division must be given the opportunity to review all proposed actions that may affect historic properties in the area and give its written concurrence before these actions can proceed (§6E-8, HRS, and Chapter 13-275, HAR). It is also the official repository of the state's inventory of historic properties and of archaeological and historical documents required to satisfy the state's historic preservation laws. This Division also oversees the Burial Councils and their jurisdiction.

d) Advisory Group

The ʻĀhihi-Kīnaʻu NAR/Keoneʻōʻio Advisory Group (Advisory Group), formed in 2004, provides guidance to DLNR regarding the management of the Reserve and adjacent state lands in Keoneʻōʻio. DLNR formed the Advisory Group to obtain advice on how to address unregulated commercial activity, primarily kayak rentals, and other matters of importance in the area. The Advisory Group was formed to reflect the diversity of stakeholder interests and is chaired by the DLNR Deputy Director. Members include educators, Native Hawaiian cultural practitioners, lineal descendants of the area, neighboring landowners, residents, visitor industry representatives, recreational snorkelers and fishers, conservation organizations, and scientists.

e) The Board of Land and Natural Resources

Approval of this plan by BLNR may trigger the following actions:

1. Preparation of regulatory compliance documents as required for implementation of management actions as outlined in the plan;
2. DLNR efforts to secure operational and planning funding for plan objectives;
3. Prioritized implementation of plan objectives by DLNR; and
4. Periodic solicitation of requests for proposals or bids for implementation of plan objectives, including issuance of permits, licenses, or contracts in accordance with applicable HAR, as necessary.

1.3.2 Management History

a) Management actions prior to Reserve establishment

The Reserve has a long history of management investment by the community and DLNR, which began prior to the establishment of the Reserve. As early as the 1960s, the Mākena to La Pérouse area was identified by the state as a key site for wilderness and marine protection as the development of Maui's coastlines began in earnest (Warnecke et al.). In the late 1960s, citizens cleaned up a dump site along the coastline and in the unimproved parking area at Kanahena. In keeping with planning efforts to protect the coastline from development, Mākena State Park was established in 1971.

With the creation of the NARS, University of Hawaiʻi Cooperative Fisheries Biologist Dr. John Maciolek submitted a proposal to nominate the first Reserve to the NARS Commission - from ʻĀhihi Bay to Cape Kīnaʻu. As a fresh water fish specialist, his aim was to create an aquatic reserve encompassing all of ʻĀhihi Bay, from Puʻu Ōlaʻi to Cape Kīnaʻu. It was later configured to include the lava flow and the unique anchialine pool ecosystems of Cape Kīnaʻu, and direct preservation attention to the "high quality, little-used region of ʻĀhihi Bay and Cape Kīnaʻu" as "developers' blades moved southward along Maui's sparsely populated leeward coast" (Mack 1975). The proposal was strengthened by marine surveys conducted in 1970 and 1972 by DLNR, concluding that the area's coral reefs were rich in species diversity and abundance of both fish and invertebrate species (Division of Fish and Game 1972). In the following months, talks commenced, sometimes passionately, about what resources should be protected, what the boundaries should be, who should manage the area, enforcement options, what activities should be allowed to occur, preservation of cultural sites, and road control and maintenance.

b) Reserve established in 1973

In June 1973, Governor John H. Burns issued Executive Order 02668, establishing ʻĀhihi-Kīnaʻu Natural Area Reserve. Soon after, issues concerning marine boundary buoys, enforcement, and interpretation arose, much as they do today.

Rapid urbanization of the Kīhei, Wailea and Mākena areas prompted the state to complete the 1977 Mākena to La Pérouse State Park study, which examined 9 miles of coastline, including the Reserve, Mākena State Park and state unencumbered lands (state owned lands not yet classified or designated). The study recommended the preservation of Mākena to La Pérouse as a wilderness area, foreseeing an increasing need for wilderness and recreation opportunities and resource preservation as the population of Maui continued to grow (H. Mogi Planning and Research 1977).

c) 1980s: New discoveries and new management actions

Between its designation and the late 1980s, several unique findings occurred in the Reserve uncovering new shrimp species in anchialine pools (Maciolek 1983), and previously undescribed red seaworms in marine lava tube caves (Fielding 1994). Letters from concerned citizens and records of DOCARE officers during these years reported illegal activity including fishing and spear-fishing, collecting of marine life, burning and abandoning of vehicles, target shooting, and flagging of archaeological sites. In order to protect resources from prohibited activities, DOFAW

constructed a lava rock wall to block off vehicular activity along the shoreline (Anon 1998). They also made parking lot improvements at Keoneʻōʻio to accommodate twenty-five cars (reduced from a larger proposed size) to provide for access.

Several studies were published on the Reserve's natural resources in the 1980s. In 1985, the University of Hawaiʻi Marine Options Program conducted a reef and reef fish survey (Bass and Teshima 1985). A survey of terrestrial resources was conducted by The Nature Conservancy's (TNC) Hawaiʻi Heritage Program (1989), that included survey reports and recommendations on the protection of the Reserve's anchialine pools (Chai 1988) and terrestrial and lava tube arthropods and insects (Howarth 1988).

Although no formal user surveys were conducted during the 1970s-1980s, Reserve managers estimate that visitor numbers were significantly lower than current levels due to lower population levels and the poor condition of the road leading to the Reserve. The road was paved and widened in several phases between the mid-1980s to mid-1990s, thereby facilitating easier vehicular access. It is unclear as to the exact date the road was completely paved to Keoneʻōʻio / La Pérouse, however, it is clear that paving the road increased visitation to the area (Vann 2005). In 1993, the road was widened at the far end of the Mākena to Keoneʻōʻio Government Road (Wong 1993).

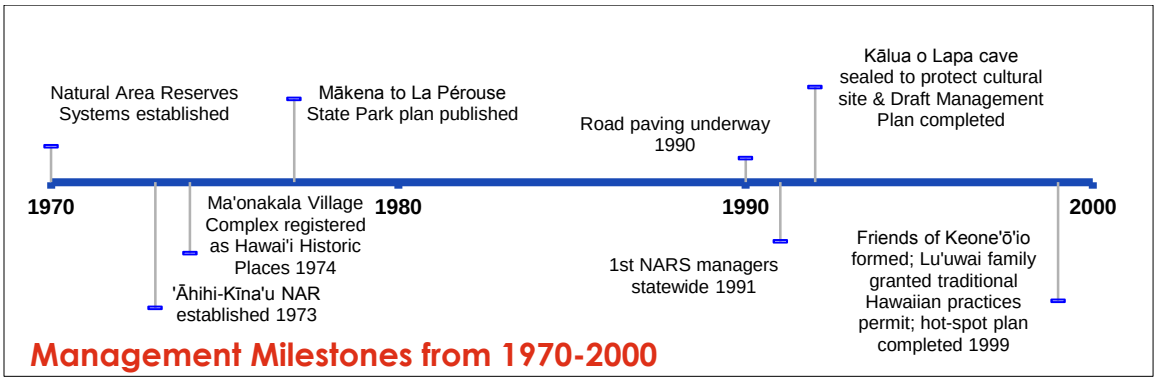

Figure 4. Reserve management milestones from 1970 to 2000.

d) 1990s-2000s: Kālua O Lapa Cave desecrated and sealed, *ahupuaʻa* tenant rights upheld, and commercial activity halted

After the disturbance and removal of cultural items and human remains from the lava tube cave containing Native Hawaiian burials near Kālua O Lapa, the cave was permanently sealed with ceremony (1992) at the request of the Burial Council. The concrete seal was reinforced again in 1994 under the direction of the NARS Commission and the Maui Island Burial Council (Anon 1998). Sealing the cave prevented further destruction and disruption of cultural and natural resources including cave arthropods.

In 1997, the Luʻuwai family of Mākena requested access to the Reserve for the purposes of teaching subsistence fishing to their children in their ancestral grounds. The NARS Commission formed a Working Group that studied the request and consequently the family was granted a special use permit in 1999 (ʻĀhihi-Kīnaʻu Working Group 1998). Activities are strictly regulated

by permit conditions and the permit must be renewed annually. The Division of Aquatic Resources (DAR) conducted an underwater survey of the marine area of the Reserve, closely replicating the 1972 study (DAR 1998) prior to the Luʻuwai family being granted their permit. They concluded that a lush finger coral bed found in 1972 had been heavily damaged by storms but shoreline fish, other bottom dwelling species, corals and ʻ*opihi* (intertidal-dwelling limpets) appeared to be doing well.

In 1998-99, growing concerns including traffic, crowding, illegal activities, commercial activity, resource degradation, user conflicts, and public safety prompted the NARS Commission and DLNR to focus attention on the Reserve as one of 25 "hotspots" statewide. The 1998 Sustainability Hot Spot Plan provided an estimate of what would be needed to adequately manage the Reserve; which included a budget of $2.7 million and eight staff.

In 1999, the HIMB selected two sites in the Reserve (Kanehena Point and Kanahena Cove) to add as permanent survey sites in the CRAMP (Jokiel et al. 2004). These reef and reef fish surveys continue today. CRAMP data help managers to understand the health of the reefs over time and in comparison to other sites statewide, which in turn guides management actions.

At this time, increasing unregulated commercial use in the Reserve was of great concern. Letters expressing concerns had been sent to DOFAW since 1992 (Evanson 1993). Commercial use, illegal activity, road traffic, kayakers, and divers were on the rise. There were concerns regarding how the resources should be better monitored, how information was being disseminated, and addressing the increasing need for trash and sanitation management. Hawaiʻi Wildlife Fund (HWF), whom had been recording data on human-dolphin interactions in neighboring Keoneʻōʻio since 1998, expressed concern that the resources were being "loved to death." During this time, a coalition of interested citizens formed a group called the "Friends of Keoneʻōʻio," whose activities brought media attention to the area. By 2003, the issues at Keoneʻōʻio and the Reserve became so notorious that in a short span of three months, more than twenty-one articles were published in Maui papers (Vann 2005).

In 2000, the Hawaiʻi Community Foundation funded HWF to produce a naturalist training manual for Keoneʻōʻio. They began training volunteers to interact with visitors; this interaction lead to the discovery that 90% of area visitors discovered the area through the publication *Maui Revealed,* in which their primary activity was snorkeling (CSV Consultants and HWF 2007). *Maui Revealed* also referenced commercial activities taking place in the area such as hiking and kayaking. Unregulated commercial activity and growing visitation prompted concerns about impacts to Reserve resources. The Advisory Group formed by DLNR took up the issue of commercial activities in 2004 and wrote a letter to *Maui Revealed* unsuccessfully requesting that they remove references to the Reserve from their popular tourist publication in order to reduce human impacts to resources. That request went unheeded and visitors continued to seek out the Reserve in high numbers.

In 2001, a partnership of Maui DLNR officials, the nonprofit Maui Mālama Pono, and the Rivers, Trails, and Conservation Assistance Program of the National Park Service (NPS) formed the "Keoneʻōʻio- Kanaloa Working Group" to examine preservation and management issues in the coastal area from Keoneʻōʻio southward to Kanaloa (Vann 2005). The group was composed of thirty participants, including landowners, managers, neighbors, commercial and private users, and community stewards, who accomplished the following actions: developed a consensus

statement of desired conditions for the area, and the associated responsibilities of stakeholders if those conditions are to exist; and proposed twenty emergency measures, divided into immediate, six-month, and one-year time frames (NPS 2003). Several of these measures were implemented, which included the fencing and gating of the road into La Pérouse Bay on ʻUlupalakua Ranch lands, enforcement of night time "raves" in the bay, an increase in visitor outreach to reduce resource damage at the Keoneʻōʻio parking area, preservation of an archeological site, and increased pressure on DLNR to address the commercial kayak activities.

These proactive efforts were connected to the nomination of the entire coastline, from the Reserve to Kanaloa Point, as a National Seashore, by Mary Evanson, a long-time resident and activist on Maui, and president of the Friends of Haleakalā National Park. She was pushing for the area between Keoneʻōʻio and Kanaloa Point to become a part of the National Park System. After many years of observing failed state efforts to protect the area to provide management resources, she concluded it could be better managed under the federal government. In February 2001, Congresswoman Mink initiated a National Park System feasibility study for the area from Keoneʻōʻio to Kanaloa Point (NPS 2003). A reconnaissance survey of the shoreline, offshore waters, and cultural sites was conducted between Keoneʻōʻio and Kanaloa Point. The study did not include the NAR. The study concluded that the area did not warrant inclusion as a National Seashore under NPS criteria. However the study did note that the many natural and cultural resources needed better management immediately.

In response to the public's demand for controls and limitations of unregulated commercial kayak operations, DLNR conducted a rapid resource assessment (DLNR 2003) to determine impacts that may have occurred to the resources due to these activities. The report recommended the following for the Reserve: ban or carefully limit both commercial use and kayaking, increase signage and staff presence, limit the number of users, and charge a parking/user fee. In September 2003, DLNR formed the ʻĀhihi-Kīnaʻu NAR/Keoneʻōʻio Advisory Group to advise DLNR on matters of importance such as unregulated commercial activity. The Advisory Group consisted of representatives from the commercial kayak industry, fishermen, cultural practitioners, residents, and scientists, some of whom were active in the Friends of Keoneʻōʻio. In December, DLNR held a public informational meeting attended by 150 people supporting a ban on commercial activity in the NAR. Following Advisory Group and NARS Commission recommendations, commercial activity was banned in the area in April 2004 (Evanson 2005).

e) 2004-2010: New era of increased management presence

Between 2004-2007, with the support of a grant from the Hawaiʻi Tourism Authority (HTA), the Advisory Group, and community groups, the DLNR took several management actions designed to reduce the impact of large numbers of visitors: 1) hired two full-time Reserve Rangers; 2) provided support to HWF for a half-time education station, naturalists, and human use surveys; 3) installed portable toilets at Keoneʻōʻio and Kanahena, trash receptacles and information signs; 4) prepared a draft Environmental Assessment (EA) of potential boundary buoys; and 5) contracted an archeological survey management plan for high use areas; a marine survey of user impacts to corals, and a marine survey and monitoring program for nearshore coral reefs.

Between 2004 to 2008, with the HTA funding, HWF led a "Makai Watch" education station at the Kanahena parking area, placed a roving naturalist at Keoneʻōʻio, and collected human use data at both locations. The HTA funding in 2004 also created the first full-time Ranger position specifically dedicated towards providing onsite presence in the Reserve. Rangers are DLNR employees that act as liaisons for DLNR and provide visitors with information about permitted uses, survey resources, and document and report illegal activity. The first Ranger was hired in 2004. It is important to note that Rangers do not have enforcement power; they must contact DOCARE or the Maui Police Department (MPD) for any enforcement action to take place.

In 2006, additional steps were taken to deal with ever increasing visitation including hiring a second full time Ranger and re-directing visitors to areas that were safer and that provided better quality experiences. In addition, more than 150 boulders were placed along the roadway through the Reserve to alleviate parking problems and ensure emergency vehicle passage through the narrow roadway. This step was also taken to eliminate illegal activity (camping, fires, littering, and drug use) that was occurring along the roadside at night. Between 2004 to 2008, on-the-ground personnel grew to a staff of five Rangers.

From December 2006 to June 2008, a volunteer education outreach program was initiated at Kanahena cove in collaboration with "Action ʻĀhihi", HIHWNMS, and others under DAR Makai Watch Program.

The Reserve Rangers and Makai Watch coordinators worked with the DOCARE and the MPD to increase enforcement attention to the Reserve and Keoneʻōʻio. Rangers call upon DOCARE officers to enforce all DLNR and NAR rules, and on MPD to address other illegal activities. The daily on-site presence enabled faster response time and greater enforcement attention to the area. Enforcement issues addressed by DLNR staff during this time included removing a woman living in a lava tube in the Reserve, and citing a commercial operator for anchoring in the Reserve and subsequent coral damage.

NAR Rangers interact with the public, answer questions, address concerns, and assist the public for compliance with NAR rules. From 2008, the level and intensity of management of the Reserve has been five full-time Rangers, providing some staff presence seven days a week, 365 days per year, and 16 hours per day in two daily shifts.

f) Recent studies conducted

Between 2004 and 2008, the HTA also funded several studies to inform management planning and action. HWF was funded to conduct several different human usage studies annually from 2004 to 2007. A Cultural Resource Management Plan (CRMP) was completed in 2007 (Desilets et al. 2007). The purpose of the CRMP was to recommend actions to protect cultural sites in specific high use corridors only. The survey concluded that as a whole, most sites are in relatively good to excellent condition, however high use of the trails to Kalaeloa (also known as "Aquarium") and Mokuhā (also known as "Fishbowl") resulted in near complete disintegration of some archaeological features. It also noted evidence that sites were being used as toilets.

Three marine assessments were conducted by HIMB and funded by the HTA grant: Human Impact Evaluation on Nearshore Environments (Rogers et al. 2008); Compilation of Existing

Information on the Marine Environment (Rogers et al. 2008); and Biological Assessment of the Reserve (Rogers et al. 2009).

A U.S. Fish and Wildlife Service-funded study (Brock 2004) surveyed the anchialine pools of the Reserve noting that they are the premier example of anchialine resources in the nation. Although protected by isolation and lack of development, the pools still were experiencing degradation as evidenced by footprints in the pool sediment, the suspected harvesting of shrimp, and human waste. The study recommended that visitors should not be allowed within 100 meters of any pool and that staff block or redirect all trails that come within this distance from anchialine pools.

In 2007, the U.S Army Corps of Engineers funded a site inspection and report on Kanahena Point, since the Reserve was one of four Maui sites used for bombing target practice by the Navy from 1945 through 1946 (Parsons 2008). Based on the remnant munitions found during site inspection, the report recommended that a remedial investigation and feasibility study be conducted to determine the extent and hazard posed by munitions. The Army Corps will begin surveying the entire Reserve, including the marine section, beginning in 2011.

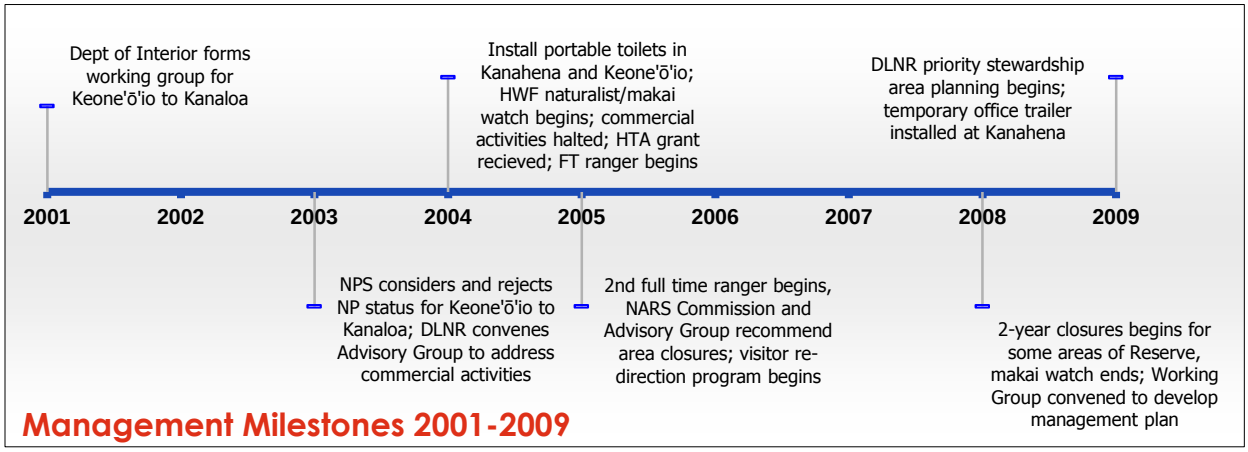

Figure 5. Reserve management milestones from 2001 to 2009.

g) Rule changes

During the study period of 2004-2008, anchialine pools, near shore marine resources, geology, and cultural sites all showed impacts from unregulated human use (Ramsey pers. comm. 2008). Many of these impacts were due to unintentional trampling from visitors wandering through the lava in search of popular snorkeling destinations. Other damages were due to poaching of marine resources, graffiti, and other illegal activity. Public safety was also a concern for managers as visitors were often injured on the remote, uneven and rough terrain of the coastal lava fields. Minor injuries such as scrapes from falls were common. In addition, there were also helicopter evacuations, emergency medical assistant responses, and visitor deaths.

In 2005, the Advisory Group and NARS Commission requested that DLNR temporarily close portions of the Reserve to prevent further resource damage and visitor injuries. However, the Attorney General's Office concluded that the NARS Commission and BLNR lacked the authority to close off portions of an entire Reserve unless it was a matter of public safety. The requested

closure would require a rule change. As such, hearings were held to amend NARS rules to provide that authority. In June 2006, staff held hearings simultaneously on four islands to present rule modifications in Natural Area Reserves. New rules went into effect in January 2007 (HAR § 13-209-1). A total of eleven rules were amended or created including the ability to create and enforce visiting hours and close a Reserve or portion of a Reserve for up to two years at a time.

With the authority provided by the rule changes, the Advisory Group and NARS Commission recommended the BLNR to adopt a two-year action plan, August 1, 2008– July 31, 2010 (NARS 2008). The plan called for 90% of the land portion of the Reserve to be closed to general public use (most of which is extremely rough, dangerous a'a lava with no trails), leaving the coastal areas near the entrance in ʻĀhihi Bay open daily for public access during visiting hours. These areas were open for the public because of the safer water entry areas and much shorter well-marked paths that allow users to enjoy the Reserve without damaging resources or compromising their own safety. The Action Plan outlined specific baseline surveys that were to be performed during the closure. After being approved by the BLNR in May 2008, access restrictions were in effect from August 1, 2008-July 31, 2010. In June 2010 the NARS Commission recommended and BLNR approved a second staff request for access restrictions for the period August 1, 2010- July 31, 2012.

In January 2008, a final (unpublished) EA to install buoys along the marine boundary of the Reserve was completed (NARS 2006, 2008a). The assessment included comments collected during a pre-consultation and public comment process that began in 2004. One benefit of the buoy installation was an increased compliance with no-take and no motorized vessel rules in the Reserve. Drawbacks included selection of the appropriate type of buoy for the site, actual costs, and installation methods.

In 2010, the County of Maui and the State of Hawaiʻi signed a memorandum of understanding regarding the road; whereas the County maintains the road and the state oversees access and maintains roadside vegetation.

h) 2008 -2010: Management planning process

This management plan builds upon the process started in 2005 with the 2005 Draft Management Plan developed by NARS staff and submitted to the Advisory Group for review and comment. In 2008, TNC and DLNR partnered to complete this draft management plan for the Reserve using Conservation Action Plan (CAP) principles.[7] This plan was developed by the Working Group, consisting of volunteers from the Advisory Group, the public, DLNR staff, and agency partners. The Working Group met between 2008-2010 in five-day long plenary sessions and ten small group meetings to develop and provide input to the plan.

This plan recognizes the substantial effort that has gone into caring for the Reserve since its inception, and as relevant, incorporates recommendations and priorities from the 1992 Draft Management Plan (NARS 1992), 1999 Sustainability Hot Spot Plan (DOFAW 1999), 2006 Draft Management Plan (NARS 2006a), and other site specific reports which offer management recommendations. Many of the recommendations have similar themes as can be seen in **Table 2**, a summary of recommended management actions since 1977.

Many factors can affect Reserve resources, therefore it is important to have input into what happens in adjacent areas and to work together to improve management. This management plan is concurrent with three adjacent or regional planning processes where synergistic opportunities are possible:

1. *DLNR Stewardship Management Area Priority:* In 2007, the Reserve was one of five areas selected statewide as a DLNR Stewardship Management Area Priority, to implement the Ocean Resources Management Plan. Maui divisions of DLNR are working together to achieve inter-departmental, place-based collaboration in the area from Maluaka (Mākena Beach and Golf Resort) to Cape Hanamanioa. Led by DOFAW, this multidisciplinary team includes NARS Commission on Water Resource Management, and DLNR DAR, Conservation and Resource Enforcement, Historic Preservation, Land Division, Office of Conservation and Coastal Lands, and State Parks.

2. *Adjacent designation:* The coastline southwest of ʻĀhihi-Kīnaʻu to Kanaloa Point has been identified as biologically important by the NARS Commission for its coastal strand and lowland dry vegetation, anchialine pools, and offshore ecosystems. This area also contains important archeological sites. The DOFAW has been conducting surveys and meetings to discuss protective designation of these resources which are currently unencumbered lands in the conservation district (Yuen pers. comm. 2009). There is also interest in DOFAW to designate parts of this land as a game management area.

3. *Update the 1977 La Pérouse-Mākena State Park Plan:* State Parks Division is developing a Mākena State Park Plan funded by Stanford Carr Development. Developing the plan was one of the conditions in their change in zoning approval. A draft plan was provided to the State Parks Division on April 20, 2012 and next steps have yet to be determined (Ohta pers. comm. 2012).

In summary, the Reserve has moved through several stages of management planning, from an agency and partner-oriented process to one broadly inclusive of stakeholders and the public. With the completion of this plan, agencies, partners and stakeholders will be better prepared to protect the resources of ʻĀhihi-Kīnaʻu, work with visitors and users to ensure enjoyment and safety for all, as well as engage in adjacent and regional planning processes that help reach Reserve goals and support compatible adjacent uses.

Table 2. Summary of the management recommendation from various plans and reports from 1977 to 2008.

Management recommendation / Source of recommendation	Monitor resource health, threat abatement, and or management effectiveness	Maintain adequate staff, volunteer and enforcement presence	Address illegal fishing and boundary issues	Control access and use to prevent resource degradation at vulnerable sites	Charge a user or parking fee	Increase outreach (e.g. signage, interpretation facilities)	Improve trails; requirement to stay on trails, and or interpretive walks	Protect and interpret cultural sites	Prevent and or control alien species	Other recommendations
Mākena-La Pérouse Plan 1977				X		X		X		Provide buffer area; prevent runoff improvements
Chai 1988	X	X	X	X		X	X			Litter control
Howarth 1988	X			X			X	X	X	Litter control
Draft Management Plan NARS 1992	X	X	X	X		X	X			
Hot-Spot Sustainability Plan DOFAW 1999	X	X	X	X		X		X	X	Infrastructure improvements; preserve wilderness experience
Brock 2004	X	X		X		X	X		X	Infrastructure improvements
Draft Management Plan NARS 2006a		X	X	X	X	X	X			Parking and vehicle controls; safety; on site manager; communications
Gulko 2005		X	X		X	X				Parking controls; limit number of vehicles
Vann 2005	X	X	X	X	X	X	X	X	X	Native plant protection; litter control; regional planning
Desilets et al. 2007	X	X		X		X	X	X		
Rodgers et al. 2008	X			X		X	X			Parking control

1.4 What We're Protecting

a) Seven targets for protection

Seven natural and cultural-resource targets have been identified as priorities for protection within the Reserve, including native biodiversity and non-biological resources: anchialine pool, coastal marine, coral reef ecosystem, cultural landscape, lava flow, native shrubland, and wilderness qualities (**Table 3**). Under each natural and cultural resource target are resources listed specifically because of their biologic or legal status, or to guide targeted management actions. It is important to note that target selection is the corner stone to the planning process, from threat identification to objective and action development. Targets are what we want to protect, conserve, or restore.

Table 3. Conservation targets.

	Conservation targets for ʻĀhihi-Kīnaʻu Natural Area Reserve						
Nested resources	**Anchialine pool**	**Coastal marine**	**Coral reef ecosystem**	**Cultural landscape**	**Lava flow**	**Native shrubland**	**Wilderness qualities**
	Aquatic species assemblage	Sheltered bays, tidepools, Hawaiian fish ponds	Clear blue water	Traditional place names, oral histories, ecological knowledge	Lava flows and formations	Native plant assemblage	Scenic views of geologic formations
	Native herb and shrub lands	Rocky intertidal	Benthic species assemblage	Archeological, cultural, and historic sites and features	New lava aeolian community	Endangered Blackburn's Sphinx Moth	Silence and isolation
	Endangered Hawaiian Stilt nesting		Reef fish; highly mobile fish		Coastal cave community		Air quality, clear airspace
			Hawaiian Monk seal; Hawksbill and Green Turtles; Hawaiian Spinner Dolphin		Endangered seabird nesting		Dark night skies

The seven targets consist of five ecosystem types, and the cultural landscape and wilderness qualities that occur throughout the Reserve. The inclusion of these cross-cutting resources as targets allows for specific management action to be taken to preserve them. This conservation target list, together with the "nested resources" listed below each target attempts to be inclusive of all unique native resources known to be present in the Reserve.

This section describes each of the seven conservation targets and the nested resources. The targets' current status or health is rated on a scale from very good to poor (**Table 4**). This ranking corresponds with the natural function of the systems and the degree of human intervention required maintaining or enhancing its current status. The intention of this management plan is to guide management actions to maintain or improve the health of the conservation targets, thus it is important to understand their current status. The estimated health of each target is based on key ecological attributes and a threat assessment.

Table 4. Resource health ratings.

Very good: Functioning at its desired status. Require little human intervention for maintenance.

Good: Within an acceptable range of variation. May require some human intervention to maintain status

Fair: Outside the range of acceptable variation. Require human intervention. If unmonitored, target is vulnerable to serious degradation.

Poor: Restoration increasingly difficult. May result in loss of viable resource(s) without effective intervention

1.4.1 Anchialine Pool

Current status is Good

a) Overview

Anchialine pools are surface brackish water pools, fed underground from both ocean and fresh water sources, and lack a surface or visible connection to the sea. In Hawaiʻi, they are found primarily in the highly porous, young coastal volcanic substrate of the island of Hawaiʻi and Maui, and coastal limestone of some other Hawaiian islands; there are about 600 anchialine pools in Hawaiʻi (Brock 2004). They are home to unique aquatic species and biologic communities. The vegetative and invertebrate communities surrounding the pools are also unique. Statewide, the distinctive aquatic algal and invertebrate communities have been decimated by development, recreational uses, and introduction of alien fish species such as tilapia. The Cape Kīnaʻu pools have been spared from these threats and are considered the most biologically intact and diverse aquatic habitats in Hawaiʻi and the nation (Brock 2004). The pools are monitored using a standardized anchialine pool monitoring protocol developed by the NPS and other partners. See **Table 5** for a summary of the **Current status and threat ratings for anchialine pools**.

Figure 6. Low-stature native and non-native vegetation growing at Kauhioaiakini, the largest anchialine pool complex in the Reserve (photo by Matt Ramsey).

b) Cultural sites

In addition to their biological values, these brackish pools provided food resources for pre-contact Hawaiian residents who used and modified the pools for sources of bait, aquaculture, and in some cases drinking water (Desilets et al. 2007). The pools were an important aquaculture resource for nearby residents and remained so into the early historical period as evidenced by unique cemented cobble wall construction. The pools are well connected by traditional trails and were a focal point for temporary and permanent habitation sites (Desilets et al. 2007).

c) Physical environment

Maciolek (1986) identified twelve groupings of pools at Cape Kīnaʻu Pool surface area ranges from a few square meters at high tide to more than 2000 m^2 at Kauhioaiakini. Pool depths vary with the tides, some can be less than 0.5 meters deep, and others such as Hālua, can exceed 5 meters in depth. The pools have variable salinities (8-22‰) and temperatures (22–28° C) that fluctuate along with the tide through underground fissures in the porous volcanic substrate. Pools extend on the surface through underground volcanic cracks and fissures, areas that provide habitat for species that live all or a portion of their lives in the dark, subterranean watery recesses. This system of underground lava tubes and fissures underlies the entire area of the Reserve at or near sea level as well as adjacent areas with similar geology.

d) Aquatic species assemblage

Organisms found in the Reserve pools include crustaceans, fishes, mollusks, sponges, tunicates, aquatic insects, and algae. Of all the species found in the pools, anchialine shrimp exhibit the greatest diversity and abundance (**Figure 7**). The diversity of these shrimp at a single site in the Reserve is the greatest known in the Indo-Pacific (Maciolek 1986). Of the ten species of shrimp documented from the anchialine pools within the Reserve, five are listed as candidate species under the ESA (Mitchell et al. 2005). Of these, three hypogeal (predominately subterranean) species are considered rare: the endemic *Palaemonella burnsi* (found only at Cape Kīnaʻu and vicinity); *Procaris Hawaiiana* (found only at Cape Kīnaʻu and Lua O Palahemo, the island of Hawaiʻi); and the indigenous *Calliasmata pholidota* (found on the Sinai Peninsula, Funafuti Atoll, Lua O Palahemo and Cape Kīnaʻu) (Gon pers. comm. 2008). These shrimp are critical to maintaining the characteristic orange-yellow colored cyanobacterial mat that coats the edges and shallow extents of many of the pools (Bailey-Brock and Brock 1993). This mat is maintained as the shrimp remove food from the surface of the crust. The pools also contain a diverse algal assemblage (Wong 1975).

Figure 7. Endemic anchialine pool shrimp (photo by Mike Yamamoto).

e) Terrestrial communities around the pools

Coastal herbs surround some of the pools, including native plants *ʻakulikuli* (*Sesuvium portulacastrum*), *makaloa* (*Cyperus laevigatus*), and *naio* (*Myoporum sandwicense)*. Additionally, the native aquatic plant *Ruppia maritima* grows within the pool. Native damselflies, dragonflies and other insects and arthropods are present in or near anchialine pools (Mitchell et al. 2005). The low stature of these native vegetation communities are threatened by taller, fast growing alien species such as *Pluchea symphytifolia*, mangrove (*Ryizophora sp*.), *Batis maritima*, sour grass (*Digitaria insularis)*, and the indigenous (or Polynesian introduction) *milo* (*Thespesia populnea*). If left unchecked, the spread of invasive vegetation and deposition of associated organic matter will fill-in the shallow pools; this unique habitat would not be able to support the native flora (Chai 1988). However, alien or other problematic vegetation (e.g. *milo*) around the pools must be removed carefully and completely to preserve the habitat of terrestrial species like the "remarkable" large black wolf spider (Howarth 1988). This native spider, *Lycosa sp*., builds a web-lined retreat in the loose ashy cindery slopes which surrounds the anchialine pools, where it is vulnerable to foot traffic and trampling as it hides in its cinder burrow during the day.

f) Native birds

The pools provide habitat for endemic waterbirds, migratory birds, and shorebirds. The endangered *ae'o* or Hawaiian stilt (*Himantopus mexicanus knudseni*) forage and nest in at least one of the anchialine pools. One to two successful nests per breeding season are observed at Kauhioaiakini pool (DOFAW unpublished data). Recovery of this endangered species is focused on protection of current populations and key breeding habitat. The total state population is estimated at 1,300 individuals (Mitchell et al. 2005). Shorebird populations include *hunakai* or sanderling (*Calidris alba*), *kioea* or bristle-thighed curlew (*Numenius tahitiensis*), *kolea* or lesser golden-plover (*Pluvialis dominica*), *ʻakekeke* or ruddy turnstone (*Arenaria interpres*), and *ʻulili* or wandering tattler (*Heteroscelus incanus*). The *ʻauku'u* or black-crowned night-heron (*Nycticorax nycticorax hoactli*) also frequent the pools. Migratory ducks and geese have also been observed on occasion. Primary threats to these birds include ants, rats, cats, dogs, mongoose, barn owls, cattle egrets, and other birds which prey on eggs, nestlings and/or adults.

Table 5. Current status and threat ratings for anchialine pools.

	Health Attributes Anchialine Pools	Current Status	Threat Code	Threats Anchialine Pools	Threat Rating
1A	Habitat use by migratory and native waterbirds	Not specified	H4	Human trampling	Very High
2A	Nesting success of *ae'o* or Hawaiian stilt	Good	H2	Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High
3A	Presence of endemic anchialine shrimp species	Good	H5	Human waste and trash	Medium
4A	Composition of plant, algal and bacterial species	Fair	H7	New trails across lava flows and damage to existing trails	Medium
5A	Absence of alien aquatic species	Very Good	H8	Unexploded ordnance	Low
6A	Hydraulic regime and water chemistry	Good	A1	Potential of alien species introduction	Very High
			A2	Impact of existing introduced species (woody plant species growing around anchialine pools and cultural sites, native plants competing with alien plants)	High
			A3	Native habitat damage by feral ungulates (browsing and trampling)	High
			A4	Decreased reproductive capacity (alien predation on native plant seeds; alien predation on water birds and seabirds, e.g. cats, mongoose)	High
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (pollution and nutrients, lights at night, viewplanes)	Low
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, severe lack of rain and temperature extremes; runnoff from severe storms, ocean pH change)	High

1.4.2 Coastal Marine

□ Current status is Good

a) Overview

Formed less than 500 years ago by flows from the Kālua O Lapa cone, the shoreline of Cape Kīnaʻu is both intricate and rugged. The complexity and low relief of the young lava shoreline provides distinctive coastal habitat types: sheltered bays, tidepools, *loko iʻa,* and basaltic intertidal. Each of these habitat types hosts unique assemblages of species. The primary threats to these areas are human trampling, poaching, fresh water flow decrease and quality changes, and climate change.

b) Sheltered bays, tidepools and *loko iʻa*

The sheltered embayments of Cape Kīnaʻu are home to unique invertebrate and algal assemblages at different depths and exposure zones (Godwin 2004). Marine tidal pools provide

yet another suite of unique sheltered habitats. Some pools host a single species of red algae, while others are completely covered by zoanthids (clusters of anemone-like animals). Pools can have fragile corals growing within inches of the water's surface, or rocks covered in coralline algae from red to deep purple hues. Deep inlets on the shore were modified into distinctive *loko iʻa* by native Hawaiians years ago. Today, the calm waters still host the fish favored for cultivation such as striped mullet or *ʻamaʻama* (*Mugil cephalus*) and bonefish or *ʻōʻio* (*Albula virgata*). Some of the brackish ponds provide habitat for the rare *Ruppia maritima,* an aquatic flowering plant which grows completely underwater. While some sheltered coves have less coral cover and more coralline algae, others contain high levels of easily breakable corals and are thus vulnerable to trampling. An index of coral trampling sensitivity was developed by the HIMB, based on the depth of the water, species skeletal strength, species morphology, rare coral species and percent coral cover (Rodgers and Jokiel 2008). Of the eighteen sites evaluated in the Reserve, those most vulnerable to trampling are on the southeastern shore of Cape Kīnaʻu (Keoneʻōʻio / La Pérouse Bay) in the sheltered habitats described above.

Figure 8. Ancient Hawaiian modified tide pool built for raising fish (photo by Matt Ramsey).

c) Basalt intertidal

The complexity of the lava rock shoreline provides herbivorous (algae eating) and schooling fishes protection from predators (Hodgson and Abbott 1992). In turn, the low levels of anthropogenic nutrient inputs (via farming, sewage treatment plants, etc.) and high levels of herbivorous fish and invertebrates like urchins control algae growth. While the alien algae *Hypnea musciformis* has been noted in the Reserve (Conklin pers. comm. 2008), the relative lack of alien algae in the intertidal and shallow water marine areas may be attributable to high levels of herbivory and natural nutrient input levels via underground freshwater flow. This type of shallow water habitat, vital fish nursery areas and refugia, have been degraded or eliminated from other Maui shorelines due to the overgrowth of alien algae.

The intertidal areas of the Reserve are notable for its diversity of native algae. In the intertidal and shallow subtidal collections from the basaltic shoreline of Cape Kīnaʻu, 124 species were identified, including new Hawaiian records for two genera and fifteen species (Hodgson and Abbott 1992). The Reserve intertidal zone is also notable for healthy populations of intertidal invertebrates such as *ʻopihi* (*Cellana* spp.), *hāʻukiʻuki* (*Colobocentrotus atratus*), and ʻ*aʻama* (*Grapsus tenuicrustatus*) (NPS 2003). The Reserve has been a site of standardized *ʻopihi* and intertidal monitoring surveys since 2009.

Table 6. Current status and threat ratings for coastal marine.

	Health Attributes Coastal Marine	Current Status	Threat Code	Threats Coastal Marine	Threat Rating
1C	*Montipora sp.* coral in sheltered tidepool	Good	H3	Illegal harvest of marine species	High
2C	Rocky intertidal species assemblage	Good	H4	Human trampling	Medium
3C	Species composition/relative abundance in sheltered bays	Good	H8	Unexploded ordnance	Low
4C	Invasive and/or alien species composition/relative abundance	Good	A5	Impact of problematic species (e.g. crown-of-thorns sea star, fish disease, coral disease)	High
			A1	Potential of alien species introduction	Medium
			A2	Impact of existing introduced species (e.g. roi, ta'ape, toʻau)	Medium
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (pollution and nutrients, lights at night, viewplanes)	Low
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean pH change)	High
			G2	Marine debris	Low

1.4.3 Coral Reef Ecosystem

☐ Current status is Good

a) Overview

The Reserve encompasses marine waters extending from shore to approximately 1/2 mile from a middle point in ʻĀhihi Bay, around Cape Kīnaʻu, to just seaward of the shoreline and fishpond at Keoneʻōʻio. Water depths range from 0-35 meters (0-115 feet). Legally protected from extractive activities for more than 30 years, and largely free of sediment, pollution and nutrients from human activities, the coral reef ecosystems of the Reserve are among the finest in the main Hawaiian Islands.

The current threats to reefs within the Reserve include lack of visitor awareness of proper conduct when snorkeling, human trampling of corals, motorized vessel traffic, anchoring, interaction with protected species (sea turtles and dolphins), illegal take of fish and invertebrates, alien fish species, crown-of-thorns sea stars, coral disease, and land-based pollution. Impending or potential threats include proposed adjacent or up-slope land use changes and resulting pollution into the ocean, unregulated human uses, climate change and ocean acidification, and the degradation of surrounding marine areas. Connectivity among reefs often dictates that the replenishment of coral communities and fish stocks depends on nearby healthy reefs, therefore care of surrounding reefs is also an essential component to maintaining the viability of Reserve reefs. See **Table 7** for a ranked list of threats to the Reserve's coral reefs.

Table 7. Current status and threat ratings for coral reef ecosystem.

	Health Attributes Coral Reef Ecosystem	Current Status	Threat Code	Threats Coral Reef Ecosystem	Threat Rating
1R	Benthic community structure	Good	H3	Illegal harvest of marine species	High
2R	Mobile species composition/relative abundance	Good	H4	Human trampling	Medium
3R	Availability of haul out, resting, or foraging areas for monk seals and sea turtles	Good	H6	Motorized ocean vessels in the Reserve; anchoring	Medium
4R	Invasive and/or alien species composition/relative abundance	Good	H9	Protected species harassment	Medium
5R	Clear, blue water	Good	H8	Unexploded ordnance	Low
			A1	Potential of alien species introduction	Medium
			A2	Impact of existing introduced species (e.g. roi, ta'ape, toʻau)	Medium
			A5	Impact of problematic species (e.g. crown-of-thorns sea star, fish disease, coral disease)	Medium
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (pollution and nutrients, lights at night, viewplanes)	Medium
			G1	Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean pH change)	High
			G2	Marine debris	Low

Kanahena Bay and Kanahena Point, sites within the Reserve, have been part of a long-term monitoring study of nine Maui reefs by the CRAMP, a HIMB program conducted in partnership with the DAR. Over an eight year period, these two sites exhibited opposite trends. Kanahena Bay was the only Maui reef to increase coral cover (17%-30% 1999-2006) (DAR and CRAMP 2007), in contrast, coral cover at Kanahena Point declined from 23%-6%. The decline at Kanahena Point was attributed to the coral-eating crown-of-thorns sea stars (*Acanthaster planci*) (Rodgers et al. 2009). Periodic sea stars population explosions have been documented in some areas of Hawaiʻi, however, they have not caused damage extensive enough to warrant a management response.

b) Water quality

The marine waters in the Reserve are classified as Class AA (**Figure 19**) under HAR. Currently the only long-term water quality monitoring, conducted by the State Department of Health, occurs at Oneloa Beach, 1/2 mile north of the Reserve (Okuba pers. comm. 2009). Marine sediment samples collected in the Reserve compared to other Maui sites show lower levels of land-based materials, higher percentage of carbonates, and similar levels of organic materials. The high carbonate composition results from extensive coral development, high calcareous algal cover, and the high rate of bio-erosion by urchins and other herbivores (Rodgers et al. 2009). In another effort to quantify nutrient levels and sources by Meghan Dailer, the Kanahena Point CRAMP site had the highest nutrient levels of all nine Maui sites (Sparks pers comm.). The

Reserve has heavy underground freshwater inputs and those freshwater sources are likely high in nitrogen from natural sources like dry-land forest and grasslands.

c) Benthic species assemblage and invertebrates

The shallow water coral reefs of the Reserve are characterized by low rugosity volcanic rock and boulder habitats, and patches of encrusting and lobate corals. Deeper reefs are structurally complex, characterized by aggregated coral heads and sand patches. At least 33 species of coral are found at depths from less than 1 to 30 meters. This diverse coral assemblage has a high percentage of unusual species including the rare *Pavona maldivensis* (Rodgers et al. 2009). High primary productivity produces copious amounts of coralline algae and supports urchin populations that are very high when compared to other areas around Maui. Therefore, crustose coralline algae is more abundant in the Reserve than in survey areas outside the Reserve. The slate pencil sea urchin (*Heterocentrotus mammillatus*) and the rock boring urchin (*Echinometra mathaei*) are the most abundant among the macro invertebrates, with densities recorded at 1-15 per m^2 at many locations (Rodgers et al. 2009). The make-up of the marine environment suggests that it evolved around naturally high nutrient levels.

At least fifty-two other subtidal invertebrate species (not including corals) were recorded in three survey sites within the Reserve in 2004, of which numerous rare individuals were represented (Godwin 2004). Lava tube caves host numerous invertebrates including a red acorn worm found only in the Reserve's underwater lava-tube caves (less than -25 meters), and not yet described by scientists. These unique red worms belong to the phylum *Hemichordata* and the class *Enteropneusta* (Fielding 1994).

d) Reef and highly mobile fish

Visual fish surveys were conducted in the Reserve in 1972, 1985, 2000 and 2007 by various researchers. The most common species documented in both abundance and biomass from those surveys was *kole*, the goldring surgeonfish (*Ctenochaetus strigosus*). In surveys conducted by HIMB in 2007, herbivores accounted for almost 75% of the total biomass; significantly higher than the statewide herbivore averages (59%) of the 55 CRAMP survey sites (Rodgers et al. 2009). Of the total fish biomass, invertebrate feeders make up 10%, zooplankton feeders 7%, and carnivorous fish 8%. Overall, 75 species of fish (17 endemic) from 21 families were recorded. Three introduced fish were recorded in low numbers, the snapper taʻape (*Lutjanus kasmira*), the peacock grouper roi (*Cephalopholis argus*), and the black-tailed snapper toʻau (*Lutjanus fulvus*).

Figure 9. Underwater view of the Reserve's coral reef ecosystem (photo by Jim Petruzzi).

e) Effects of refugia

Marine protected areas like the Reserve provide refuge for larger fish, which allows those fish to produce more and better eggs than smaller fish, protect habitats and biodiversity, and provide a spill-over of eggs and adults to adjacent areas. HIMB research indicates overall fish biomass is greater in the Reserve than in adjacent areas surveyed (Rogers et al. 2009), as well as other open areas in Maui (Rogers 2005). Some fish species commonly exploited for commercial and recreational uses are common in the Reserve (Rodgers et al. 2009), and divers often dive just outside of the Reserve to take advantage of the enhanced fishing adjacent to the Reserve (Ramsey pers. comm. 2008).

f) Protected species

Five marine species with protected status frequent the Reserve: *ʻilio-holo-i-ka-uaua* or Hawaiian monk seal (*Monachus schauinslandi*), *ʻea* or the hawksbill turtle (*Eretmochelys imbricata*), *honu* or the green sea turtle (*Chelonia mydas*), *naiʻa* or spinner dolphin (*Stenella longirostris*), and *koholā* or humpback whale (*Megaptera novaeangliae*).

The Hawaiian monk seal has been listed as an endangered species under the federal ESA since 1976 and also under state law. Current populations are estimated at 1,100-1,200 seals archipelago- wide and declining, as only one of five juvenile monk seals reaches maturity. Monk seals have been sighted in the Reserve annually since the National Oceanic Atmospheric Administration (NOAA) data collection began in 2002 (Wurth 2008).

Of the two sea turtle species that occur in the Reserve, the hawksbill turtle is rarely sighted, but they have nested at nearby Oneloa Beach in Mākena State Park (King et al. 2004). Only seventy-two females, listed as endangered under the ESA and state law, nest in the main Hawaiian Islands (Mitchell et al. 2005). The green sea turtle is listed as threatened under the ESA and state law. In Hawaiʻi, the green sea turtle is genetically distinct from worldwide populations. In the first 25 years of legal protection (in 1978), populations increased by 53%, but still face numerous threats today. Green sea turtles are frequently observed in the Reserve.

The spinner dolphin population is estimated at 3,300 individuals in Hawaiian waters. Protected by the Marine Mammal Protection Act, the species is not considered depleted in Hawaiʻi, however rule-making around provisions of the act are being considered in an Environmental Impact Statement by NOAA Fisheries Service to reduce human-dolphin interactions during daytime resting. Spinner dolphins rest during the day in La Pérouse Bay near the Reserve boundary where they are visited by tour boats and swimmers on a regular basis (HWF 2008). Consequently, La Pérouse Bay remains listed as a potential time-area closure site to protect the spinner's resting habitat (LeFors pers. comm. 2009).

The *koholā* or humpback whale is an endangered species. In 1993 it was estimated that there were 6,000 whales in the North Pacific Ocean, and that 4,000 of those came to Hawaiʻi. Subsequently, the population is estimated to be growing at between 4% and 7% per year. Today, as many as 10,000 humpback whales may travel to Hawaiʻi each year from their North Pacific feeding grounds to mate, calve, and nurse their young. Because these massive mammals frequent Reserve waters during the winter months, Reserve waters are also included in the HIHWNMS.

1.4.4 Cultural Landscape

□ Current status is Good

a) Overview

The cultural landscape of the Reserve includes Native Hawaiian village sites, *heiau*, *ahu* (shrine), burials, trails, shelters, caves, *loko iʻa*, traditional place names, oral histories, and ecological knowledge and mythology of the travels of the Hawaiian deity preserved in the landscape. Furthermore, post-contact structures such as ranching walls and a lighthouse site reveal life in this region for many in early Hawaiʻi. The cultural landscape is the entirety of the landscape, the physical history, and living connections to the place and past. As defined by the World Heritage Centre, cultural landscapes are distinct geographical areas or properties that uniquely represent the combined work of nature and man (UNESCO 2008).

Cultural sites within the Reserve have been damaged by trampling from ungulates (deer, goat, pig) and humans, damaged by tree growth, impacted by human waste and trash, and direct vandalism such as spray painting. Another threat to cultural resources is the lack of preservation and sharing of Native Hawaiian and regional culture and history, making it vulnerable to loss. In spite of the impacts described in some locations, many of the cultural sites here remained largely intact and thus constitute an outstanding opportunity for preservation and interpretation of these irreplaceable resources.

Figure 10. A lava structure adjacent to an anchialine pool, part of the rich cultural landscape of the Reserve (photo by Matt Ramsey).

b) Traditional place names, oral histories and ecological knowledge

The Sea of Keoneʻōʻio (La Pérouse Bay) and the Reserve are the setting for many historic and supernatural events. Of Pele's (Hawaiian goddess of fire) adventures in the area, the story is told of how she coveted the handsome Paea, who fled with his sweetheart, Kālua, toward the Bay of Keoneʻōʻio where he kept his canoe and fishing gear. Pele caught up with the mortals near Puʻu Māhoe, where she turned Paea's body into Pōhaku Paea, in the sea near Mokuhā. She caught Kālua at Puʻu Naio (Hill of Conquest) and turned her into the ridge just below the hill, called Puʻu Kālua-lapa (Sterling 1998). Today, this site is known as, Kālua O Lapa, the volcanic vent that created much of Cape Kīnaʻu.

Renowned for its rich fishing grounds, fish ponds and shark lore, historic accounts and descendants of the area offer rich insights into the marine environment. As an example, the fishponds of Keoneʻōʻio were credited to high chief Kauholanuimahu (of the island of Hawaiʻi), whose *ʻaumakua* (family god), a benign shark, entered the pools via an underground passage

bringing with him schools of fish (Sterling 1998). Kamakau, the preeminent native Hawaiian scholar, wrote in the mid-1800s that he met a woman who lived at Maʻonakala in Kanahena who was engulfed by a shark there, but her life was spared through the efforts of a small shark that freed her (Sterling 1998). According to oral histories from native residents of Mākena to Keoneʻōʻio, unique relationships with certain sharks were commonplace (Maly and Maly 2005). Overall, records indicate that in the past larger and higher densities of marine life existed here, as did unique relationships and strong connections between native residents and the land and sea of Honuaʻula (Maly and Maly 2005).

Place names record many stories of this land and are integrally connected to places across the landscape. An interview with a descendant of Honuaʻula, Leslie Kuloloio, emphasizes the role of fishermen in the naming of each coastal feature to help locate fishing grounds (Desilets et al. 2007). Another important component of the protection and preservation of the cultural landscape is the direct involvement of ancestral descendants of Honuaʻula Moku in the Reserve's management and activities. Currently there are two arenas of this involvement: through representation on the Advisory Group; and through a NAR permit process. Past permits have been granted to perpetuate traditional practices in the Reserve, a *kuleana* (right, responsibility) maintained by the Luʻuwai *ʻOhana*.

c) Archeological, cultural, and historic sites and features

The Reserve contains a variety of traditional Hawaiian and early historic resource sites. Cultural and historic sites are protected within the boundaries of the Reserve by HAR § 13-209-4, which prohibits removal, damage and disturbance of any historic or prehistoric remains. Some Reserve sites at Keoneʻōʻio are included in the La Pérouse Archeological District which is on the Hawaiʻi Register of Historic Places.

The CRMP for the Reserve and Keoneʻōʻio was completed in March 2007 (Desilets et al. 2007). It focuses on the management of cultural resources along the most heavily visited trail corridors. Additionally, the cultural survey team conducted an ethnographic and underwater survey. The plan identifies the current status of sites, their vulnerability to damage, and their prioritized management recommendations for better management of these sites. The southeastern portion of the Reserve contains the highest density of archeological features. The area includes trail networks, rock shelters, habitation complexes, modified anchialine and marine pools, and *heiau*, clearly illustrating the importance of this area and the significant fishing grounds for this region of the island. Additionally, the Reserve also contains modern sites such as the remains of the Kanahena light house used from 1886-1918, which was later replaced by the navigational beacon at Cape Hanamanioa.

The Reserve contains a variety of traditional Hawaiian and early historical cultural resource sites. Some, such as Maʻonakala Village Complex in Kanahena are well known. In 1971 a team from the Bernice Pauahi Bishop Museum cleared and mapped the ruins at Maʻonakala (Desilets et al. 2007). The Bishop Museum team identified nine major archeological features including a canoe shed, a *heiau*, a well, and several *ʻiliʻili* (small stones) paved house enclosures. In 1974, the complex was listed in the Hawaiʻi Register of Historic Places as Site 50-50-14-1018 (Desilets et al. 2007). However, for reasons unknown, as of 2010 the site is no longer listed, according to the Hawaiʻi State Historic Preservation Division. Other known archeological resources in the Reserve include a series of sites and complexes identified by R. Bordner during his Chaminade

University field school survey (Bordner 1990). He inventoried the Kualapa Cluster, Kauhioaiakini and Halua pools, as well as sites along the trails leading to these features.

The Kanahena parking area, at the surf break known as "Dumps" was once a World War II era dumpsite, cleaned up sometime between the late 1960s and 1973. One eyewitness described the dumpsite at Kanahena as "an open junkyard ...cast off washing machines and stoves, barbed wire, glass, crushed and rusting oil drums and tin cans...provide an element of sheer destruction that is without peer" (Warnecke et al.). Robert Luʻuwai shares that during WWII, Maui's coastline was encased in barb wire waiting for the second attack by Japan. After the war, the Army Corp of Engineers removed the wire from the Mākena area and dumped it at the location of what is currently the Reserve's Kanahena Parking Area. As a result of this initial dumping, people began dumping material there that could not burn (old washing machines, etc.) (Luʻuwai pers. comm. 2009). In 1973, Inez Ashdown expressed relief that the clean-up of the dumpsite was finally complete. She wrote, "thanks to Harry Gibson and those with whom he works, we have eradicated the horrid wartime dump-site there in the historic village called Maona-ka-la."

Table 8. Current status and threat ratings for the cultural landscape.

	Health Attributes Cultural Landscape	**Current Status**	**Threat Code**	**Threats Cultural Landscape**	**Threat Rating**
1L	Cultural and historic sites intact	Good	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	High
2L	Traditional place names, knowledge of place, practices, histories	Fair	H2	Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High
3L	Documentation of archeological, cultural, and historic sites and features	Fair	H4	Human trampling	High
			H5	Human waste and trash	Medium
			H7	New trails across lava flows and damage to existing trails	Medium
			H8	Unexploded ordnance	Low
			A2	Impact of existing introduced species (woody plant species growing around archeological sites)	High
			A3	Damage by feral ungulates (browsing and trampling)	Medium
			A1	Potential of alien species introduction	Low
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (pollution and nutrients, lights at night, viewplanes)	Low

1.4.5 Lava Flow

☐ Current status is Good

a) Geologic setting and age of lava flows in ʻĀhihi–Kīnaʻu Natural Area Reserve

The Reserve encompasses young rugged lava flows on Haleakalā volcano's southwest rift zone. The Reserve includes the Kālua O Lapa cinder cone and the *ʻaʻā* lava from the cinder cone (Sherrod et al. 2007). These lava flows reach seaward, forming Cape Kīnaʻu and coating the adjacent offshore sea floor. Thus the Reserve is one of only a few protected areas in Hawaiʻi to enclose an entire lava flow from its source to end point on the ocean floor.

Figure 11. Young, rugged flows from Haleakalā volcano's southwest rift zone (photo by Judy Edwards).

Also within the Reserve is the coastal part of an older, similar sequence of lava flows that lie to the northwest of the Kālua O Lapa lava. This older sequence, the Kanahena flows, erupted from an unnamed fissure at about the 430 m altitude (1,400 feet) on the southwest rift zone. It is named for the *ahupuaʻa* and a small coastal settlement where the flows meet the shoreline.

Kālua O Lapa, the best known of these two lava sequences, began its eruption along a short narrow fissure now marked by spatter ramparts. The eruption could have formed quickly at the site of Kālua O Lapa, where most of the cinders and spatter were erupted and built a cinder cone 50 meters (160 feet) high. Lava erupting from this site oozed downslope to form the lava terrain bisected today by the Mākena Road as it heads to La Pérouse Bay. At least one of the flows crusted over, where molten lava moving beneath it could ultimately drain out creating a natural tunnel or lava tube. Collapsed sections of the roof along this tube created natural cave openings, that were accessed and used by early settlers.

The rough surface of the Kālua O Lapa lava creates a hummocky terrain whose deepest depressions are near the shoreline. Several depressions along the coastal stretch have floors that lie below sea level, allowing ocean water to infiltrate and form shallow anchialine pools. The Kanahena lava sequence is also *ʻaʻā* but somewhat lower in relief than the Kālua O Lapa lava. It too lacks vegetation, indicative of its young age compared to other flows. There are no known lava tubes associated with the Kanahena sequence. The Reserve encloses only the lower, downslope half of the Kanahena sequence. See **Section 1.2.2 Geologic Setting** for more on the age of the flows.

b) Ecosystems and habitat created by young lava flows in the Reserve

In addition to anchialine pools and native shrublands, the unique geologic characteristics of the young flows created another four unique ecosystems or habitats described below: aeolian ecosystems on unvegetated lava; lava tube cave and associated subterranean voids; littoral ecosystem; and potential seabird nesting habitat (Duvall pers. comm. 2008). In addition, the distinctive geography of the flows provides navigational markers for seasonal feeding by *ʻōpeʻapeʻa*, the Hawaiian hoary bat (*Lasiurus cinereus semotus*) at dusk along the shoreline (Pratt pers. comm. 2008). The Reserve is also a flyway for *ʻuaʻu*, the Hawaiian petrel (*Pterodroma sandwichensis*), returning to their nesting areas at night to the summit of Haleakalā (Duvall pers. comm. 2008). Both of these species are listed as endangered under the ESA. The primary threats to the geologic formations and lava-associated ecosystems include impacts of direct vandalism to lava flow structures and resources, human presence, foot traffic and noise in sensitive areas, lights at night that could disrupt wildlife behavior, and alien species that consume, harm, or compete with native species.

Aeolian (wind-supported) ecosystems on unvegetated lava

On the barren new lava of the Reserve, a community of insects and spiders lives hidden in the *ʻaʻā* clinker, cracks and recesses, feeding on windborne debris. These unique communities are called neo-geo-aeolian, or new lava aeolian. Within six months of an eruption, before the first plant life, native invertebrates begin to colonize a lava flow, representing the early stages of formative aeolian ecosystems (Howarth 1979). Lichens and ferns follow, which are succeeded over time by other plant communities. Native insect and arthropod species documented during Howarth's (1988) survey include the case-building larvae of the native *Hyposmocoma* moth and orb-weaving *Lyclosa* spider (Hawaiʻi Heritage Program 1989). Howarth's also observed the endemic dragonfly, *pinao* or *Anax strenuus* searching for the aeolian insects over the lava flow. Walking on or disturbing the *ʻaʻā* surface changes the character of the surface, disturbing lichen growth and aeolian species habitats, and encourages the dispersal of weed propagules, contributing to higher plant establishment (Hawaiʻi Heritage Program 1989). Weed dispersal on the lava flow is evident on most established trails and roadsides.

Lava tube cave and associated subterranean voids

Terrestrial cave-adapted insects and arthropods live primarily in medium size voids. They can live only where the air is stagnant, saturated with water vapor, and where food is present (from surface vegetation via roots). Cave faunas are mostly associated with younger lava flows, before erosion fills the medium sized voids (age range is from a few 100 to a few 1,000 years old). Of the cave-adapted species found at Kālua O Lapa, the isopod, *Hawaiioscia parvituberculata*, is endemic to this cave complex. The blind sheetweb spider, *Meioneta gagnei,* shares the same unique characteristics with the isopod. Both have evolved to become sightless. Both have been found in the few caves known at Kālua O Lapa, however, the subterranean extent of the cave system is not documented, and therefore, the distribution of these species within the Reserve is not known. Furthermore, Kālua O Lapa cave also contains important native Hawaiian cultural and archeological remains including a number of human burials. Because of extensive vandalism to these remains and cultural record, the cave entrances have been permanently sealed to preserve their sanctity and integrity. The cave biota was surveyed in the late 1980's and is recommended to be re-surveyed to determine current status.

Littoral (associated with the marine coast) habitat

The Reserve contains one of the finest undisturbed boulder beaches on Maui. While the unique marine mollusks and crustacea have been described, the numerous insects and myriapods, many of which are strictly nocturnal, have not. One of the more remarkable animals is the endemic marine cricket, *Caconemobius sp*., which is present by the hundreds along the margins of Reserve boulder beaches and anchialine pools. This cricket and other habitat associated species live on the coast and up to several hundred feet inland, where there are few other competing species (Howarth 1988).

Seabird nesting habitat

Recent surveys for nesting seabirds in the Reserve have no findings. However, the burrows and protective crevices of the lava provide potentially suitable nesting habitat for two small seabirds, *ʻakēʻakē*, or band-rumped storm petrel (*Oceanodroma castro*), and *ʻou* or Bulwer's petrel (*Bulweria bulwerii*). The *ʻou* or Bulwer's petrel is a highly pelagic, nocturnal gadfly petrel with a pantropical distribution. It is recognized by the state as indigenous. Both have declined from coastal areas of the main islands statewide due to human impacts, and both are thought to have been common in the Reserve prior to human disturbance. Remains of two *ʻakēʻakē* were found on Cape Kīnaʻu on two separate occasions in 1987 and 1988, indicating to biologists that the birds may continue to attempt to nest there (DOFAW unpublished data 2008). The rugged terrain and deep lava tubes and fissures of the new lava may provide some protection from disturbance by people, predators (e.g. cats, rats, mice, mongoose, dogs, and ants), and harsh weather, suggesting that threat management would result in successful recovery for those species. Surveys to determine presence and location of nesting seabirds are needed. The *ʻakēʻakē*, a state-listed endangered seabird, is the smallest and rarest seabird that nests in Hawaiʻi (Mitchell et al. 2005).

Table 9. Current status and threat ratings for lava flow.

	Health Attributes Lava Flow	Current Status	Threat Code	Threats Lava Flow	Threat Rating
1F	Natural lava formations unmodified; Lava flows and formations - condition	Good	H2	Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High
2F	Habitats unmodified (littoral, cave, aeolian, and seabird nesting)	Good	H8	Unexploded ordnance	High
3F	Use of habitat by Hawaiian Hoary Bat and Hawaiian Petrel	Good	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	Medium
4F	Use of habitat by Band-rumped Storm Petrel	Poor	H4	Human trampling	Medium
			H7	New trails across lava flows and damage to existing trails	Medium
			A3	Native habitat damage by feral ungulates (browsing and trampling)	High
			A4	Decreased reproductive capacity (alien predation on native plant seeds; alien predation on water birds and seabirds, e.g. cats, mongoose)	High
			A2	Impact of existing introduced species	Medium
			A1	Potential of alien species introduction	Low
			G1	Climate change and severe weather impacts to native biodiversity (e.g. habitat shifting and alteration, coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean pH change)	High

1.4.6 Native Shrubland

Current status is Poor

a) Overview

A mix of native and non-native vegetation covers approximately 17% of the terrestrial portion of the Reserve. Of this vegetated area, approximately 18% is native and 82% is non-native (derived from on-the-ground survey data and aerial photo analysis). These areas are largely *mauka* of the road except at Keoneʻōʻio and Kanahena. Rainfall is low, ranging from 400 mm (15 inches) along the coastline to 600 mm (24 inches) per year along the *mauka* boundary 152 meters (500 feet) elevation (Rodgers et al. 2008). When compared to the historical extent of this ecotype for the island of Maui, less than 2% of the native vegetation is left today on Maui. The life cycles of plants in elevations below 304 meters (1,000 feet), are keyed to a very severe and prolonged dry season and variable wet season (Medeiros et al. 1986).

The primary threats to native vegetation are browsing and grazing by feral ungulates, vegetative damage by alien insects, and drought conditions. Other threats include direct competition with introduced plants, seed predation by rats and mice, fire, and climate change. However, it has been shown that in the absence of major threats such as ungulates and introduced grasses, areas of the lowland dry ecotype have an advantage in lava and thin soil substrate, and recover well following threat reduction actions. Examples of this type of recovery projects are at Puʻu O Kali, Papapakai, Auwahi, and Kanaio, where ungulate movement has been controlled through fencing.

b) Non-native and native mixed

In the shallow soils and rugged lichen covered *ʻaʻā* field of a *kīpuka* located *mauka* of the road near Puʻu O Kanaloa, native *wiliwili* trees grow within large groves of non-native *kiawe* or mesquite (*Prosopis pallida*) trees. The summer deciduous endemic *wiliwili* is an important tree of the remnant native dry forest zone, now severely threatened by the *Erythrina* gall wasp, a recently-introduced insect which consumes the leaves of the tree. Tree growth is largely *kiawe*, in the largest *kīpuka* comprised largely of sand, located *makai* of the road. The sub-canopy vegetation is composed of the native shrubs *ʻilima* (*Sida fallax*), *ʻuhaloa* (*Waltheria indica*), *naio* (*Myoporum sandwicense*), *ilieʻe* (*Plumbago zeylanica*), and non-natives *koa haole* (*Leucaena leucocephala*), and Spanish needle (*Bidens pilosa*). In older lava *kīpuka*, *koa haole* dominates the native *ʻilima* shrubland. Rare species include *maiapilo* (*Capparis sandwichiana*) and *ʻāwikiwiki* (*Canavalia pubescens*) (Hawaiʻi Heritage Program 1989).

c) Native assemblages on pioneer vegetation on lava flows

ʻUhaloa is one of the most common native plants found in the Reserve in small *kīpuka*, especially where lava flows are in transition between *pāhoehoe* and *ʻaʻā*. Additional native species found here include *pili* grass (*Heteropogon conortus*), and *maiapilo*. In some areas, *Parmelioid lichens*, early colonizers, are found on the rough lava surfaces.

The endemic shrub *maiapilo* (*Capparis sandwichiana*), a member of the caper family, is one of the most common native shrubs found in the Reserve. *Maiapilo* is abundant on the *ʻaʻā* flows relative to the few other areas of Hawaiʻi where it is found. *Maiapilo* perseveres where many other natives do not as it is almost completely non-edible by ungulates (Medeiros pers. comm. 2008). Persisting in the harshest and driest environments in Hawaiʻi, interestingly *maiapilo* remain green year-round. Among the sweetest smelling flowers of Hawaiian flora, *maiapilo* can sometimes be smelt before it can be seen. Some have speculated that the plant is named for its banana shaped fruits which are foul smelling when ripe. *Maiapilo* produces a copious amount of nectar. The nectar is likely an important food source for adults of Blackburn's sphinx moth (*Manduca blackburni*) and other native moths. Blossoms open in the evening, remain open throughout the night, and close during daylight hours.

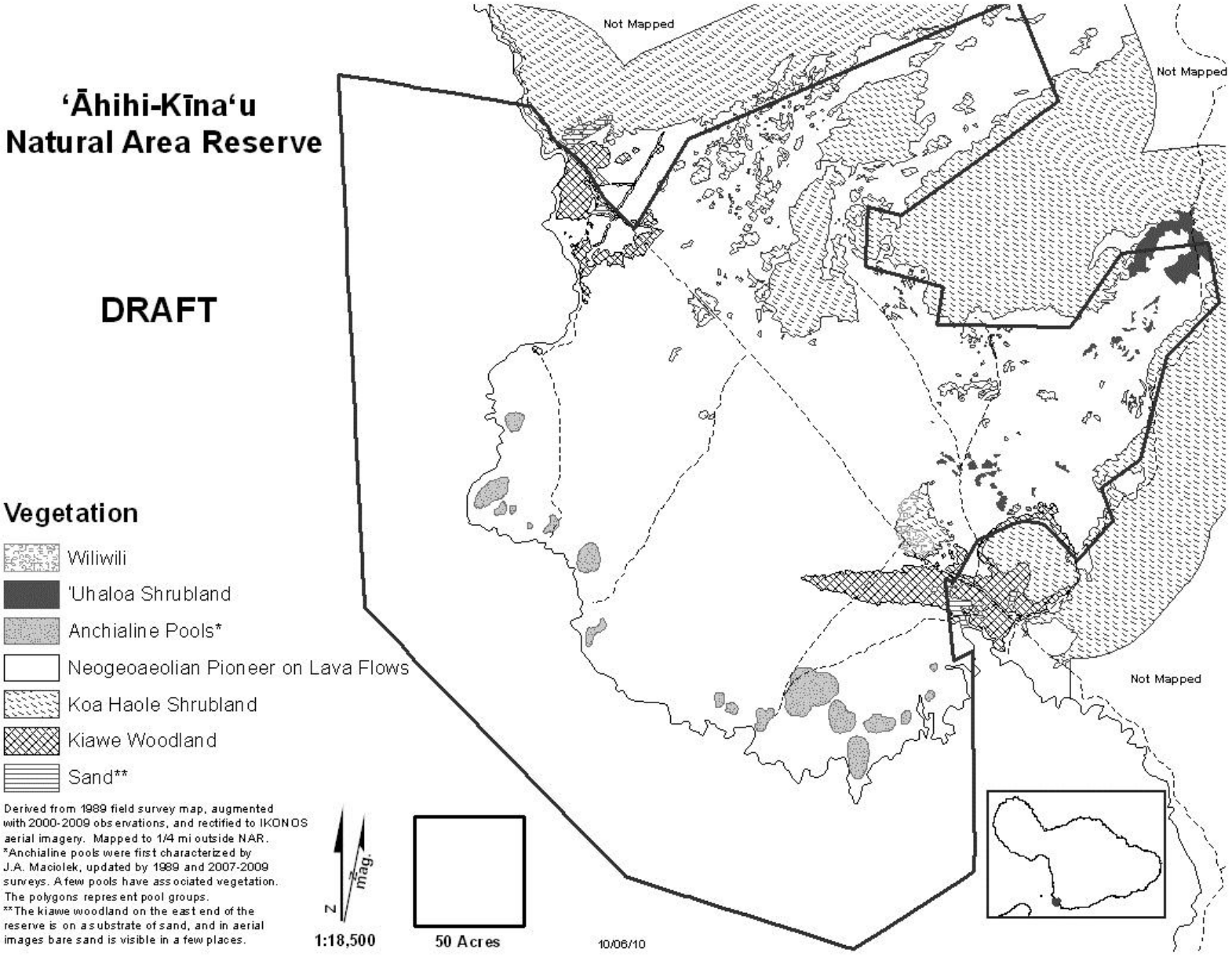

Figure 12. Reserve map showing vegetation, community, and substrate types (map by Stephanie Tom).

Table 10. A summary of some of the native and introduced plant species found in the Reserve (Hawaiʻi Heritage Program 1989; Warshauer et al. 2008; 2008 observations).

Native plant species	Non-native species
ʻakulikuli (*Sesuvium portulacastrum*)	pickle weed (*Batis maritima*)
ʻāwikiwiki (*Canavalia pubescens*) (C)	mesquite (*Prosopis pallida*) - kiawe
alena (*Boerhavia herbstii/Boerhavia repens*)	kou (*Acacia farnesiana*)
hao (*Rauvolfia sandwicensis*)	koa haole (*Leucaena leucocephala*)
ilieʻe (*Plumbago zeylanica*)	mangrove (*Rhizophora mangle*)
ʻilima (*Sida fallax*)	natal redtop (*Rhynchelytrum repens*)
koali awahia (*Ipomoea indica*)	sourbush (*Pluchea symphytifolia*)
maiapilo (*Capparis sandwichiana*)	sour grass (*Digitaria insularis*)
makaloa (*Cyperus laevigatus*)	tree tobacco (*Nicotiana glauca*)
milo (*Thespesia populnea*)	spanish needle (*Bidens pilosa*)
naio (*Myoporum sandwicense*)	fireweed (*Senecio madagascariensis*)
pili grass (*Heteropogon conortus*)	
ruppia (*Ruppia maritime*)	
ʻuhaloa (*Waltheria indica*)	
wiliwili (*Erythrina sandwicensis*)	

d) Blackburn's Sphinx Moth

Also present in these vegetative communities are native insects, the best known of which is the Blackburn's sphinx moth (*Manduca blackburni*). This endemic Hawaiian sphinx moth is the first Hawaiian insect to be listed as endangered under the ESA. The Reserve contains portions of critical habitat for this moth (Richardson and Hopper 2003). The primary threats to the moth's habitat include development, fire, alien species, ungulates, non-native parasitoids, and insect predators. According to the recovery plan, actions to prevent this should include protection, management, restoration of dry to mesic shrublands and forests, and restoring native nectar-resource food plants for adult Blackburn's sphinx moths such as *maiapilo* and *S. coriacea* (Richardson and Hopper 2003).

Figure 13. Maiapilo (*Capparis sandwichiana*), an endemic Hawaiian shrub (photo by Emily Fielding).

Table 11. Current status and threat ratings for native shrubland.

	Health Indicators Native Shrubland	Current Status	Threat Code	Threats Native Shrubland	Threat Rating
1N	Forest stand structure and reproductive success of *wiliwili*	Poor	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	Low
2N	Diversity and trend status of native plant assemblages	Poor	A3	Native habitat damage by feral ungulates (browsing and trampling)	Very High
3N	Extent of native plant assemblages		A4	Decreased reproductive capacity (alien predation on native plant seeds)	Very High
4N	Extent and status of native insects and arthropods		A1	Potential of alien species introduction	High
5N	Restoration of native plant assemblages		A2	Impact of existing introduced species (native plants competing with alien plants)	High
			L3	Fire	Medium
			G1	Climate change and severe weather impacts to native biodiversity (e.g. habitat shifting and alteration, severe lack of rain and temperature extremes)	High

1.4.7 Wilderness Qualities

☐ Current status is Good

a) Overview

The mandate for the NARS states, “the legislature finds and declares that Hawaiʻi has unique natural resources, and that these should be protected and preserved for the enjoyment of future generations and to provide baselines about such natural resources ” (HRS §195-1). Some qualities essential to protection and preservation of its natural resources are “wilderness” qualities. Conceptually, wilderness qualities at the Reserve can be described as eco-centric, where wilderness is safeguarded by a relative lack of human impact.

Under DLNR, resources are valued and managed first for resource protection and preservation, and second for people and recreational purposes (DLNR 1997). These qualities, described below, include the tangible and measurable aspects that ensure the preservation of wilderness qualities and can be traced back to objective analysis provided by monitoring. Explicitly stating these qualities enables them to be monitored, thereby decreasing their susceptibility to neglect. Thus, these wilderness qualities can be attributed to, and associated with preserving the ecology, landscape and the possibilities for enjoyment of future generations. Primary threats to this conservation target include crowding from people, vehicular access, noise and light pollution, and surrounding and encroaching development.

Figure 14. Aerial view of the Reserve (photo by Tony Novak-Clifford).

b) Viewscapes of geologic formations and the cultural landscape

The Reserve and surrounding landscape provides the best example and possibilities for landscape conservation, protection, and cultural preservation on Maui. At any vantage point within the Reserve, sweeping, unobstructed views are available from the sea up to the volcanic vent, Kālua O Lapa, and further upward towards the southwest rift zone of Haleakalā and often to the island of Hawaiʻi. Part of the landscape within the Reserve allows for a glimpse into the geologic history of Maui and the processes by which the volcanic islands came to be. The landscape is relatively unmodified and provides a window to view the places traveled by Hawaiian deities and ancestors. On a clear day, one can see four islands: Hawaiʻi, Kahoʻolawe, Molokini, Lānaʻi – and Mokuhā is named as the place from which you can see this (moku – island, ehā –four) (Luʻuwai pers commwith Bill Evanson). The view towards the mountains presents the geologic history from one of the youngest flows to the older Maui Nui complex and the natural regenerative and erosional character of the landscape. For wildlife like seabirds and bats, the unimpeded landscape provides for habitat connectivity. Currently, the landscape is relatively free of structures and lights at night. The resulting low noise levels, dark nights, clear air and sea space, contribute to habitat quality for wildlife and a sense of beauty, remoteness or renewal for people.

Table 12. Current status and threat ratings for wilderness qualities.

	Health Attributes Wilderness Qualities	Current Status	Threat Code	Threats Wilderness Qualities	Threat Rating
1W	Viewscapes of geologic formations	Good	H1	Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)	High
2W	Non-economic existence or intrinsic value	Good	H5	Human waste and trash	Medium
3W	Dark nights and clear air and sea space	Good	H6	Motorized ocean vessels in the Reserve; anchoring	Medium
4W	Silence and a sense of isolation	Fair	A2	Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, native plants competing with alien plants, introduced fish species, e.g. roi, ta'ape, toʻau)	Medium
			A1	Potential of alien species introduction	Low
			L1	Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and viewplanes, hydrologic regime change)	High
			L2	Existing coastal development (pollution and nutrients, lights at night, viewplanes)	Medium

1.5 Critical Threats

a) Threats identified

Through the collaborative management planning process involving stakeholders and agency managers, twenty-four threats to Reserve resources have been identified. These are grouped under four categories: human uses; alien species; land-based impacts; and global impacts. These categories were chosen because they correspond with a world-wide effort to standardize planning language in conservation, the Conservation Measures Partnership (CMP), discussed further below. Some of these threats have an impact on just one type of resource in the Reserve, however, many of them affect multiple resources. Each of these threats has been ranked using a process that identified what threats affect which resource(s) and its levels and types of impact. The resulting ranking helps focus effort on the highest threats and to direct energy and resources to reduce them.

These threat rankings are not absolute, as they are ever changing. The severity, scope, contribution, and irreversibility can each be affected by a management action, change in access, introduction of a disease (on land and/or in water) or innumerable other factors. The threat analysis in this plan includes the time between 2008 and 2010. During much of this time, human access to the resources of Cape Kīnaʻu was restricted. Relative threat ranking will change over time as management actions reduce threats and as new threats emerge that need to be addressed.

Threats listed here include potential and existing impacts. For instance, potential, or preventable threats, such as intentional introduction of alien species, may be listed as high as or higher than an existing threat even though it has not occurred yet. Some of the most effective actions are those aimed at preventing and stopping threats that are not a problem now, but have the potential to cause irreversible impacts unless acted upon.

Threats to resources are grouped into four categories with each individual threat in the category ranked as very high, high, medium, or low. The ranking process considers factors such as the relationship of the threat to the resources, historical impacts, severity, scope, contribution, and irreversibility. The ranking can be seen in **Tables 15-18**.

b) Using the Conservation Measures Partnership system

World-wide, much work is being done by conservation organizations to build a common language and nomenclature to improve the practice of conservation. A joint venture of 14 major conservation organizations and collaborators committed to improving the practice of conservation are working together to describe the problems they are facing and the solutions they are using. Standardized classifications can help managers better understand their site, compare data across sites, and accurately compare notes and share lessons learned with others in similar situations. This common language of threats increases the chances of designing and implementing effective monitoring and evaluation systems and ultimately, enhancing program and project design and implementation for successful biodiversity conservation. CMP threat taxonomy was utilized to develop the four Reserve threat categories (**Table 13**).

Table 13. Reserve threat categories in relation to international categories from the CMP.

	ʻĀhihi-Kīnaʻu NAR Threat Category	Associated Conservation Measures Partnership (CMP) Threat Category
1	Human use (H)	*CMP 6. Human Intrusions and Disturbance; CMP 5. Biological Resource Use*
2	Alien species (A)	*CMP 8. Invasive and Other Problematic Species and Genes*
3	Land-based impacts (L)	*CMP 1. Residential & Commercial Development; CMP 9. Pollution; CMP; 7. Natural Systems Modification*
4	Global impacts (G)	*CMP 11. Climate Change & Severe Weather*

1.5.1 Human Use

a) Levels and impacts of human use

Surveys of human use patterns (2002-2007) report an average of 700 people per day or 250,000 people per year who visit the Reserve (CSV Consultants and HWF 2007) and neighboring Keoneʻōʻio (HWF 2006), ranking the area as one of Maui's most sought after visitor location (**Table 14**). From surveys conducted at Kanahena parking area, HWF estimated that approximately 75% of Reserve visitors are from outside of the state and 25% are local residents (both referred to as visitors). Overall, more visitors are present on weekends than weekdays. More than half of the visitors are interested in snorkeling and ocean wildlife viewing. Other visitors are interested in the geology and lava flows, hiking opportunities, beach going, and sight-seeing of La Pérouse Bay, while some are lost or simply exploring (CSV Consultants and HWF 2007).

Table 14. Comparison of number of annual visitors at some of Maui's popular destinations.

Natural and Marine Attractions	Annual average visitors*
Haleakalā National Park	1,600,000
Molokini Marine Life Conservation District	400,000
ʻĀhihi-Kīnaʻu Natural Area Reserve	250,000
Maui Ocean Center	200,000
Honolua Marine Life Conservation District	160,000
Whaler's Village Museum	160,000
Atlantis Submarines	100,000

* Visitor annual estimates from Haleakalā National Park pers. comm. 2007, Hawaii's Local Action Strategy to Address Recreational Impacts to Reefs 2005, Hawaiʻi Wildlife Fund reports, Maui Ocean Center pers. comm. 2007, Maui County Data Book 2006, Atlantis Submarines pers. comm. 2007.

The high volume of visitors to the Reserve can often result in crowding, traffic, and parking issues. There is a general lack of awareness of how to help protect and preserve natural resources of Native Hawaiian and regional culture and history. Trampling is the most common source of damage from people. Trash and human waste, vandalism, and poaching also contribute to resource degradation. Other impacts to resources include destruction of archeological structures, rock removal and vandalism, creation of new trails and damage to existing trails, and protected species harassment. Protected species harassment specifically

includes disturbance of endangered and protected marine animals: Hawaiian monk seals disturbed while resting and molting on shore; sea turtles disturbed while basking on shore; spinner dolphin resting period disturbed by swimmers; and swimming sea turtles chased and touched by swimmers. See **Table 15** for prioritization of human use threats to resources.

Figure 15. High visitor use at Kanahena Cove (photo by Matt Ramsey).

Table 15. Threats to resources from human use.

	⇒Targets⇒ ⇓Threats⇓	Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flow	Native shrublands	Wilderness qualities	Summary Threat Rating
Threats	H1: Vehicular traffic (noise, emissions, congestion, wear and tear, off-road vehicles)		High			Medium	Low	High	High
	H2: Destruction of resources (damage to formations, structures, rock removal, spray paint, vandalism)	High	High			High			High
	H3: Illegal harvest of marine species			High	High				High
	H4: Human trampling	Very High	High	Medium	Medium	Medium			High
	H5: Human waste and trash	Medium	Medium					Medium	Medium
	H6: Motorized ocean vessels in the Reserve; anchoring				Medium			Medium	Medium
	H7: New trails across lava flows and damage to existing trails	Medium	Medium			Medium			Medium
	H8: Unexploded ordnance	Low	Low	Low	Low	High			Medium
	H9: Protected species harassment				Medium				Low

*Indirect threats: too many people, lack of visitor awareness of Reserve resource, visitor safety, lack of management capacity. The ranking of the impact of these threats come from a variety of sources: reports, expert assessments, and observations.

Up until the implementation of a two year action plan in August 2008, damage to natural and cultural resources across Cape Kīnaʻu was the primary threat to resources. A closure was approved by the BLNR in August 2008 for a 2 year period and was extended for an additional 2 years in June 2010 (see **Figure 16**, August 2008-2010 and August 2010-2012 restricted access zoning). Restricted access to Cape Kīnaʻu and Kālua O Lapa protects sensitive resources vulnerable to human impacts. During the closure, resources and human use have been

monitored to gather information for future management action. For example, human use data collected by Rangers between September 2008 and January 2010 show, on average, 152 vehicles per day parking at the Kanahena parking area and 260 per day at La Perouse.

Since the two year access restrictions beginning in August 2008, use of the Reserve occurs primarily from Kanahena Cove and Kanahena Parking Area. Visitors park their vehicles either at the Reserve entrance, where there is space for only a few cars, along the road near Kanahena Cove, or at the Reserve's Kanahena Parking Area. Signs clearly mark closed areas and prohibited activities.

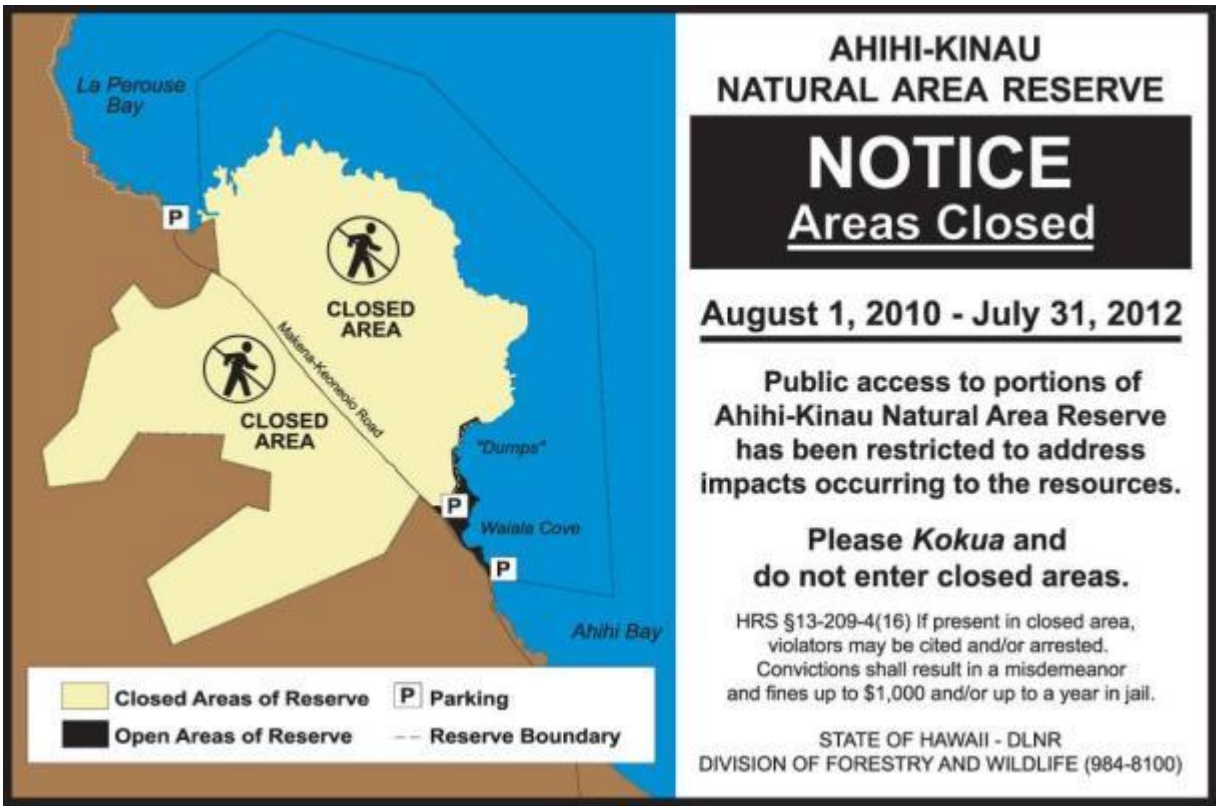

Figure 16. Notice of August 2010-2012 open access and restricted access areas.

b) Safety and facilities

Public safety incidents and concerns here have included injuries from lava and coral, deaths by drowning, getting lost, life-threatening personal health emergencies, evacuations, car breakdown, lockout, theft, deer shootings, and unexploded ordnance. Unexploded ordnance (UXO) from maneuvers conducted by the U.S. military in the 1940s may still be present in the Reserve. Surveys to determine the extent and nature of UXO are underway (2011-2012).

Current infrastructure is unimproved, very limited, and includes two unpaved parking areas with portable toilets (one in the Reserve's Kanahena Parking Area, and one outside of the Reserve at Keoneʻōʻio/La Pérouse Bay). A portable office trailer was installed in 2009 at the Kanahena Parking Area to serve as an office for staff operating seven days a week. Signage of the closure is provided at the Reserve's entry, Kanahena Parking Area, Keoneʻōʻio and all along

the road. Traffic issues include two-way traffic on the narrow one-lane undivided, road where there are few spots to pull over, and excessive traffic on a single lane road. Traffic backs up through Kanahena Cove and in Keoneʻōʻio where the pavement ends and parking is limited.

c) Illegal activities

Incident data from Reserve Rangers suggests poaching of resource fish species and intertidal species is the most prevalent resource-related violation, including night-time poaching. Resource-related (approximately 40% of reported incidents) and non-resource related violations are on a downward trend, from peak levels during 2005-2006 (NARS unpublished data). The decrease aligns with the increase of site presence of Rangers. According to DOCARE, the most prevalent illegal activity is entry by boat into the Reserve (DOCARE unpublished data). The most common incidents for MPD response is vehicle break-ins (MPD unpublished data).

1.5.2 Alien Species and Other Biological Threats

a) A critical threat in Hawaiʻi and the Reserve

The introduction and spread of alien species has contributed significantly in the past and is now the predominant cause of biodiversity loss in Hawaiʻi. The silent invasion of Hawaiʻi by insects, pathogens, weeds, and other pests is the single greatest threat to Hawaiʻi's economy and natural environment, and to the health and lifestyle of Hawaiʻi's people.

Hawaiʻi, with far above-average vulnerability to invasions (Loope and Mueller-Dombois 1989; Denslow 2003), is also a major international hub of commerce. It is by far the U.S. region most damaged by alien species, with large numbers of and serious impacts from vertebrates, invertebrates, diseases, and flowering plants (OTA 1993).

Alien species threats specific to the Reserve's resources are summarized below in **Table 16**. Threats include the introduction of new and/or more aggressive alien species; competition with existing introduced plant species; browsing, grazing and trampling by introduced ungulates; introduced insects; predators on native plant seeds; woody plant species growing around anchialine pools and archeological sites; marine alien fish and invertebrates; and water and seabird predators. Nearly every Reserve resource is affected by alien species or other biological threats. The degree of threat varies with the species and the resource.

Figure 17. Introduced feral goats consume both native and non-native vegetation (photo by Joe Fell-McDonald).

Table 16. Threats to resources from alien species and other biological threats.

⇒Targets⇒ ⇓Threats⇓		Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flow	Native shrubland	Wilderness qualities	Summary Threat Rating
Threats	A1: Potential of alien species introduction	Very High	Low	Medium	Medium	Low	High	Low	High
	A2: Impact of existing introduced species(woody plant species growing around anchialine pools and archeological sites, alien plants competing with native plants, introduced fish species, e.g. roi, taʻape, toʻau)	High	High	Medium	Medium	Medium	High	Medium	High
	A3: Native habitat damage by feral ungulates (browsing and trampling)	High	Medium			High	Very High		High
	A4: Decreased reproductive capacity (alien predation on native plant seeds; alien predation on water birds and seabirds, e.g. cats, mongoose)	High				High	Very High		High
	A5: Impact of problematic native species (e.g. crown-of-thorns sea star, fish disease, coral disease)			High	Medium				Medium

*The ranking of the impact of these threats come from a variety of sources: reports, expert assessments, and observations.

b) Alien species in terrestrial and aquatic areas

Some well-documented threats, such as aquatic alien species (particularly fish) in anchialine pools, have decimated the native biota in many of the pools on the island of Hawaiʻi; elevating this potential threat to the highest level. Anchialine pool surveys indicate that Reserve pools are currently free of introduced aquatic species.

Alien plants around the anchialine pools would completely fill these unique systems if not for weed control intervention. Nesting native waterbirds in the pools are vulnerable to predation by small mammals (e.g. cats, dogs, rats and mongoose) and predatory introduced birds (e.g. barn owls and cattle egrets). Nesting seabirds are also vulnerable to these introduced predators.

Coastal dry shrubland and forests are inundated by very high levels of browsing by deer and goats which gives alien plant species a competitive advantage. For example, one of the only native plants surviving in the Reserve under this stress is the flowering shrub, *maiapilo* which, by virtue of its chemical composition, is completely inedible by even the hardiest goat. A fenced enclosure next to the Reserve has kept a small area ungulate-free for a number of years now, and flourishes with native plant species, an indication of the kind of recovery of native terrestrial resources possible if ungulate browsing were stopped.

In the early 2000s, the inadvertent alien introduction of the *Erythrina* gall wasp (*Quadrastichus erythrinae*), decimated a keystone species of native low elevation forests, the *wiliwili* (*Erythrina sandwicensis*) tree, by consuming its leaves. A parasitoid bio-control agent was

released in the hopes of controlling the gall wasp in 2009. The State Department of Agriculture has seen some early signs of success of the bio-control, as the *wiliwili* trees regain leaf production.

c) Alien species on near shore and coral reef ecosystems

The introduced fish, roi (*Cephalopholis argus*), is thought to be a threat to Reserve reefs. Roi were introduced to Hawaiian waters by the state in the 1950s to enhance local fisheries. Hawaiʻi's DAR recently documented that roi populations have increased fifteen-fold since the 1980s in the main Hawaiian Islands, and have become the dominant nearshore predator on Hawaiʻi's reefs where they consume small native fishes. A University of Hawaiʻi study estimated that in a 3 mi^2 area off the Kona Coast of the island of Hawaiʻi, the roi eat 99 tons of reef fish annually — the equivalent of 8.2 million fish. Two other introduced fish are present in the Reserve, taʻape or blue lined snapper (*Lutjanus kasmira*) and toʻau or blacktail snapper (*Lutjanus fulvus*).

d) Other biological threats

Other biological threats include crown-of-thorns sea stars outbreak, coral disease, fish disease and alien algae. Crown-of-thorns sea stars (*Acanthaster planci*) occur naturally in Hawaiʻi and throughout the Indo-Pacific. It has caused documented damage to Reserve reefs between 1999 and 2006 when coral cover at Kanahena Point declined from 23%-6% (Rodgers et al. 2009). That reef area has since shown coral re-growth. Crown-of-thorns sea stars are still present in the Reserve; however, the extent of current impact is observed to be less than previously recorded. Like other natural occurrences, managers need to understand if natural or anthropogenic factors drive the population blooms of crown-of-thorns sea stars.

Coral disease was documented by University of Hawaiʻi researchers in a Reserve tidal pool in 2009. In 2010, the disease increased its extent and effect on the *Montipora* sp. coral colonies found in the pool. Monitoring of the corals is ongoing. Fish disease has also been documented for the Reserve's most abundant reef fish, kole or yellow-eye surgeon fish (*Ctenochaetus strigosus)* (Ramsey pers com 2008). Alien algae (Hypnea musciformis) are present in some intertidal areas of the Reserve (Conklin pers com 2008), however, the low levels are attributed to high herbivory by fishes and invertebrates and natural levels and types of nutrients in the underground fresh water flow.

1.5.3 Land-Based Impacts

a) Effects of run-off on coral reefs

Improper coastal development and poor land management practices are some of the greatest threats to coral reefs, creating runoff of sediment and pollution that covers and kills coral. Numerous studies indicate that runoff damages coral reefs. In the steep, high islands of Hawaiʻi, where the terrain slopes dramatically seaward, no place is more than 29 miles from the coast. Furthermore, sewage discharge (even when treated) and fertilizers (which contain nutrients) encourage the growth of algae that crowd out reef-building corals. Herbicides, soils, insecticides from homes and golf courses, oil, grease, and toxic chemicals from paved roads and

storm drains are all part of land-based pollution. These effects are especially pronounced in harbors and bays, where there is less natural flushing from the tides and currents that normally move sediments off of coral reefs.

b) Low levels of run-off in the Reserve

The marine waters of the Reserve are some of the most pristine in the state, attributable to good natural flushing, relative lack of land-based pollution and sedimentation, and low amounts of organic matter. The Reserve and surrounding areas are largely free of cultivation, exposed soils, or impervious surfaces such as pavement or development. Rainfall is low and the lava substrate is highly porous, and as a result, run-off is minimal most of the year. The greatest contribution of run-off comes during wet-season Kona storms which periodically carry muddy waters into the sea. Because of overall excellent water quality, the State Department of Health marine water classification for this area is AA.[8]

Figure 18. Soil run-off into Reserve waters, a threat to coral reef resources (photo by Matt Ramsey).

c) Other land-based impacts

Other land-based impacts to the Reserve's resources include upslope disruption of hydrology from well drilling or other changes to underground water flow. The proper functioning of anchialine pools is dependent on the natural influx of underground freshwater. On the island of Hawaiʻi, the anchialine pools at Kaloko-Honokōhau National Park have been recently affected by upslope land-use changes (e.g. freshwater well drilling; residential and commercial development), an impact that may be preventable at the Reserve.

d) Need for preventive action

Without preventive action to care for the Reserve's resources as part of a biological and cultural landscape, the Reserve could become hemmed in by human structures and activities and thus continue to lose the inherent integrity that defines it as a unique Hawaiian place. The effects of current structures in and adjacent to the Reserve are thought to be low, in terms of pollutants, night light pollution (which can disrupt wildlife), obstruction of views, and loss of wilderness qualities. However, proper planning and forethought about adjacent developments can dramatically reduce future impacts to the Reserve from outside its boundaries. Fire is another land-based issue which cannot be ignored in any conservation area, especially on the dry leeward side, and planning must take this threat into account. Land-based impact threats specific to the Reserve's resources are summarized below in **Table 17**. Threats include the proposed development; existing coastal development; and fire.

Table 17. Threats to resources from land-based sources.

⇒Targets⇒ ⇓Threats⇓		Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flow	Native shrublands	Wilderness qualities	Summary Threat Rating
Threats	L1: Proposed adjacent coastal or upslope development (e.g. land-based pollution and nutrients and resulting alien algae growth, light pollution, altered wilderness qualities and scenic resources, hydrologic regime change)	High	High	High	High			High	High
	L2: Existing coastal development (e.g. land-based pollution and nutrients, lights at night, scenic resources)	Low	Low	Low	Medium			Medium	Low
	L3: Fire						Medium		Low

*The ranking of the impact of these threats come from a variety of sources: reports, expert assessments, and observations.

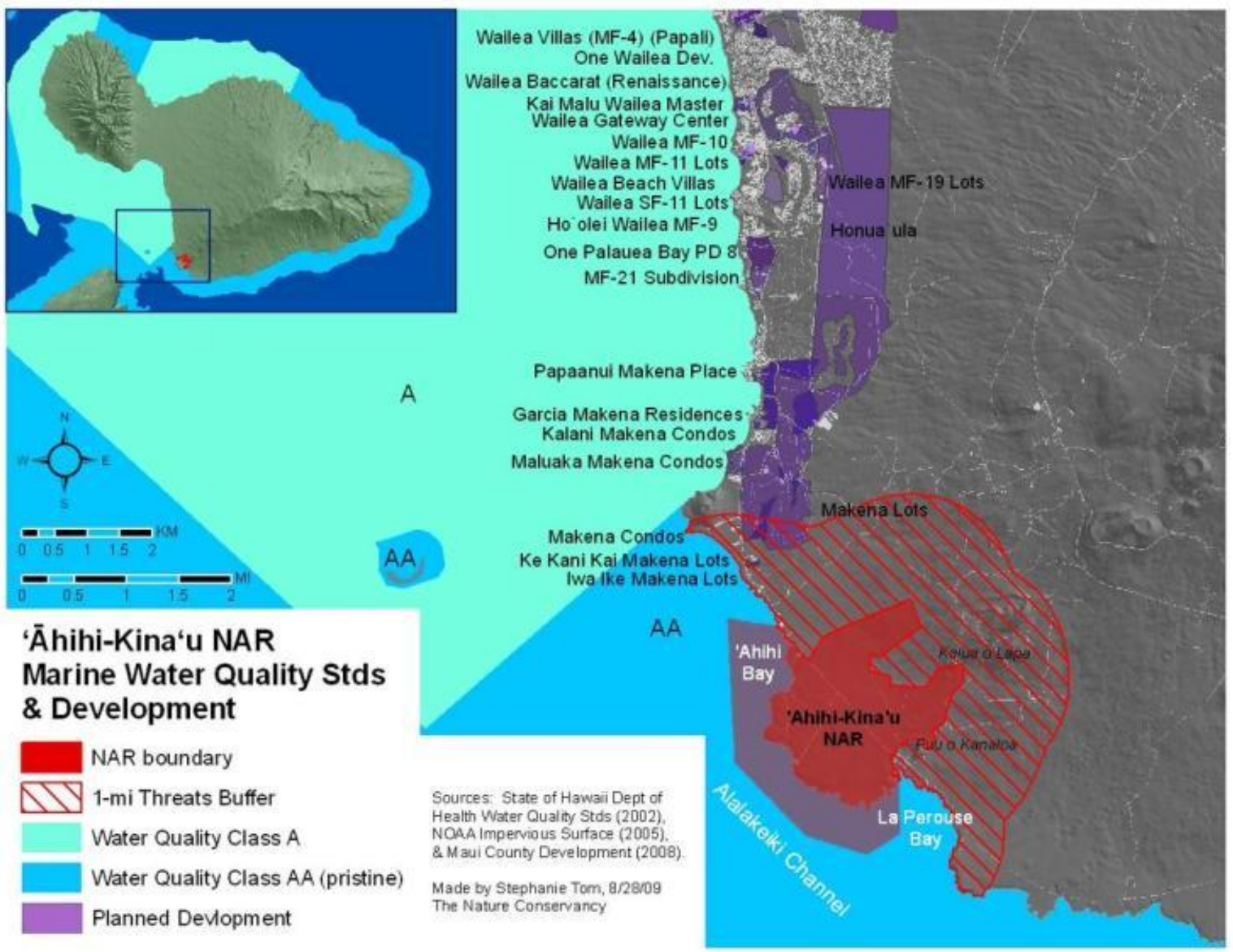

Figure 19. Map showing state water classification in the Reserve and around the island of Maui, as well as current and planned development in relation to a one-mile area around the Reserve (map by Stephanie Tom).

1.5.4 Global Impacts

a) Climate change

Climate change threatens the viability of all ecosystems on Earth. No conservation targets are immune – terrestrial, marine, or freshwater vertebrates, invertebrates, or plants. Climate change will affect each conservation target, however, to a different degree. The coarse spatial scale of current climate change data, the uncertainty inherent in projecting future greenhouse gas emissions, and the complex responses of species and ecosystems to changing climate conditions, pose challenges to addressing the threat of climate change in conservation planning. Climate change has caused vegetation shifts, phenological changes, alterations in wildlife behavior, and other significant ecological impacts (Aldous et al. 2007).

The single most important strategy for the future of coral reefs worldwide is to reduce the amount of climate change that occurs. Preventing massive damage to ecosystems on a global scale cannot be done without reducing greenhouse gas emissions and taking steps to slow down global climate change. However, even though the global scale of climate change is outside of the direct control of Reserve managers, the short- and long-term viability of biological resources are directly related to abating direct threats at a local scale.

b) Resilience to climate change

As this is a short-term plan, it is not designed to implement long-term climate change adaptation strategies. Rather, this plan provides the best available short-term approach to the long-term problem by implementing all known conservation measures needed, thereby enhancing biological integrity and therefore conferring resilience to future impacts from climate change. To achieve resilience, managers need to focus on the most pervasive current threats, which are the focus of this plan. For the Reserve's coral reefs, threat reduction includes reducing the effects of land-based sources of pollution, illegal fishing, and alien species. For native shrublands, threat reduction would include weed control, native plan restoration, small mammal predator control and ungulate control. Managers working to support biological community health and ecosystem function, will decrease the impacts of severe global threats.

c) Marine debris

Marine debris is another threat to Reserve resources that can come from far beyond its own shores. Local action entails removal of the plastic debris once it washes up to prevent possible impacts to marine life and seabirds from entanglement in nets and lines or from ingesting plastics.

Table 18. Threats to resources from global impacts.

⇒Targets⇒ ⇓Threats⇓		Targets							
		Anchialine pools	Cultural landscape	Coastal marine	Coral reef	Lava flow	Native shrubland	Wilderness qualities	Summary Threat Rating
Threats	G1: Climate change and severe weather impacts to native biodiversity (habitat shifting and alteration, e.g. coral bleaching; severe lack of rain and temperature extremes; runnoff from severe storms, ocean pH change)	High		High	High	High	High		High
	G2: Marine debris			Low	Low				Low

*The ranking of the impact of these threats come from a variety of sources: reports, expert assessments, and observations.

Figure 20. Staff and volunteer removing marine debris from the Reserve (photo by Matt Ramsey).

2.0 The Action We Will Take

Thus far in this plan, we have discussed the setting, management context and history, resources, and threats. Going forward, **Section 2.0** takes the Working Groups' and subject matter experts' best thinking on the information, and **Sections 2.2** and **2.3** propose objectives and strategic actions to reduce the identified threats, increase the viability of priority target resources, and provide for information needs. **Table 21** lists and prioritizes objectives and strategic actions. **Section 2.4** discusses measures of success, and **Section 2.5** examines sustainable finance mechanisms and a budget.

2.1 Analysis of Issues

a) Human use impacts

The three main issues addressed in this plan are human use, management capacity, and alien species. The primary issues regarding people are resource damage, safety, crowding, lack of visitor awareness about the Reserve, and manageability. Regarding resource damage from people, the southern half of Cape Kīnaʻu and along the trail to Mokuhā is where most of the damage has been documented, and where most safety concerns occurred. In addition, the entire Cape was a former naval bombing range and unexploded ordnance can be found throughout the area. The area *mauka* of the road has no marked trails and a history of cave vandalism and occupation. Prior to implementing access restrictions in 2008, staff found it difficult to adequately control detrimental impacts to resources and respond to frequent safety incidents.

This plan recommends allowing access to areas relatively resilient to human use and well suited for nature study and restricting access to those areas where resource damage has occurred, where resources are vulnerable to human impacts, and/or where visitor safety is documented to be a concern.

It is proposed that access is allowed during visiting hours in the popular Kanahena Cove and Dump's surf area as well as a trail out to the point (Ka Lae Mamane). The remainder of the land area would be accessible, as it is now, by special use permit or staff guided service trips or educational hikes. The marine portion of the reserve remains open to swimming, snorkeling and non-motorized vessels. Trails and interpretation in the public access area will be improved, and action will be taken to provide limited interpretive hikes into the restricted area. Improvements to the Kanahena parking area are planned to facilitate and provide for the focus of visitors there.

The establishment of information, interpretation, and volunteer programs aims to improve visitor experience and their knowledge about the Reserve, enhance management capacity, increase levels of public support and participation, reduce human impacts, and increase voluntary compliance with NARS rules.

b) Building management capacity

DOFAW capacity to manage this heavily used area has always been challenged, but has increased significantly with the initiation of the Ranger program in 2005. The remoteness of the site and highly protected status of the Reserve, combined with large numbers of daily visitors, requires intensive management. Five of twelve priority actions recommended in this plan (listed in **Section 2.3** come from the management capacity building goal. It is a high priority to build a strong foundation for the program so that this plan can be implemented.

c) Alien species and other biological threats

Alien species issues are especially highly ranked, constantly changing and must be addressed in a dynamic fashion as this plan explains. However, basic operating and human use issues must be addressed before other natural resources issues can receive the appropriate attention.

2.2 Management Framework

2.2.1 Natural and Cultural Resources Focus

The NARS, as originally conceived, focuses on natural resource protection and enhancement (**Table 19**). This plan builds upon this fundamental, legislative mandate, and reflects a broader shift in the approach and thinking of natural resource management efforts in Hawaiʻi in moving away from a strict biological focus and toward an integrated biological and cultural focus.

2.2.2 A Vision for the Reserve

Vision: Through *kōkua* and *mālama*, the natural and cultural resources of ʻĀhihi-Kīnaʻu Natural Area Reserve are respected and protected as a living legacy. *Aloha ʻāina*.

The Working Group developed a vision for the Reserve focusing on respect and protection of natural and cultural resources, while emphasizing that human effort, in the form of *kōkua* (help) and *mālama* (care), is essential (ʻĀhihi-Kīnaʻu Working Group 2008). The phrase "*aloha ʻāina*" which literally means "love of the land or of one's country," is a very old concept to judge from the sayings illustrating deep love of the land (Pukui and Elbert 1986).

2.2.3 Four Goals

This management plan has four management goals that address priority management needs: managing human uses, controlling alien species and other biological threats, preventing land-based impacts, and building management capacity. Goals are brief, broad statements that relate to the vision and are simple to understand and communicate. Under each goal, there are a set of objectives and strategic actions for implementation.

Table 19. Hawaiʻi Revised Statutes [§195-1]

Findings and declaration of necessity:

(1) the State of Hawaiʻi possesses unique natural resources, such as geological and volcanological features and distinctive marine and terrestrial plants and animals, many of which occur nowhere else in the world, that are highly vulnerable to loss by the growth of population and technology;

(2**) these unique natural assets should be protected and preserved, both for the enjoyment of future generations, and to provide base lines against which changes which are being made in the environments of Hawaiʻi can be measured;**

(3) in order to accomplish these purposes the present system of preserves, sanctuaries and refuges must be strengthened, and additional areas of land and shoreline suitable for preservation should be set aside and administered solely and specifically for the aforesaid purposes; and

(4) that a statewide natural area reserves system should be established to **preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawaiʻi.** [L 1970, c 139, pt of §1]

Table 20. The four management goals.

Goal 1. Manage Human (H) Use	We will manage human uses to protect natural and cultural heritage, and develop appreciation, understanding, and *kuleana* for the Reserve through education and interpretation.
Goal 2. Build and Maintain the Reserve's Management (M) Capacity	We will build and maintain the human and financial resources, infrastructure, and partnerships, necessary to support the Reserve's capacity to ensure effective site management through time.
Goal 3. Control Alien (A) Species and Other Biological Threats	The native biological community and cultural resource integrity of the Reserve is strengthened and maintained as the result of the successful control of alien species and other biological threats in terrestrial and aquatic habitats.
Goal 4. Prevent Land-based (L) Impacts	We will work to control and prevent land-based impacts from source areas within, adjacent to and upland of the Reserve from having any significant, negative impact on the habitats, wildlife, and scenic resources found in the Reserve.

2.2.4 Adaptive Management

This plan was developed with NARS staff, the working group, and input and comment from the public, the Advisory Group, and the NARS Commission (2008-2012). Over that time, management actions were undertaken and the degree that threats affected resources and people changed. For instance, goats were not in the Reserve prior to 2008, and now by 2011 herds of goats were present.

Change happens! We need to be nimble to address threats as they evolve and to take advantage of opportunities to address them. This plan was written to be adaptive, which means both expecting change and learning from actions. Some aspects of the plan are designed to remain relatively constant – our vision, what we aim to protect, and our goals and objectives. Strategic actions are more flexible – we may find that there is a better way to reach the objective and goal. This process of adjusting needs to happen in a way that is predictable and transparent to the department, the Advisory Group, and the interested public, and learning is documented and assessed

In order to learn and adapt, managers need to take special care with collecting and utilizing the most current and accurate information. We know that there is uncertainty and complexity inherent in managing natural ecosystems, and therefore we need to approach management with the understanding that we are learning (Salafsky et al. 2001).

In the framework of this plan, managers will collect and analyze information as they implement actions so that expectations can be compared with actuality. As management progresses, managers transform comparison into learning — to improve understanding, and modify actions and plans.

2.3 Goals, Objectives and Strategic Actions

a) Objectives and strategic actions

Objectives are specific and measureable statements of what will be achieved in the Reserve. They represent what needs to be done based on current status and condition of targets and provides us with the ability to measure and gauge our effectiveness. The objectives focus on abating the most critical threats, enhancing resource viability, and building management capacity.

Each of the objectives addresses a management need, and is implemented by a set of strategic actions. The 43 strategic actions in this plan are focused, feasible, and appropriate courses of action to be carried out by the Reserve staff, a project team, and/or through partnerships or contracts. A prioritized summary table of objectives and actions is provided at the end of this section (**Table 21**). This plan provides overall guidance for action but does not provide work plans or detailed budgets, which will be done by staff on an annual basis.

For the implementation of this plan to be successful, it requires substantial support by other state departments, DLNR divisions, federal agencies, non-governmental organizations, Advisory Group members, contractors, and other sectors. Key partners have played important roles in the past and are expected to continue to support effective resource management.

The actions in this section are prioritized. The top priority actions are:

- Hire a full-time Reserve manager – M1 (a)
- Build and maintain staff capacity to meet Reserve needs – M1 (b)
- Implement a Reserve sustainable financing plan – M1 (c)
- Improve and maintain on-site facilities– M3 (c)
- Recruit partners in support of the plan's implementation– M4 (b)
- Manage visitors and access points – H1 (a)
- Establish and maintain trails and boundaries – H1 (b)
- Minimize the impact of unexploded ordnance – H1 (e)
- Establish an interpretative program – H2 (a)
- Implement and operate a volunteer program – H2 (b)
- Protect and stabilize high priority cultural resource sites – H3 (a)
- Deter and remove ungulates from the Reserve – A1 (b)

Table 211. The prioritized 14 objectives and 43 strategic actions.

Summary Table of Goals, Objectives & Strategic Actions	Priority
Goal – Build and Maintain the Reserve's Management (M) Capacity	
Objective M1- Secure and sustain the level of human and financial resources needed	A
Strategic Actions:	
a) Hire a full-time Reserve manager	•
b) Build and maintain staff capacity to meet Reserve needs	•
c) Implement a Reserve sustainable financing plan	•

d) Establish a Reserve user fee program	
e) Empower and strengthen the Advisory Group	
Objective M2- Provide Biological Resource Status Information for Management	B
a) Conduct biological status monitoring of terrestrial resources	
b) Conduct biological status monitoring of aquatic resources	
Objective M3- Provide on-site infrastructure to meet management needs	B
Strategic Actions:	
a) Complete the Reserve's facility and infrastructure planning	
b) Improve and maintain Reserve access gates and roads	
c) Improve and maintain on-site facilities	•
Objective M4- Initiate and maintain strategic partnerships	A
Strategic Actions:	
a) Identify strategic partnership needs under the plan	
b) Recruit partners in support of the plan's implementation	•
Goal 2 – Manage Human (H) Use	
Objective H1- Reduce the negative impacts of visitors and increase safety	A
Strategic Actions:	
a) Manage visitors and access points	•
b) Establish and maintain trails and boundaries	•
c) Effectively enforce use regulations, by zone	
d) Gather relevant information regarding visitor levels and user behavior	
e) Minimize the impacts of unexploded ordnance	
Objective H2- Improve knowledge and promote awareness of the Reserve	B
Strategic Actions:	
a) Establish an interpretive program	•
b) Implement and operate a volunteer program	•
c) Provide cultural information to increase a sense-of-place and awareness of historical significance	
Objective H3- Protect and stabilize cultural resource sites	A
Strategic Actions:	
a) Protect and stabilize high priority cultural resource sites	
b) Inventory all archeological sites found within and adjacent to the Reserve	•
Goal 3 – Control Alien (A) Species and Other Biological Threats	
Objective A1- Control ungulate populations	A
Strategic Actions:	
a) Improve our understanding of ungulate impacts and controls	•
b) Deter and remove ungulates out of the Reserve	
c) Exclude ungulates from entering the Reserve	
Objective A2- Control priority alien plants and animals in terrestrial habitats	B
Strategic Actions:	
a) Remove predatory animals from around priority anchialine pools and seabird nesting areas	
b) Reduce alien plant populations in native habitats	
c) Reduce alien invasive insect populations in native habitats	
d) Prevent new alien introductions	
Objective A3- Control Priority Alien Organisms in Aquatic Habitats	B
Strategic Actions:	
a) Remove non-native fish from coral reefs and anchialine pools	
b) Detect alien algae density and emerging threats on coral reefs and anchialine pools	
c) Investigate the most effective ways to address emerging coral reef threats	

Objective A4- Actively Restore Native Plant and Wildlife Assemblages	C
Strategic Actions:	
a) Replant native species at test sites in anchialine and shrubland habitat	
b) Implement a native habitat restoration plan for the Reserve	
Goal 4 – Prevent Land-based (L) Impacts	
Objective L1- Maintain high coastal water quality	B
Strategic Actions:	
a) Prevent or minimize sources of land-based pollution into Reserve waters	
b) Upgrade sewage systems within and adjacent to the Reserve	
c) Educate neighbors on pollutant impacts and reduction efforts	
d) Monitor water quality for coral reefs within Reserve's waters	
Objective L2- Reduce upland development impacts	C
Strategic Actions:	
a) Designate and prevent development within a Reserve buffer zone	
b) Review and influence progress on proposed development projects	
c) Acquire and hold adjacent lands and infrastructure	
Objective L3- Prevent or minimize manmade light pollution within Reserve boundaries	C
Strategic Actions:	
a) Prevent or minimize sources of manmade light pollution	
b) Educate neighbors on light pollution impacts and reduction efforts	

Objectives are prioritized as A, B, or C (A= highest priority)

- *Top twelve priority actions recommended by the Working Group to be implemented first.*

2.3.1 Goal 1. Build and Maintain the Reserve's Management (M) Capacity

We will build and maintain the human and financial resources, infrastructure, and partnerships, necessary to support the Reserve's capacity to ensure effective site management through time.

Objective M1 – Secure and Sustain the Level of Human and Financial Resources Needed

By 2015, successfully secure all necessary human and financial resources to implement and sustain priority management activities outlined in the management plan.

Strategic Actions

Action M1 (a) – **Hire a full-time Reserve manager. (Priority)**
Tasks include: (i) refill vacant Reserve manager position; review, revise and advertise position, widely recruit the best candidate; and (ii) hire the full-time position by mid-2012.

Action M1 (b) – **Build and maintain staff capacity to meet Reserve needs. (Priority)**
Tasks include: (i) assess responsibilities and duties and make adjustments to expand and increase skills of Rangers, as necessary; (ii) fund and hire a full-time information, education and volunteer coordinator; (iii) ensure staff capacity for writing and managing grants; and (iv) fund and hire a biologist and necessary natural resources staff to implement and manage activities related to native species/habitat management and monitoring; and (v) secure equipment and supplies to meet program needs

Action M1 (c) – **Implement a Reserve sustainable financing plan. (Priority)**
Tasks include: (i) work with the Advisory Group, partner organizations, donors, and the public to implement a sustainable financing plan to achieve financial stability for the Reserve (as detailed in **Section 2.5** of this plan); (ii) plan and secure the necessary sources of annual revenue utilizing a multi-pronged approach (NAR Fund, grants, and fees); (iii) create and grow an endowment mechanism to support the annual costs of the Reserve's management into the future; and (iv) initiate an administrative rule change process to enable the department to collect fees to pay for management.

Action M1 (d) – **Establish a Reserve user fee program.***
Tasks include: (i) building on the sustainable finance section of this plan, best practices (below), and other analysis to establish a parking fee (or other user fee) program to fund a portion of the Reserve's management; (ii) obtain public support for the proposed user fee program through assistance by the Advisory Group, local community partners, and partner organizations; (iii) obtain any state rule changes required; (iv) obtain state and county support for implementation of the user fee program; (v) implement the user fee program and initiate process to collect and manage revenues generated; and (vi) communicate clearly to Reserve visitors what their fees are used for in supporting Reserve management. *NARS rule change is required

Best practices for user fees:

1. Use fee revenues for quality improvements to trails, signs/maps, toilets, and other facilities.
2. Make small fee increases rather than making them in large jumps.
3. Use monies for operational costs rather than as a control mechanism for visitor entry.
4. Retain and use money for specific, known, Reserve purposes, rather than for general revenues.
5. Use extra money for conservation of the area visited.
6. Provide abundant information to the public about the income earned and the actions funded through it. (Eagles et al. 2002)

Action M1 (e) – **Empower and strengthen the Advisory Group.**
Tasks include: (i) continue the Advisory Group meetings to provide a public forum for discussion of management of the Reserve and regional resources and to support plan implementation; and (ii) revisit, revise and improve Advisory Group effectiveness through strategic membership recruitment, and administrative and convening support.

Objective M2- Provide Biological Resource Status Information for Management

By 2015, the state, federal, and supporting partners will have worked together to successfully secure the necessary human and financial resources to survey and obtain current information and periodically monitor the status of all priority biological resources in the Reserve.

Strategic Actions

Action M2 (a) – **Conduct biological status monitoring of terrestrial resources.**
Tasks include: (i) conduct baseline surveys and obtain current data on resource status and health in accordance with restoration plan; (ii) develop monitoring plans for each identified priority species or habitat; (iii) periodically monitor the status and trends of native plant assemblages, invertebrates in lava-tube caves, new lava, anchialine pools, littoral areas, and shrublands; and (iv) monitor

the demography, status and trends of seabirds and waterbirds (inventory and monitoring activities are summarized in **Table 28**).

Action M2 (b) – **Conduct biological status monitoring of aquatic resources.**
Tasks include: (i) conduct baseline surveys and obtain current data on resource status and health; (ii) develop monitoring plan for each identified priority species or habitat (iii) continue DAR and CRAMP at two sites, Kanahena Point and Kanahena Cove, to track status of coral reef health and trends; (iv) continue DAR fish surveys at five sites which includes one integrated fish and benthic survey site within the NAR, and one integrated site within Keoneʻōʻio Bay; fish surveys are conducted three times per year; (v) continue periodic monitoring of marine intertidal areas for ʻopihi, other invertebrates and algae to track status and trends according to establish standards; and (vi) continue periodic monitoring of anchialine aquatic ecosystems for trends and status according to interagency standards (inventory and monitoring activities are summarized in **Table 28**).

Objective M3 – Provide On-Site Infrastructure to Meet Management Needs

Provide the necessary on-site infrastructure to implement priority management activities under the management plan.

Strategic Actions

Action M3(a) – **Complete the Reserve's facility and infrastructure planning.**
Tasks include: (i) by 2013, conduct an assessment of the existing Reserve's facility and infrastructure levels and future needs in order to implement the approved management plan; (ii) by 2014, complete a short-term (2014–2017) and long-term (2017–2027) facilities and infrastructure plan to meet management plan needs (including visitor access controls, visitor facilities provision, interpretive and educational programs, and office and equipment space for on-site operations by Reserve staff), and taking into account neighboring Mākena State Park planning considerations and possible Kanaio Natural Area Reserve expansion efforts; (iii) by 2016, obtain rulemaking agreement and sign-off by state and county authorities to implement short- and long-term facilities and infrastructure plans; and (iv) during 2016, implement plans to build and maintain necessary facilities, infrastructure, and equipment (e.g. vehicles, Ranger equipment, trail maintenance equipment, and digital, radio, and telecommunication).

Action M3(b) – **Improve and maintain Reserve access gates and roads.**
Tasks include: (i) conduct management according to the Memorandum of Agreement (MOA) among state and county authorities on access, maintenance, enforcement, and liability for the single lane road through the Reserve.

Action M3(c) – **Improve and maintain on-site facilities. (Priority)**
Tasks include: (i) as per the short-term plan, improve and maintain Ranger stations and staff office facilities within the Reserve; (ii) install infrastructure to provide the necessary access to digital, radio, and telecommunication needs; (iii) as per the plan, improve and maintain visitor facilities within the Reserve, including parking, lavatories, informational stations and interpretive areas; (iv) as per the plan, improve and maintain waste management facilities for visitors and staff within the Reserve; and (v) implement a waste management awareness and education program for the Reserve's visitors.

Objective M4 – Initiate and Maintain Strategic Partnerships

By 2015, a full suite of federal, state, county, non-government, and community partners will have been recruited and actively engaged in the Reserve's management and financing process.

Strategic Actions

Action M4(a) – **Identify strategic partnership needs under the plan.**
Tasks include: (i) for priority actions, identify how partnership would provide benefits.

Action M4(b) – **Recruit partners in support of the plan's implementation. (Priority)**
Tasks include: (i) identify and recruit partners to implement priority strategic actions.

2.3.2 Goal 2. Manage Human (H) Use

We will manage human uses to protect natural and cultural heritage, and develop appreciation, understanding, and *kuleana* for the Reserve through education and interpretation.

Objective H1 – Reduce the Negative Impacts of Visitors and Increase Safety

By 2014, we will reduce the frequency of negative impacts caused by visitors by half (from 2007 levels) within specified priority natural and cultural (terrestrial and marine) resource areas in the Reserve. A downward trend in such negative impacts will continue through 2015.

Strategic Actions

Action H1 (a) – **Manage visitors and access points. (Priority)**
Tasks include: (i) establish two zones (limited-open and restricted access as seen in **Figure 21**) based on assessment of existing human use data and visitor access and activities in the Reserve; (ii) establish visitor limits on parking capacity at Kanahena parking area;(iii) eliminate roadside parking in the Reserve so that all Reserve visitors go to Kanahena parking area; (iv) assess, improve and maintain appropriate levels of solid and human waste facilities at access points.

Table 222. Reserve access and use summary.

Reserve zoning summary		
Public Access Area	**Restricted Access Area**	**Ocean Area**
Open for snorkeling and nature study during daylight hours	Entry under special use permit, staff led educational hike or service project	Open for nature study during daylight hours; no motorized vessels, no anchoring

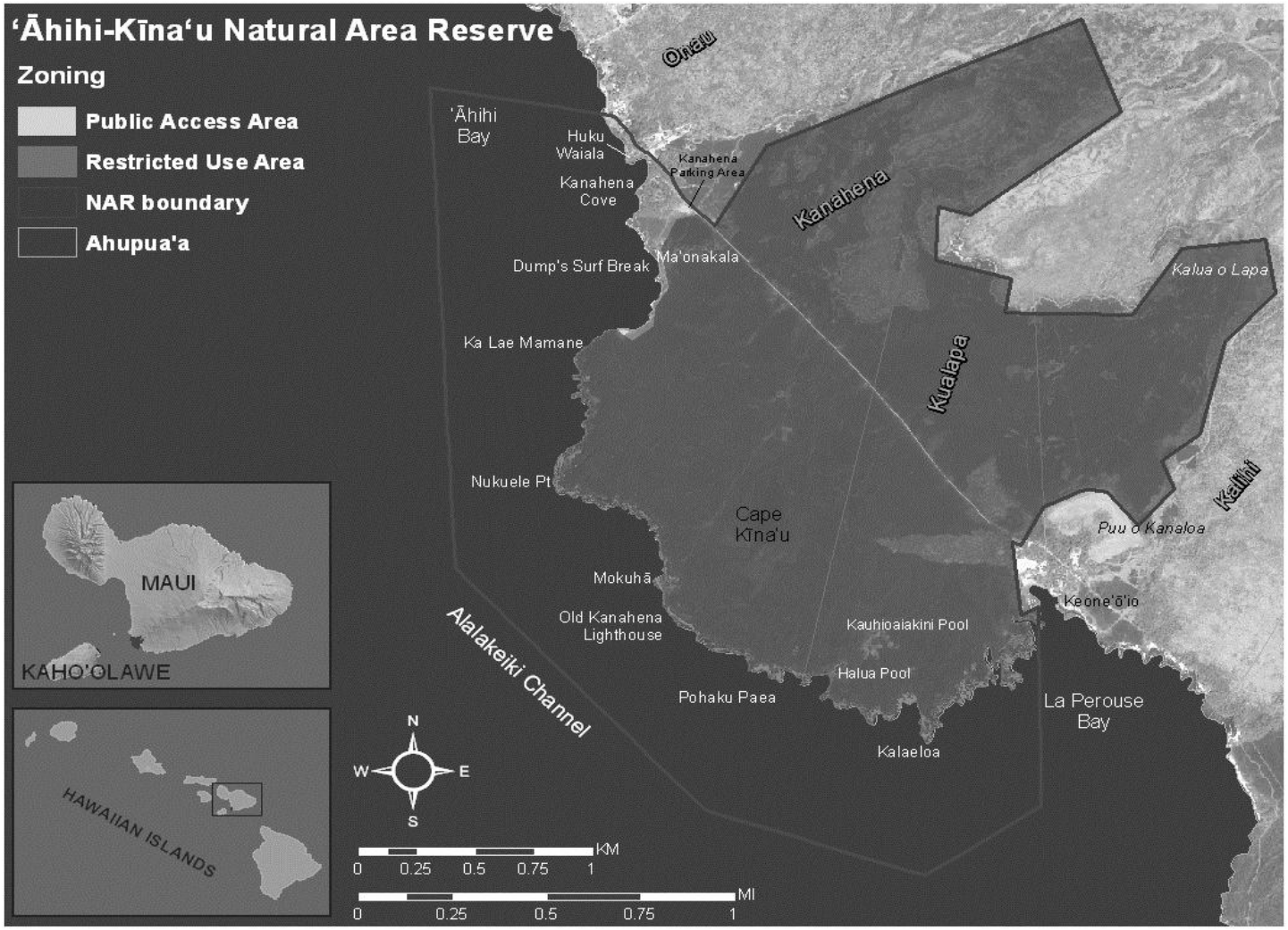

Figure 21. Map of zoning proposed in this plan under Action H1 (a) (map by Stephanie Tom).

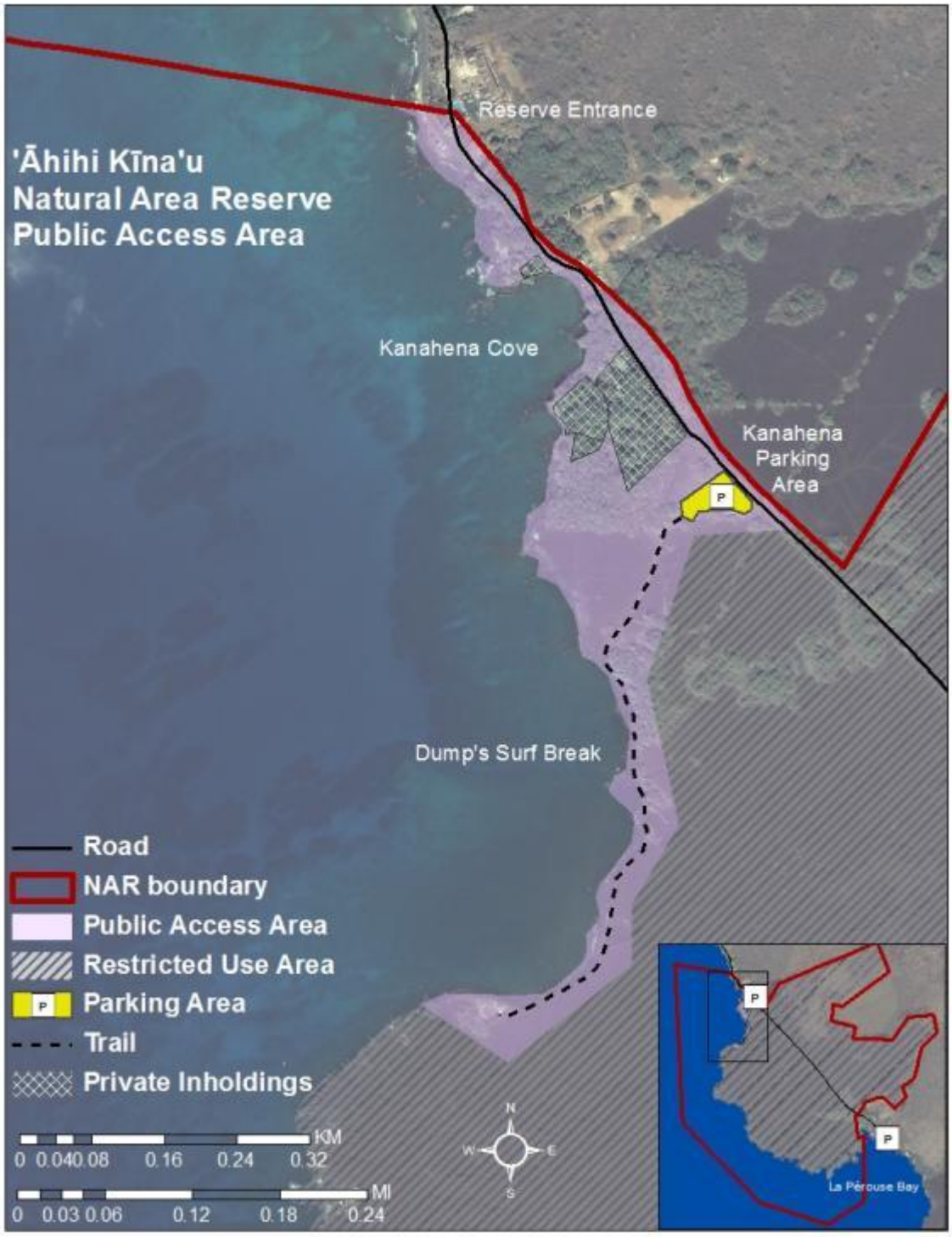

Figure 22. Detail of public access area (map by Roxie Sylva).

Action H1 (b) – **Establish and maintain trails and boundaries. (Priority)**
Tasks include: (i) establish and maintain visitor trails (terrestrial) limited to readily accessible, low-risk areas in the open zone; (ii) in the open zone, establish interpretive areas and informational materials at strategic points; (iii) in the restricted access zone, provide for Ranger guided interpretive hikes along established trails in safe areas; (iv) decrease illegal motorized vessel entry and passage by installation of visible markers on land and sea (e.g. range finders);

(v) establish a marine trail system to direct visitors to enter and exit locations and underwater places that are interesting and will not cause habitat decline; (vi) establish a Working Group of the Advisory Group to assess and review current marine and terrestrial boundary definition and effectiveness; and (vii) as necessary, relevant, and defined, recommend BLNR review and approve the adaptation of Reserve boundaries to maximize management effectiveness.

Action H1 (c) – **Effectively enforce use regulations, by zone.**
Tasks include: (i) in collaboration with DOCARE improve enforcement of Reserve rules and regulations; (ii) review, assess, and propose increases in fines and penalties for violations, as needed; (iii) research feasibility of employing remote sensing and surveillance technologies to document prohibited activities; (iv) gather and compile data on enforcement and compliance to track trends and inform efforts; and (vi) work to enhance enforcement of protected species rules, regulations and laws (e.g. monk seals, turtles, whales, dolphins).

Action H1 (d) – **Gather relevant information regarding visitor levels and user behavior.**
Tasks include: (i) build and improve data collection and monitoring on visitor levels, behaviors, impacts, and relevant user information using accepted methods; and (ii) analyze human use data to improve our understanding of human use trends and inform management decision-making.

Action H1 (e) – **Minimize the impact of unexploded ordnance.**
Tasks include: (i) work closely with the Army Corp of Engineers to determine the risks, hazards and remedial actions required for safety and resource protection.

Objective H2 – Improve Knowledge and Promote Awareness of the Reserve

By 2015 the number of Maui visitors and regional residents who are aware of and have knowledge about the biological and cultural importance of the Reserve will increase 100% from 2007 levels.

Strategic Actions

Action H2 (a) – **Establish an interpretive program.**
Tasks include: (i) develop a professional interpretation and outreach plan which addresses management needs and resource considerations while building a *kuleana* and *mālama ʻāina* ethic for the Reserve among residents and visitors; (ii) utilize professional services to design the interpretive components (themes, messages, content, delivery, etc.) and desired outcomes and behaviors; (iii) utilize this plan as well as the expertise of the Advisory Group, its working groups, subject matter experts and Reserve staff; (iv) improve awareness of biologically- and culturally-appropriate, low-impact visitor behavior through informational materials and a "good stewardship etiquette while visiting" program; (v) provide information and raise visitor awareness of appropriate visitor behavior and cultural resource rules and regulations; and (vi) establish and coordinate Ranger guided interpretive hikes along established trails in safe areas according to recommended best practices below.

Conduct Ranger guided interpretive walks according to these best practices:

1. Staff or docent-led
2. Regular training provided for hike leaders
3. Frequency of visitors are limited so as not to cause harm to resources
4. Designed to be consistent with the primary purposes of a Natural Area Reserve

5. Choose locations and activities for participant safety, what you can teach, resource protection and wildlife uses. Some sensitive areas are not appropriate locations to take groups
6. Educational value will differ with different audiences and reasons why a group or individual might visit an area (e.g visitors/residents, youth/adults). School groups need curriculum-based criteria to meet standards.
7. Start the program small, don't over promise
8. Teach respectful behaviors expected in the NAR
9. Allow enough time to convey educational messages
10. Both the program and the visitor need to have a sense of purpose
11. Establish limits based on location, wildlife, impacts
12. Incorporate Hawaiian culture and history and be culturally appropriate

Action H2 (b) – **Implement and operate a volunteer program. (Priority)**
Tasks include: (i) within the interpretation and outreach, develop a state-of–the-art program to train, supervise, and recognize volunteers that assist in the implementation of program goals, including broadening community support of caring for the natural and cultural resources of the Reserve; (ii) initiate a regular/daily volunteer program to help inform and educate residents and visitors; (iii) initiate an occasional volunteer program to assist in various management activities; and (iv) incorporate service learning opportunities.

Action H2 (c) – **Provide cultural information to increase a sense-of-place and awareness of historical significance.**
Tasks include: (i) conduct a study of available archival sources, including stories, songs, maps, Hawaiian language newspapers, and other historic documents; (ii) interview and document oral histories of lineal descendants with *kuleana* over Reserve lands and other knowledgeable island residents; and (iii) integrate the cultural and historic material into an interpretive program and training for staff and volunteers.

Objective H3 – Protect and Stabilize Cultural Resource Sites

By 2015 we will protect, stabilize, and maintain the integrity of at least three high priority cultural resource sites inside and adjacent to the Reserve.

Strategic Actions

Action H3 (a) – **Protect and stabilize high priority cultural resource sites. (Priority)**
Tasks include: (i) establish a knowledgeable and respected cultural resource Working Group (through the Advisory Group), comprised of cultural practitioners, community leaders, and technical experts (archeologists, historians) to assess the type and level of threats facing archeological sites utilizing the 2007 CRMP; (ii) identify the archeological sites of highest cultural significance based on recommendations made by the Cultural Resource Working Group, based on the assessment; (iii) design and implement an archeological stabilization plan and monitoring to protect high priority cultural resource sites; (iv) initiate management actions specific to site needs; and (v) apply for federal designation of priority cultural resource sites under the Archeological Resources Protection Act.

Action H3 (b) – **Inventory all archeological sites found within and adjacent to the Reserve.**
Tasks include: (i) complete inventory-level survey and recording of all archaeological sites previously undocumented within Reserve boundaries (Archeological Inventory Survey); (ii) detailed mapping and site descriptions of known priority and/or high-visitation archaeological sites within and immediately adjacent to the Reserve, including the Keoneʻōʻio anchialine pool/inlet complex and Maʻonakala Village Complex; (iii) mapping and historic use investigation of anchialine pool and lava tube systems; and (iv) management recommendations made for preservation and monitoring of priority archaeological sites within and immediately adjacent to the Reserve.

2.3.3 Goal 3. Control Alien (A) Species and Other Biological Threats

The native biological community and cultural resource integrity of the Reserve is strengthened and maintained by 2015 as the result of the successful control of alien species and other biological threats in terrestrial and aquatic habitats.

Objective A1 – Control Ungulate Populations

By 2015, we will have reduced the abundance of feral (goats and pigs) and introduced (deer) ungulates from native terrestrial habitat and cultural sites within the Reserve to 80% of their estimated 2010 population sizes.

Strategic Actions

Action A1 (a) – **Improve our understanding of ungulate impacts and controls.**
Tasks include: (i) complete a survey to estimate ungulate (deer, goats, pigs) population and assess habitat use patterns and impacts; (ii) conduct periodic monitoring of ungulate populations and behavior; (iii) identify preferred animal removal techniques and process within DLNR guidelines; (iv) identify sites with high potential for native habitat restoration following use of proposed ungulate controls; assess how existing roads, substrate, stream courses, cultural sites, and other physical factors would influence fence line construction; (v) prepare draft EA, including map of proposed fence line and cost estimate for various fencing scenarios on Tax Map Key boundary on lava; and (vi) share new understanding, EA recommendations, and secure BLNR approval on planned ungulate control (deterrence, removal, and exclusion) process and EA.

Action A1 (b) – **Deter and remove ungulates out of the Reserve. (Priority)**
Tasks include: (i) complete short-term deterrent and removal efforts around impacted priority cultural resource sites within DOFAW guidelines; (ii) based on evaluation of deterrence and removal efforts, assess utility and feasibility of employing these controls on a wider scale throughout the Reserve; (iii) prepare and provide public outreach materials that illustrate the humane nature of ungulate deterrence and removal efforts used; (iv) install fence per EA and Best Management Practices (BMP) for terrain and ungulate types; and (v) following installation of Reserve-wide exclusion fence efforts, remove all ungulates and monitor for any continued ungulate presence within Reserve boundaries.

Action A1 (c) – **Exclude ungulates from entering the Reserve.**
Tasks include: (i) in the short-term, identify representative areas of native forest and shrubland habitat negatively impacted by ungulates within the Reserve; (ii) within two to three high-priority areas of both habitat types, immediately exclude ungulates over the short-term by fencing small enclosures in *mauka* areas. In anchialine pool areas, deter ungulates in other ways, not by fencing (**Figure 23** triangles); (iii) by 2015, permanently exclude all ungulates by installing fence *mauka* of the road in the Reserve boundary/perimeter (**Figure 23** bold black line); and (iv) monitor and maintain perimeter fence line around the Reserve.

Figure 23. Reserve map showing the three high priority sites for immediate habitat restoration through ungulate exclusion and/or removal. Proposed ungulate exclusion fence (described in A1 (a) and A1 (b)): thick outline on *mauka* boundary. Ungulate enclosures for native vegetation – triangles. Immediate ungulate removal in anchialine areas (described in A1 (C): no fence) - oval (map by Stephanie Tom and Roxie Sylva).

Objective A2 – Control Priority Alien Plants and Animals in Terrestrial Habitats

At high-priority native terrestrial habitat restoration sites, by 2015 we will have reduced the population density of top alien invasive plants and animals by at least 50%.

Strategic Actions

Action A2 (a) – **Remove predatory animals from around priority anchialine pools and seabird nesting areas.**

Tasks include: (i) for this action, work closely with DOFAW's Maui non-game biologists to initiate a program to periodically trap, remove, and deter predators (e.g. rats, mice, mongoose, cats, dogs) that prey on the eggs, young, and adults of native waterbird populations that nest on/use anchialine pool habitats (including Kauhioaiakini); (ii) set-up a program to intercept and remove predators starting each year just before the breeding season (March) and continuing through August (or when the last chicks have fledged); (iii) monitor the effects of reduced predators on native waterbird populations and nesting areas, monitor predator activity, bird demography and breeding success; (iv) control and maintain low to no levels of predatory mammal presence at high-priority anchialine pool sites; (v) survey to determine presence/absence and location of nesting seabirds, automated vocalization recording devices should augment the studies, and specific management strategies should be based on results of studies; (vi) based on evaluation of removal efforts for anchialine and coastal areas, assess utility and feasibility of employing these controls on a wider scale and/or throughout other habitat types (native forest and shrubland) in the Reserve; and (vii) prepare and provide public outreach materials that illustrate the humane nature of predator removal efforts used and benefits to native species.

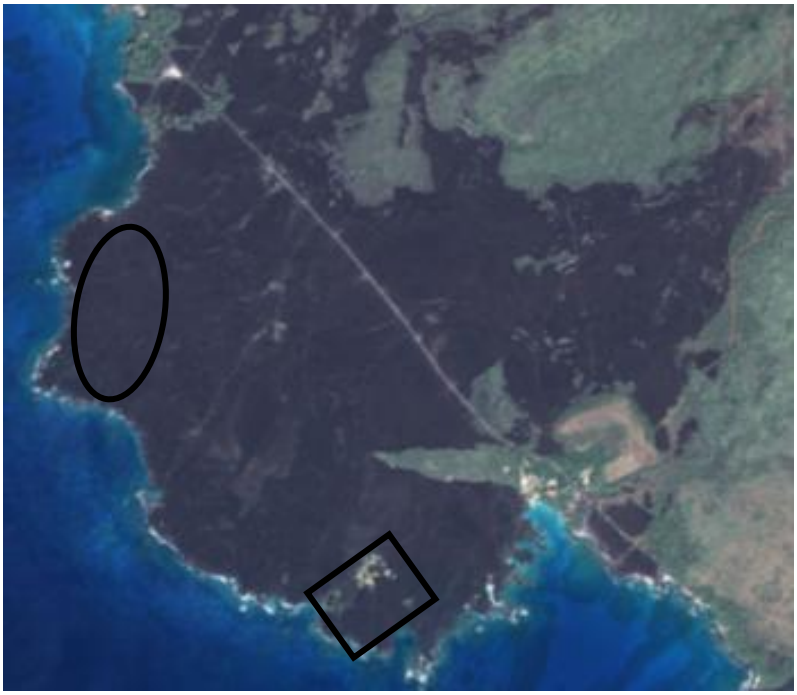

Figure 24. Reserve map showing habitat restoration areas for native waterbirds and seasonal migratory birds (square) and seabirds which are expected to but not currently nesting (oval) (map by Roxie Sylva).

Action A2 (b) – **Reduce alien plant populations in native habitats.**
Tasks include: (i) initiate a program to remove invasive plant species in three representative areas of high-priority lava flow or shrubland habitat needing active restoration (identified also in **Actions A1 (c)**, **A4 (a)**, and **Figure 23**); (ii) maintain anchialine pool aquatic community integrity through the careful removal of alien invasive sourbush, sour grass, pickle weed, mangrove, and indigenous woody plants such as Milo from and around pools and completely remove alien vegetation from site so as not to provide habitat for alien insects and rodents; (iii) monitor and control recruitment of invasive seedlings through time; and (iv) develop and explore effective

methods for landscape monitoring of vegetation structure and composition in lava flow, shrublands, and anchialine areas of the Reserve.

Action A2 (c) – **Reduce alien invasive insect populations in native habitats.**
Tasks include: (i) monitor effects of bio-control on alien invasive gall wasps and on *wiliwili* trees in native forest and shrubland habitat within the Reserve; (ii) establish and specific management strategies based on results of studies; and (iii) conduct baseline inventory to document presence/absence of other harmful alien invertebrates.

Action A2 (d) – **Prevent new alien introductions.**
Tasks include: (i) establish a mechanism for rapid response to eliminate new introductions at the incipient species level; and (ii) continue to identify other high priority alien or other biological threats for early detection and further study using Maui Invasive Species Committee priority species determinations. These are reviewed as needs/discoveries arise and tied to incipient species which are most economically and efficiently controlled.

Objective A3 – Control Priority Alien Organisms in Aquatic Habitats

Within coral reef and anchialine pool habitat in the Reserve, by 2015 we will have reduced the population density of the priority alien fish and aquatic plant species by at least 50%.

Strategic Actions

Action A3 (a) – **Remove non-native fish from coral reefs and anchialine pools.**
Tasks include: (i) initiate a program to remove alien invasive roi (*cephalopholis argus*) within a designated removal zone (to be determined) on coral reef habitat within the Reserve together with adequate data collection methods; (ii) monitor and maintain suppression of resident roi population to low or no individuals within the removal zone through time; (iii) quantify effects of roi removal to inform future management action to be taken in the Reserve; and (iv) initiate a capture and relocation program to remove any introduced marine and brackish water fish species from anchialine pools and relocate them to adjacent reef areas or other appropriate action as necessary.

Action A3 (b) – **Detect alien algae density and emerging threats on coral reefs and anchialine pools.**
Tasks include: (i) conduct periodic monitoring of marine intertidal areas for alien algae according to interagency standards for early detection; (ii) conduct periodic monitoring of anchialine aquatic ecosystems according to interagency standards for early detection of the spread of alien invasive plant and animal species, as well as other changes, and to provide information for trends and for comparison to other pool sites in Hawaiʻi; (iii) conduct periodic monitoring for coral bleaching and disease, crown-of-thorns sea stars and marine invasive species in accordance with interagency standards; (iv) coordinate rapid response to identified threats with appropriate agencies and partners; and (v) continue to identify other high priority marine threats for early detection and further study.

Action A3 (c) **– Investigate the most effective ways to address emerging coral reef threats.**
Tasks include: (i) monitor trends and status of coral disease, coral bleaching, reef fish disease, and (native) crown-of-thorns sea stars' population blooms within the Reserve; (ii) explore ways to address threats with experts.

Objective A4 – Actively Restore Native Plant and Wildlife Assemblages

By 2015, we will have successfully implemented a native habitat restoration plan for the Reserve that results in the restoration of at least 5 acres within both native shrubland and lava flow habitats.

Strategic Actions

Action A4 (a) – **Replant native species at test sites in anchialine and shrubland habitat.**
Tasks include: (i) identify three representative areas of high-priority native habitat needing active restoration (same sites as identified in **Actions A1 (c)**, **A2 (b)**, and **Figure 23;** requires ungulate removal); (ii) within these priority test sites, initiate a program to replant native plants and reestablish a native plant assemblage with a species composition and diversity of native plants that best reflects a native community, based on best available information and expert opinion; (iii) monitor and document survivorship rates, species diversity, and other details observed for restored native plant assemblages at these sites; and (iv) maintain restored native plant assemblages and remove alien invasive plant recruits from test sites.

Action A4 (b) – **Implement a native habitat restoration plan for the Reserve.**
Tasks include: (i) conduct a survey to characterize the status of native plants, native invertebrates and native wildlife within the Reserve (including spatial extent) and compare results to 1989 baseline survey; (ii) develop a native shrubland and lava flow habitat restoration plan, incorporating lessons from native ecosystem restoration efforts at priority representative sites; (iii) manage for seabirds when appropriate findings are made according to the Maui Endangered Seabird Project BMP; (iv) implement the restoration plan where relevant within the Reserve; (v) monitor restored native plant assemblages, remove alien invasive plant recruits, and maintain ungulate free reserve; and (vi) conduct research on historical trends regarding biotic and climatic changes within the region and study regional analog ecosystems that provide a window into the past.

2.3.4 Goal 4. Prevent Land-based (L) Impacts

We will successfully control and prevent land-based impacts from source areas within, adjacent to and upland of the Reserve from having any significant, negative impact on the habitats, wildlife, and scenic resources found in the Reserve.

Objective L1 – Maintain High Coastal Water Quality

By 2015, coastal water quality within the Reserve will meet or exceed state standards for Class AA waters.

Strategic Actions

Action L1 (a) – **Prevent or minimize sources of land-based pollution into Reserve waters.**
Tasks include: (i) assess and identify primary point and non-point source contributions of land-based pollution into the Reserve waters, including nutrient loading and soil erosion from up-slope development; (ii) review and choose appropriate BMP to be employed within and adjacent to the Reserve to prevent or minimize these sources; and (iii) implement BMPs to address pollutant sources.

Action L1 (b) – **Upgrade sewage systems within and adjacent to the Reserve.**
Tasks include: (i) characterize nature of current sewage holdings and systems; (ii) upgrade existing cesspools to septic tank systems as necessary; (iii) maintain visitor restroom facilities and sewage systems in an environmentally responsible manner; and (iv) explore possible use of alternative sewage system technologies for application within the Reserve.

Action L1 (c) – **Educate neighbors on pollutant impacts and reduction efforts.**
Tasks include: (i) develop and disseminate outreach products for neighbors and residents upland of Class AA waters with relevant messages about reducing pollutant and nutrient loads on landscape, upgrading sewage systems, and other efforts to minimize pollution; (ii) use neighbor outreach opportunity to educate about planting non-invasive plants, and preferably coastal and dry forest native plants on their properties to reduce the chance of new invasive plant or pest introductions to the Reserve.

Action L1 (d) – **Monitor water quality for coral reefs within the Reserve's waters.**
Tasks include: (i) conduct periodic water quality monitoring at sampling stations in the Reserve waters; (ii) initiate a community volunteer water quality monitoring program; and (iii) conduct periodic marine debris removal along the Reserve coastline with volunteers.

Objective L2 – Reduce Upland Development Impacts

By 2015, negative upland development impacts on the Reserve's natural and cultural resources will be largely reduced or fully mitigated through the use of various strategies to restrict or mitigate land use.

Strategic Actions

Action L2 (a) – **Designate and prevent development within a Reserve buffer zone.**
Tasks include: (i) Review, amend, or establish BMP for land use practices within the lands adjacent to the Reserve's boundaries; (ii) assess the land ownership interests within a 1-mile radius surrounding the Reserve's boundaries by Tax Map Key and land use zoning status (**Figure 25**); (iii) prioritize land management actions according to proximity, feasibility, and potential for impact to resources; (iv) design and propose an approximately 1-mile buffer zone surrounding the Reserve's boundaries within which land development activities are minimized and seek to have this accepted and approved by county and state authorities; (v) where possible, purchase, seek conservation easements on, or rezone lands encompassed within proposed 1-mile buffer zone; and (vi) work with state and county authorities to ensure a high level of scrutiny on Special Management Area permit applications in the buffer zone.

Action L2 (b) – **Review and influence progress on proposed development projects.**
Tasks include: (i) utilize and strengthen existing state and county development project permit review and approval processes in order to be notified about and comment on planned development efforts on lands neighboring the Reserve in a timely manner; and (ii) contribute to the development of a permit review process so that planned development within neighboring properties is conducted in a manner that maintains the cultural and ecological integrity of the Reserve's resources while adhering to conservation and agricultural land zoning requirements and building codes.

Action L2 (c) – **Acquire and hold adjacent lands and infrastructure.**
Tasks include: (i) seek the support of the NARS Commission and BLNR to advocate for NAR addition or expansion into eligible adjacent lands; (ii) through purchase, trade, and/or conservation easements, acquire and hold lands important to the Reserve in order to prevent development from occurring; and (iii) begin discussions with landowners within the Reserve to acquire in-holdings, and with owners of infrastructure (e.g. electric lines) about the possible return to a more natural state over time.

Objective L3 – Prevent or Minimize Manmade Light Pollution Within Reserve Boundaries

By 2015, nighttime light levels within the Reserve will not exceed naturally-occurring levels so as to prevent alteration or disruption of native wildlife nocturnal behavior.

Strategic Actions

Action L3 (a) – **Prevent or minimize sources of manmade light pollution.**
Tasks include: (i) determine natural ambient light levels at night within Reserve boundaries and if those levels exceed county lighting ordnances; (ii) assess and identify primary sources of light pollution that contribute to altered/elevated ambient light levels; (iii) implement BMP that prevent or minimize light sources exceeding natural ambient light levels at night within Reserve boundaries; and (iv) monitor and maintain ambient light levels within the Reserve at near or naturally-occurring levels at night.

Action L3 (b) – **Educate neighbors on light pollution impacts and reduction efforts.**
Tasks include: (i) develop and disseminate outreach products for neighbors with relevant messages about the need for reducing light pollution to naturally-occurring ambient light levels at night, and how to take local actions to do so (i.e. shielding lights).

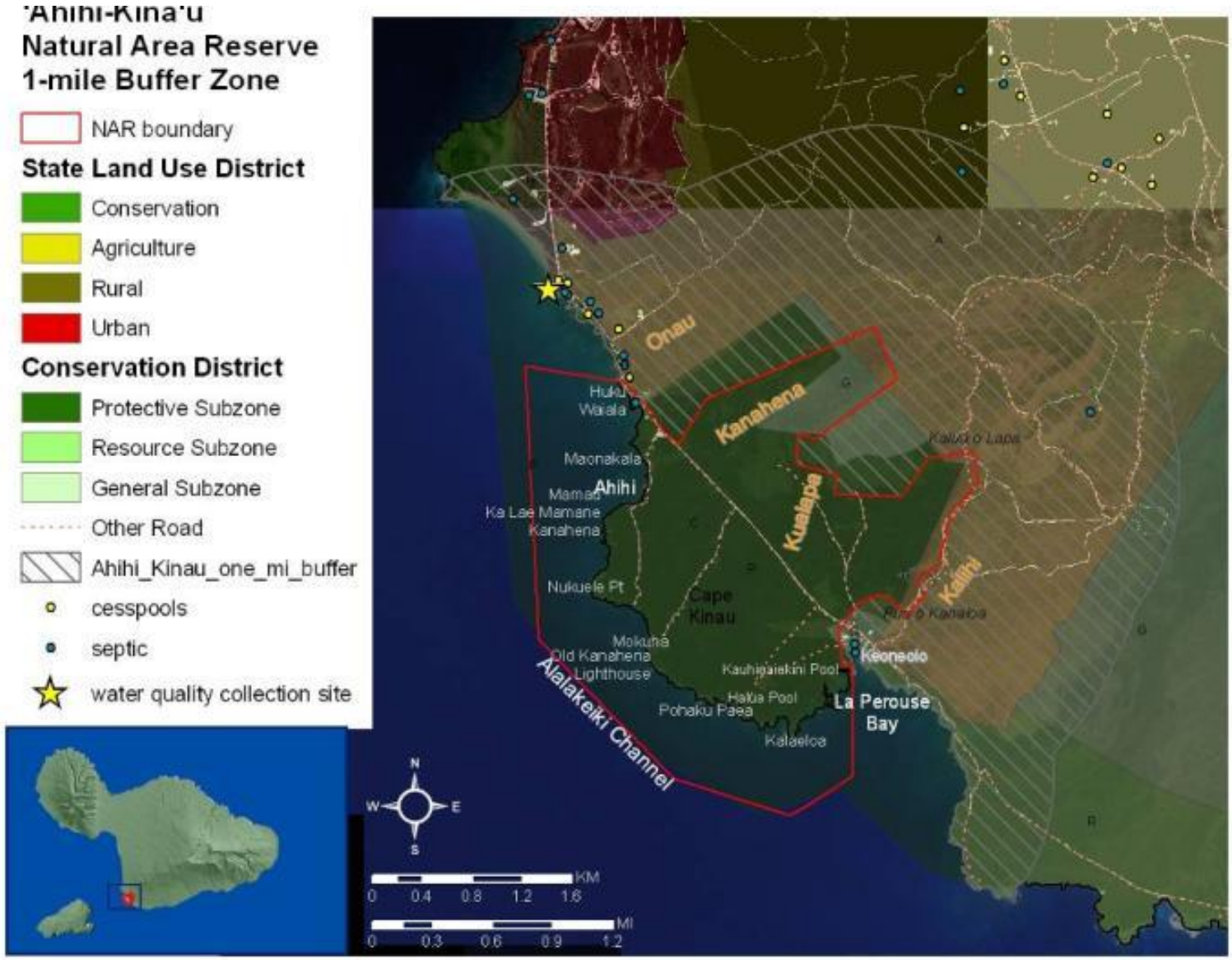

Figure 25. A one mile buffer around the Reserve and associated state land use districts (map by Stephanie Tom).

2.3.5 Strategic Courses of Action and Use of Results Chains

a) Strategies employed in the conservation of Reserve resources

The objectives and actions listed under each of the four goals follow standard strategies used in conservation action throughout the world. In fact, each of the 14 objectives and 43 actions to address threats can be distilled down to the seven strategy categories listed in **Table 23**.

b) Results Chains

A Results Chain is a simple method used to help clarify our beliefs about how conservation strategies contribute to reducing threats and achieving the conservation of specific targets. This tool provides a way to visualize how the strategic actions lead to the outcomes that were identified in the goals and objectives.

Results Chains define how we think a project strategy or activity is going to contribute to reducing a threat and conserving a target. It focuses on the achievement of results, not the execution of activities. Importantly, it is composed of assumptions that can be tested, indicators of success and time-frames.

Provided in the **Appendix** are four priority Results Chains for the strategies of education (EDU), enforcement (ENF), extraction (EXT), and zoning (ZON).

1. Results Chain for the strategy of Education (EDU) to address recreation (REC) and management capacity (CAP) needs (**Figure 28**).
2. Results Chain for the strategy of enforcement (ENF) to address recreational (REC) and illegal harvest (HRV) threats (**Figure 29**).
3. Results Chain for the strategy of extraction (EXT) of alien or invasive (INV) to address threats of resource degradation (DEG) and pollution (POL) (**Figure 30**).
4. Results Chain for the strategy of zoning (ZON) to address threats from recreation (REC) and resource degradation (DEG) (**Figure 31**).

Table 23. Summary of Results Chains strategies and its relationship to objectives, actions, and threats.

Strategy	Related Objectives	Priority Actions	Threats Addressed
Zoning (ZON)	M3, H1, L2	M3b,H1a, H1b, H1c, L2a	Recreation Degradation
Enforcement (ENF)	H1, H2	H1b, H1c, H2b	Recreation Harvest
Education (EDU)	M3, H1, H2, A1, A2, L1, L3	M3a,H1b, H1c, H2a, H2b, H2c, A1b, A2a, L1c, L3b	Recreation Capacity Invasive
Extraction (EXT)	A1, A2, A3	A1a, A1b, A1c, A2a, A2b, A2c, A3a	Invasive Degradation Pollution
Development (DEV)	L1, L2, L3	L1a, L1c, L2a, L2b, L2c, L3a	Pollution
Restoration (RST)	M2, H3, A1, A2, A3, A4, L1, L3	M2a, M2b, H3a, A1a, A1b, A1c, A2a, A2b, A2c, A2d, A3a, A3b, A3c, A4a, A4b, L1d, L3a	Degradation Invasive Pollution
Management (MGT)	M1, M2, M3, M4, H1, H2, H3, L1, L2	M1a, M1b, M1c, M1d, M1e, M1f, M2a, M2b, M3a, M3b, M3c, M4a, M4b, H1a, H1d, H2a, H2b, H3a, L1a, L1b, L2a	Pollution Capacity

2.4 Measuring Success

a) Introduction

Measuring the results of our management efforts allows us to determine whether we are making progress relative to our desired results and are adapting our actions to successfully address changing conditions within the land- and seascape.

Objectively measuring and honestly reporting on the degree of our success also enhances public trust and our relationship with partners and the Maui community. Therefore, our measures must be designed to enhance our accountability, credibility, and transparency with the public in order to ensure long-term support and return-on-investment. These measures will also serve as the foundation for an improved understanding of what management actions work best under various conditions. Such information will in turn allow for improved decision-making and adaptation of management efforts.

In order to evaluate the level of our success in managing the Reserve, two sets of measures have been identified within this plan:

1) Effectiveness measures – intended to help us understand whether or not our management actions are achieving their desired/intended results; and
2) Status measures – intended to help us understand what the state of our priority natural and cultural resources is through time, and whether or not there are observable changes occurring.

Effectiveness measures will be periodically used to gauge the level of achievement made toward each management objective through time. The language used within the description of each objective alludes to the requirements needing to be met for that objective to be fully achieved. The number and type of associated effectiveness measures varies with the complexity, risk, and uncertainty associated with the objective in question. **Table 24** shows strategy effectiveness indicators.

Status measures are directly linked to priority resources targeted for conservation, in relation to the key ecological attributes of our conservation targets, and the priority threats we plan to abate. A status for each of the target resources has been set, and in tracking status assessment measures, we aim to increase our understanding of how to move condition of targets from “good” or “poor” to “very good” or “good” viability ranking. **Table 25** shows status assessment indicators per conservation target. More indicators are shown in the Results Chains (see **Figures 28-31**).

b) Methodology

Accepted biological and social survey methods will be employed in the monitoring of effectiveness and status measures. Specific survey instruments and methods used will be developed and implemented under collaboration with and guidance from state biologists, scientific experts, and technical partner organizations.

Baseline data collection of status and effectiveness measures is to be conducted during 2010 and 2011. In some cases, data already exists for certain status measures relating to specific target resources. Such secondary sources of information will be used as historic information to augment baseline survey efforts conducted. Where similar survey methods have been used, this may allow for a level of comparability and integration of secondary data into Reserve baseline studies, as applicable (e.g. reliability of data assured; adequate sample size provided).

The periodic measurement of effectiveness and status measures will commence in 2012. Frequency of data collection beyond baseline survey will be dependent upon survey methods used and difficulty of measurement (logistically, financially, and practically). For example, in some cases, data for status measures may only be collected every few years or semi-annually. In other cases, some effectiveness measures may be collected monthly or even daily. The methods for and frequency of data collection and the responsible party(ies) involved in data collection will be identified in the implementation of this plan.

c) Evaluation

A formal evaluation of the Reserve's management effectiveness will be completed five years from the time the plan begins implementation, pursuant with the approved goals and objectives. The results of this evaluation will be published and provided to the public, particularly with the Reserve's partners, stakeholders, and community interest groups. Management partners will use evaluation results to assess overall performance, make necessary adjustments in resource allocations and management activities, and adapt to changing conditions or threats on site. Adaptations made to management actions will be done in support of any observed improvements and/or maintenance of the viability of priority resource targets.

d) Summary of inventory and monitoring tasks

Inventory and monitoring actions for conservation targets are included within the strategic actions. The inventory and monitoring **Table 28** in the **Appendix** summarizes the inventory and monitoring related tasks under each strategic action from **Section 2.3**. Many of these baseline inventory or monitoring actions address the status measures/indicators that are listed by conservation target in **Table 25**. Data collected for status indicators can help managers know if they are meeting the objectives and increasing the viability of resources, thereby providing information for improved management.

Table 24. Strategy effectiveness indicators by objective.

Actions we are taking to achieve the desired results:	
Objectives	**Indicators**
Objective H1- Reduce the negative impacts of visitors and increase safety	-Reduced frequency of negative visitor impacts -Number of parking stalls provided for visitors -Number of cars allowed entry into NAR, by day -Number of visitors observed within open areas, per day sampled -Number of visitors observed in sensitive areas, per day sampled -Level of reported frustration from traffic congestion by visitors -Level of average visitor understanding of rules and issues in Reserve -Number of total Reserve volunteer labor hours per month -Ratio of number of citations and/or warnings given per month against number of observed violators per month; number of cases brought to trial per year; number of prosecutions per year; annual fine revenue generated from violations -Number of illegal harvest observations per month, per impact category
Objective H2- Improve knowledge and promote awareness of the Reserve	-Number of visitors briefed on interpretive walks; average proportion of visitor receipt of materials and review of signs -Level of observed visitor compliance with low-impact guidelines -Level of congruence between visitor attitudes and behaviors and management goals
Objective H3- Protect and stabilize cultural resource sites	-Frequency of removal or disturbance of rock walls, formations, and other structures
Objective M1- Secure and sustain the level of human and financial resources needed	-Level of public participation in local management -Amount of allocated annual management budget by State of Hawaiʻi government; total annual revenues; number of unfunded activities/initiatives per month
Objective M2- Provide biological resource status information for management	-Status monitoring conducted
Objective M3- Provide on-site infrastructure to meet management needs	-Infrastructure maintained; meets management needs
Objective M4- Initiate and maintain strategic partnerships	-Partnerships maintained; meets management needs
Objective A1- Control ungulate populations	-Relative abundance of invasive ungulates per unit area - Invasive ungulates removed per unit area per removal event
Objective A2- Control priority alien invasive plants and animals in terrestrial habitats	-Number of invasive organisms per unit area; geographic extent of invasive species; invasive biomass removed per unit area per removal event
Objective A3- Control priority alien invasive organisms in aquatic habitats	-Number of native bird fledglings per sensitive area -Species diversity; number of native versus invasive fish observed
Objective A4- Actively restore native plant and wildlife assemblages	-Geographic extent of native habitat: presence/absence of native flora and fauna per unit area per sensitive habitat type
Objective L1- Maintain high coastal water quality	-Levels of fecal bacteria, nitrates, phosphorus, dissolved oxygen/biochemical oxygen demand, conductivity, turbidity, temperature, total solids, and toxics in nearshore ocean waters
Objective L2- Reduce upland development impacts	-Density of development surrounding Reserve -Distance of new development from Reserve boundaries
Objective L3- Prevent or minimize manmade light pollution within boundaries	-Nighttime levels and location of artificial light

Table 25. Status assessment indicators by target.

How is the general status of the project changing?	
Target	**Indicators**
Anchialine Pool	-Abundance of migratory birds and/or native water birds -Nesting success of *ae'o* or Hawaiian stilt -Presence, abundance, & distribution of *Caridean* shrimp across the pool groups -Composition of plant species around pools -Quality & quantity of algal & bacterial species -Presence/absence of alien aquatic species -Water quality parameters: Salinity, temperature, nitrogen, & phosphorus
Coastal Marine	-Percent coral cover/prevalence coral disease -Structure of community assemblage of intertidal organisms (algae & invertebrates) -Community structure of mobile subtidal reef species in sheltered embayments (abundance, diversity & biomass) -Benthic community structure of coral, coralline algae, algae, & other sessile invertebrates
Coral Reef Ecosystem	-Percent coral cover/prevalence coral disease -Benthic community structure of coral, coralline algae, algae, & other sessile invertebrates -Community structure of mobile subtidal reef fish, marine reptiles, invertebrates, & highly mobile fish species (abundance, diversity, & biomass) -Use patterns & behavior of Hawaiian monk seal, Spinner dolphins, Green & Hawksbill turtles -Number of turtles resting at Mokuhā beach -Presence & abundance of alien or invasive species & displacement of native communities -Levels of sedimentation, nutrients, & pollutants
Cultural Landscape	-Changes in condition of cultural and historic sites -Use and knowledge of place names, culturally important sites, and history of place -Documentation of archeological, cultural, and historic sites and features
Lava Flow	-Presence and location of nesting seabirds -Disturbance of flow features, caves, and other features -Extent and status of native littoral invertebrates -Extent and status of native cave and new lava aeolian invertebrates -Levels of use of lava flow and associated habitats by endangered species- the Hawaiian Hoary Bat, Hawaiian Petrel, Band-rumped Storm Petrel
Native Shrubland	-Forest stand structure and reproductive success of *wiliwili* -Extent and status of native insects and arthropods -Diversity and trend status of native plant assemblages -Extent of native plant assemblage -Restoration of native plant assemblages
Wilderness Qualities	-Overall visitor and car counts in the Reserve -Behavioral patterns of flagship species -Reported level of satisfaction by visitors -Existence value -Level of anthropogenic sources of night light -Reported presence/absence of mechanical air or sea vehicles -Contiguous viewscapes of geologic features -Level of conguence between visitor attitudes and behaviors and management goals -Decible levels at visitor areas -Awareness of other human presence in the area

2.5 Sustainable Finance

a) Introduction

The purpose of this section is to gain a better understanding of the financial needs of the Reserve and to introduce several options for increased and sustainable funding. First, this section provides a clear picture of the current and future financial requirements for managing the Reserve, explains the updated budgets, and explores feasible financing mechanisms that will help generate revenues for the Reserve so that it can augment its funding from the State. **It is important to emphasize here that the goal is not to run the NAR as a money-making enterprise or a business for profit's sake. Rather, the primary goal of this sustainable finance plan is to identify what the funding shortfalls are under different management scenarios and then raise enough reliable money to support the Reserve's conservation and management costs.** Raising the necessary funds for conservation management will enable NARS staff to protect and maintain the Reserve's unique natural attributes so that they can be enjoyed by Hawai'i's residents and its visitors well into the future.

b) Historical operating budget and Reserve management

During the period between 1985 and 2010, the Reserve's staff roster grew from one-quarter to six full-time employees. The Reserve was able to hire staff to carry out its mandate by using NAR funds and a 4-year Hawaii Tourism Authority (HTA) grant. The past few years, however, have seen a dramatic decrease in both funding sources due to State revenue shortfalls and the completion of the HTA grant. The Reserve lost more than half of its staff between 2010 and 2012 due to a variety of factors. Given the economic crisis that started in 2008, and the number of visitors to the Reserve, the need for stable and reliable funding is all the more critical and requires Reserve managers to consider revenue generation to augment its State funding (**Figure 26**). The aim of this plan is to identify the management costs and stabilize income for operational management of the Reserve by exploring new ways to generate revenues.

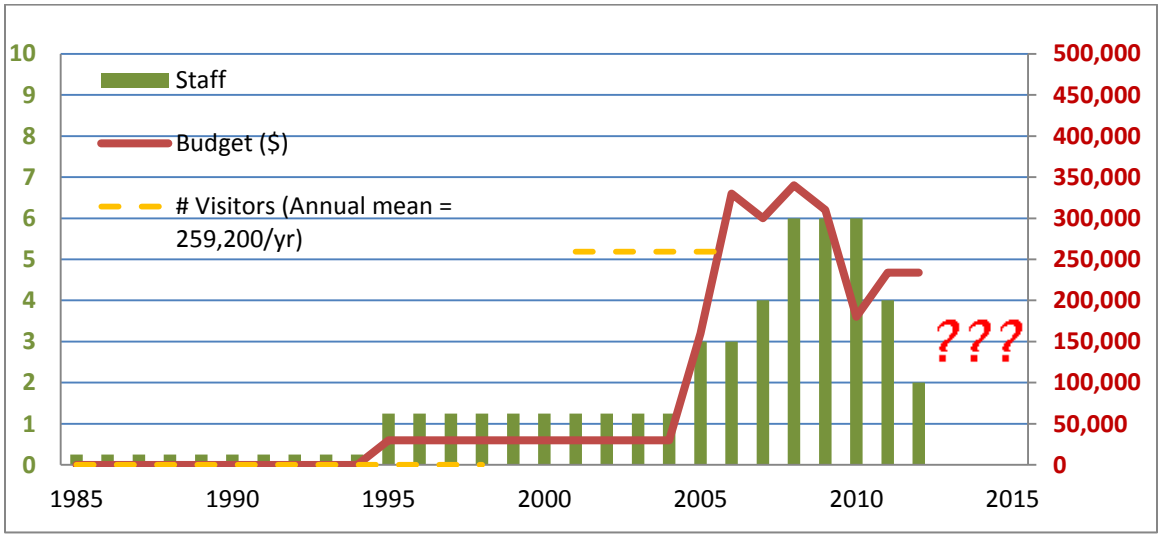

Figure 26. Visitor numbers, staffing and operating budget from 1985-2012.

c) Protected areas and sustainable funding

From data was collected from the mid 2000's, about quarter million visitors per year drove through or visited the Reserve per year (CSV Consultants and HWF 2007). Based on a daily average, about two thirds of those visitors use the Public Access Area (NARS unpublished data). There are many examples from around the world of protected areas successfully using various funding mechanisms to cover operational costs necessitated by this level of use (Hawaiʻi, USA, Australia, Belize, Costa Rica, Kenya, Palau and the Philippines to name a few). Ensuring that tourism follows a sustainable path and that it contributes to sustainable management of protected areas requires concrete partnerships and enhanced collaboration across sectors, including the tourism industry, government at all levels, protected area managers and planners, and the visitors themselves.

One way the tourism sector can contribute to help cover the costs of management is through fees. For example, fees that are used in Hawaiʻi and protected areas worldwide include: entrance, recreation, user, and concession fees, as well as merchandise sales, taxes, license, permits, and private donations. The bottom line is that government funding is currently insufficient and managers must try feasible mechanisms to generate the necessary revenues to support management and conservation. For example, visitors to the Reserve can help the sustainable management of the Reserve by sharing some of the costs of operations and maintenance through user fees. Results from a willingness to pay survey conducted on Maui show that most respondents were happy to pay $5 and contribute it towards marine conservation (Bernard 2003). Experience from around the world also shows that the willingness to pay by visitors to special places is quite high. The Reserve needs only to tap into this ready source of funding to help support the costs of managing the Reserve.

d) Use of fees as a sustainable finance mechanism

Fees have been used to raise funds for site management where visitor use is high in several Hawaiʻi areas, including Hanauma Bay Nature Preserve, Haleakalā and Hawaiʻi Volcanoes National Parks, Diamond Head, Pali, and ʻIao State Parks, Na Ala Hele Trails (per–person for commercial operators on certain designated trails only), and soon at the Mokulua Islands State Wildlife Sanctuary (per–person for guided kayak tours by commercial operators, other fees apply for larger boats). Fees range from $3 per person to $10 per car. Hawaiʻi residents are exempt from these fees at some locations like Hanauma Bay. Collection of a fee in the NAR would require an administrative rule change process that typically takes 18-24 months. Even with these local and worldwide precedents, fees can encounter a less than enthusiastic response if not rolled out properly. Guidelines on encouraging public support for user fees include:

1. Use fee revenues for quality improvements to trails, signs/maps, toilets, and other facilities;
2. Make small fee increases rather than making them in large jumps;
3. Use monies for operational costs rather than as a control mechanism for visitor entry;
4. Retain and use money for specific, known, Reserve purposes, rather than for general revenues;
5. Use extra money for conservation of the area visited; and

6. Provide abundant information to the public about the income earned and the actions funded through it. (Eagles et al. 2002)

When done right and with enough lead-time and education given to the various stakeholders, user fees and donations are good, steady sources of revenue to help fill the funding gaps in protected areas. The management plan Working Group strongly supports a sustainable finance mechanism for the Reserve, such as the collection of a parking fee (Hawaiʻi residents exempted). Collected funds should stay on-site and be used for management of the Reserve. The financial analysis of these ideas show that revenues could be generated from implementing a parking fee and would help in meeting the management costs of the Reserve.

For entry fee collection, in-house management is strongly preferred. However, it may need to be managed through a concession as it may be too resource intensive to manage in-house.

Examples of staff required to manage entry fees include:

- Hanauma Bay has thirteen staff operating cashier booths for entry fees
- Haleakalā has seven staff and a machine for entry fee collection

e) Operating budget

In order to know how much money to raise, managers must first know how much it takes to operate and effectively manage the Reserve for the next 5 years. Once these basic, essential figures are identified, this section explores expanding the fundraising efforts so that enhanced conservation management scenarios can be considered and funded. **It is worth re-emphasizing here that the primary purpose of generating funds is for the management, preservation and protection of the Reserve.** This, in addition to the principles of carrying capacity and respect for this special place should, above all else, remain paramount in considering any revenue generating ideas. There are many cases where visitor management and maximizing revenues become the primary goals of management and sadly, the protected area deteriorates because it is overused and "loved to death." Hence, the need for this management plan that includes visitor education, enforcement and limiting the impacts of visitors' activities at the Reserve. To follow are descriptions of what the different management scenario budgets include. A more detailed description of the objectives and strategic actions can be found in **Section 2.3** and a summary in **Table 21**.

f) Basic management scenario

To manage the Reserve at its most basic level, approximately $400,000 a year is needed for the next 5 years. This is the absolute minimum required to manage a Reserve of this size, popularity and usage. Anything less than this barebones budget would cause the Reserve to be ineffectively managed and slip into deterioration due to lack of staff capacity and financial resources. The budget for this scenario includes salaries and benefits for a manager, a volunteer coordinator, four Rangers, parking area improvements, portable toilets, solid waste management, environmental analyses, vehicle maintenance and replacement costs, operations equipment, and supplies. This is the baseline to which other scenarios are added.

g) Enhanced management scenario

In addition to the base costs above, the moderate management scenario includes additional conservation and management activities that preserve and enhance the biodiversity, cultural and wilderness values of the Reserve. Under this scenario, several key objectives and strategies are funded including: information and interpretation programs, enhanced enforcement, protection and stabilization of priority cultural resource sites, control of ungulate populations, and anchialine pool and native waterbird management. This scenario includes major capital improvement projects like the fencing required to keep out ungulates in years 3 and 4. While the funding needed for this level of management is more than twice the baseline level, it is achievable through creative fundraising (grants) and multi-sectoral partnerships.

h) Funding gap analysis

Table 26 below illustrates the required 5-year funding under two management scenarios (basic and enhanced). It also lays out the projected income from the State NAR Fund allocation to the Reserve and the potential revenues generated from implementing a parking fee. The remaining gaps could then be filled by fundraising through grants and partnerships.

Table 26. Operating costs, management and revenue generation scenarios for the Reserve.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Operating Costs & Revenues ($)	**2011**	**2012**	**2013**	**2014**	**2015**
BASIC Management Scenario	407,877	416,790	382,729	383,698	384,695
ENHANCED Management Scenario	827,877	726,790	1,002,729	1,193,698	544,695
Annual Income (State Funds)	180,000	180,000	225,000	225,000	225,000
Variance analysis BEFORE revenue generation					
Funding gap - BASIC scenario	(227,877)	(236,790)	(157,729)	(158,698)	(159,695)
Funding gap - ENHANCED scenario	(647,877)	(546,790)	(777,729)	(968,698)	(319,695)

i) Income from the Natural Area Reserve Fund

Currently, the main sources of income for the Reserve are from State and NAR Funds. NAR Funds are money derived from a tax on all transfers or conveyance of realty or any interest therein in the State of Hawaiʻi as established by HRS 195-9, that created this special NAR Fund from which the Reserve draws. Twenty percent of this conveyance tax goes to the NAR Fund and from this, a portion (in 2009 it was $125,000) goes to the Reserve on an annual basis. In 2013, the percentage that goes to the NAR Fund is scheduled to increase to 25%, which is why the projected income from 2013-2015 goes up to $225,000 from $180,000 during 2011-2012. This is a critically important source of income for the Reserve and is one of its main lifelines. It is clear, however, that even at increased levels of funding from the NAR Fund, there is not enough to meet even the baseline management scenario, which is why this management plan explores alternative revenue generating mechanisms to supplement the Reserve's income.

j) Current funding levels

The 2010 to 2012 funding has been insufficient to support the most basic staffing level, which is vitally important to maintain in order to protect and preserve the Reserve's resources.

If funding and resources are not increased to support the Reserve's management, there is a high risk that it may deteriorate further, along with public appreciation, enjoyment, and respect for the area. However, it is worth noting, that the basic scenario presented here is by no means enough to preserve and run the Reserve at the level that will satisfy the mission and goals presented in this plan, but rather merely insures basic staff presence and operations. Meaning, that in addition to the income-generating idea presented (parking fees), more funding is needed to implement this plan in the future (**Figure 27**). Thus, the budget for the basic scenario presented above is only a starting point for increased levels of Reserve management.

k) Reduction of funding gap through grant writing and revenue generation

An important source of funds for management is grants and the Reserve needs to have the capacity to manage grants in order to fully utilize the opportunity.

Through revenue generation at the Reserve, primarily from parking fees, enough monies can be raised to meet the financial costs of the basic level of management. To test the theory, the model used conservatively assumed a 150 vehicles per day (this is based on averages from human use surveys from 2008-2010) for 350 days a year. Three pricing levels ($5, $7 and $10 per car), as well as two implementation scenarios (via concession or parking lot machine) were examined for their revenue generating potential. Under the concessionaire scenario, only 1/3 of the revenues would accrue to the Reserve, with 2/3 of the revenue going to the concession. In contrast, if implemented with a parking lot machine, even with its $44,000 setup costs, the Reserve could gain enough income to cover its basic management costs. **Table 27** (below) shows the sensitivity of revenues to the parking fee price chosen. Depending on how it is implemented and the fee level chosen, these parking fees could generate revenues ranging from $87,500 to $520,000 over the next five years. This potential revenue to the Reserve represents a closing of the funding gap by half at the very least and even to fully covering all basic management costs.

This funding mechanism taps the majority of the users (visitors) who are willing to bear some of the costs of preserving the Reserve. It is highly feasible to implement this mechanism and it would augment the State's dedicated funding to the Reserve. Any remaining gap can be filled through grants and highly leveraged partnerships. In summary, these parking fees would generate substantial revenues for the Reserve and be a key source of sustainable funding for its operations and long-term preservation.

Table 27. Potential annual revenues from parking fees.

Potential annual revenues from parking fees					
Via Parking Concession	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
At $5 parking fee	$87,500	$87,500	$87,500	$87,500	$87,500
At $7 parking fee	$122,500	$122,500	$122,500	$122,500	$122,500
At $10 parking fee	$175,000	$175,000	$175,000	$175,000	$175,000
Via Parking lot machine					
At $5 parking fee	$218,500	$257,500	$257,500	$257,500	$257,500
At $7 parking fee	$323,500	$362,500	$362,500	$362,500	$362,500
At $10 parking fee	$481,000	$520,000	$520,000	$520,000	$520,000

This supplemental income makes fundraising for the higher level management activities more feasible. By reducing the amount that needs to be raised, the Reserve, in close collaboration with partners, can apply for grants and solicit donations that are targeted and specific to conservation activities. Generating Reserve revenue to help meet basic management needs also affords managers more time to prepare and fundraise for other priorities that are scheduled for a later date, after the basic needs have been met. Through collaborative partnerships, coalitions, donors and other supportive groups (e.g. Friends of ʻĀhihi-Kīnaʻu NAR), this Reserve could generate revenues that could sustainably take care of its needs well into the future**. Figure 27** (below) illustrates the two funding scenarios analyzed in this section (basic and enhanced) and two funding sources, the NAR Fund, and parking fee.

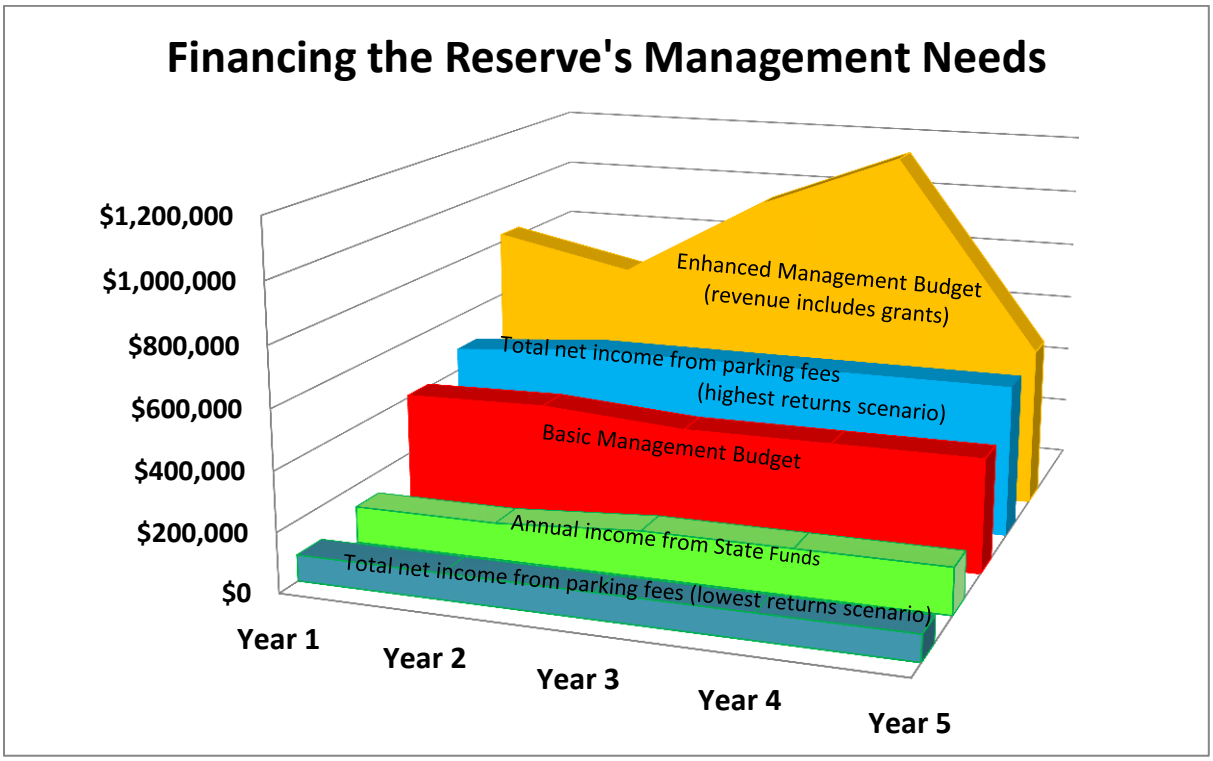

Figure 27. Financing the Reserve's management needs; estimated budgets and funding sources

Appendix

Subtitle 9 Natural Area Reserves System
Rules Regulating Activities Within Natural Area Reserves

§ 13-209-1 Purpose and applicability.
(a) The purpose of these rules is to regulate activity within natural area reserves established pursuant to section 195-4, Hawaiʻi Revised Statutes.
(b) These rules shall apply to all persons entering the boundaries of a natural area reserve. [Eff 6/29/81]; R 6/29/81]

§ 13-209-4 Prohibited activities. The following activities are prohibited within a natural area reserve:

(1) To remove, injure, or kill any form of plant or animal life, except game mammals and birds hunted according to department rules;
(2) To introduce any form of plant or animal life, except dogs when permitted by hunting rules of the department and service animals accompanying their handlers;
(3) To remove, damage, or disturb any geological or paleontological features or substances;
(4) To remove, damage, or disturb any historic or prehistoric remains;
(5) To remove, damage, or disturb any notice, marker, or structure;
(6) To engage in any construction or improvement;
(7) To engage in any camping activity or to establish a temporary or permanent residence;
(8) To start or maintain a fire;
(9) To litter, or to deposit refuse or any other substance;
(10) To operate any motorized or unmotorized land vehicle or air conveyance of any shape or form in any area, including roads or trails, not designated for its use;
(11) To operate any motorized water vehicle of any shape or form in freshwater environments, including bogs, ponds, and streams, or marine waters, except as otherwise provided in the boating rules of the department;
(12) To enter into, place any vessel or material in or on, or otherwise disturb a lake or pond;
(13) To engage in commercial activities of any kind in a natural area reserve without a written special-use permit from the board or its authorized representative;
(14) To have or possess the following tools, equipment, or implements: fishing gear or devices within ʻĀhihi-Kīnaʻu Natural Area Reserve, including but not limited to any hook-and-line, rod, reel, spear, trap, net, crowbar, or other device that may be used for the taking, injuring, or killing of marine life; cutting or harvesting tools or gear, including but not limited to chainsaws, axes, loppers, any mechanized or manual sawtooth tool, seed pickers, or machete, that may be used for the taking, injuring, or killing of plant life; and hunting gear or tools that may be used for the taking, injuring, or killing of wildlife, except as permitted by the hunting rules of the department;
(15) To hike, conduct nature study, or conduct any activity with a group larger than ten in size; *Unofficial compilation: HAR 13-209 – Rules Regulating Activities within Natural Area Reserves*

(16) To be present in an area closed pursuant to section 13-209-4.5 or after visiting hours established pursuant to section 13-209-4.6;
(17) To anchor any motorized or nonmotorized water vehicle of any shape or form in the marine waters of ʻĀhihi-Kīnaʻu Natural Area Reserve;
(18) To enter into any cave, as defined in section 6D-1, Hawaiʻi Revised Statutes, or any portion thereof;
(19) To conduct any other activity inconsistent with the purpose and intent of the natural area reserves system. [Eff 6/29/81; am 12/9/02; am 7/3/03; am 1/26/07](Auth: HRS § 195-5) (Imp: HRS § 195-5)

Hawaiʻi Administrative Rules
Department of Health
Water Quality Standards

§ 11-54-3 <u>Classification of Water Uses</u>.
(c) Marine waters.
(1) Class AA. brackish and saline coastal waters and Class AA estuarine waters) It is the objective of class AA brackish coastal waters and saline coastal waters and class AA estuarine waters that these waters remain in their natural [pristine] state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. To the extent practicable, the wilderness character of these areas shall be protected. No zones of mixing shall be permitted in this class:
(A) Within a defined reef area, in waters of a depth less than 18 meters (ten fathoms); or
(B) In waters up to a distance of [300] 500 meters or [(one thousand feet)] one thousand six hundred and forty feet off shore if there is no defined reef area and if the depth is greater than 18 meters (ten fathoms). The uses to be protected in these classes of waters are oceanographic and coastal research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation, and aesthetic enjoyment. The classification of any water area as Class AA brackish or saline coastal waters or class AA estuarine waters shall not preclude other uses of the waters compatible with these objectives and in conformance with the criteria applicable to them;
(d) Marine bottom ecosystems[.]
(1) Class I. It is the objective of class I marine bottom ecosystems [that], which may be found beneath either Class AA or Class A waters, that they remain as nearly as possible in their natural [pristine] state with an absolute minimum of pollution from any human-induced source. Uses of marine bottom ecosystems in this class are passive human uses without intervention or alteration, allowing the perpetuation and preservation of the marine bottom in a most natural state, such as for nonconsumptive scientific research (demonstration, observation or monitoring only), nonconsumptive education, aesthetic enjoyment, passive activities, and preservation;

§ 6E-8, HRS, and Chapter 13-275, HAR
State Historic Preservation Division Rules
Rules Governing Procedures for Historic Preservation Review
(http://hawaii.gov/dlnr/hpd/pdfs/revproc_har/275_284/pdfs/275.pdf)

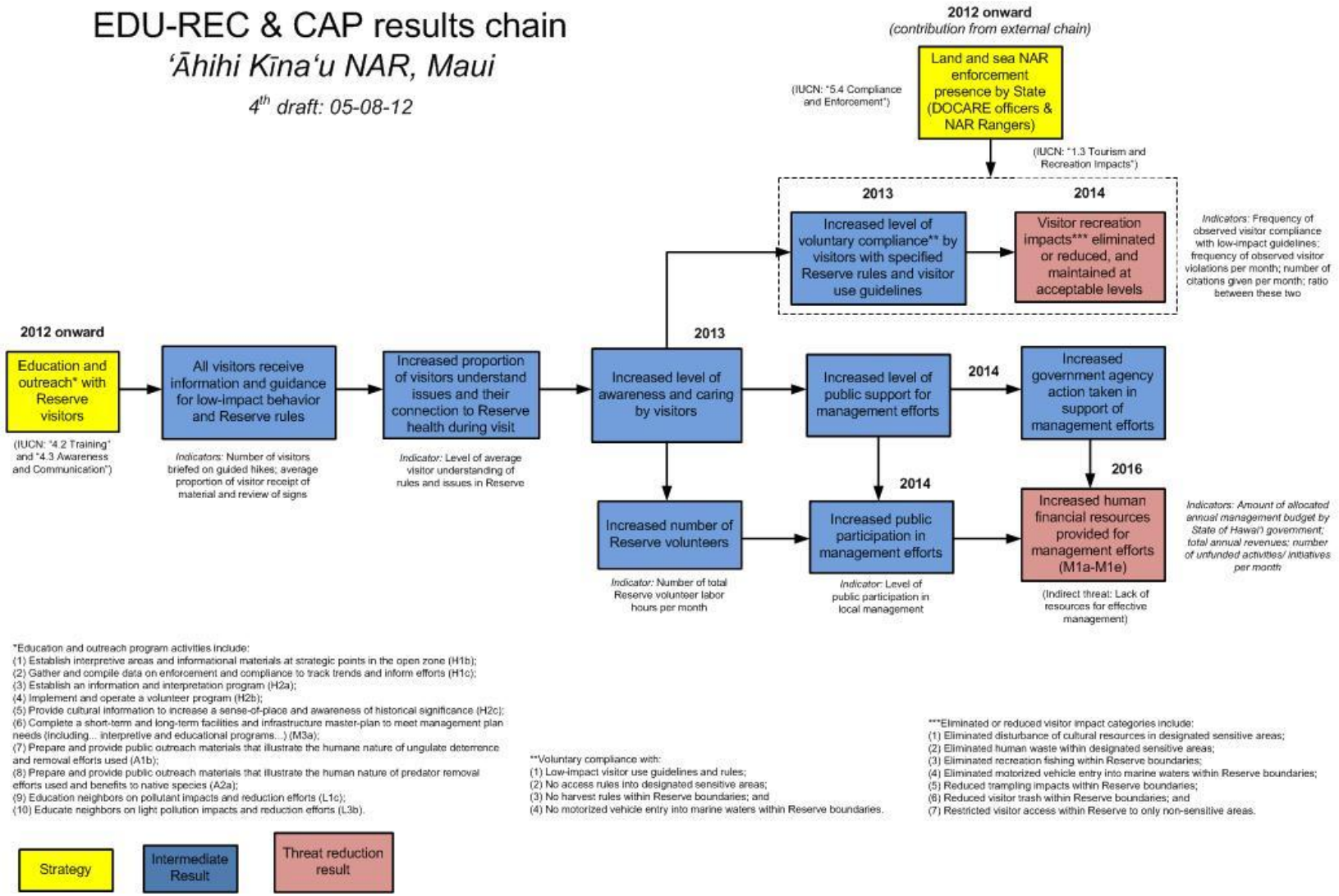

Figure 28. Results Chain for the strategy of Education (EDU) to address recreation (REC) and management capacity (CAP) needs (Roxie Sylva).

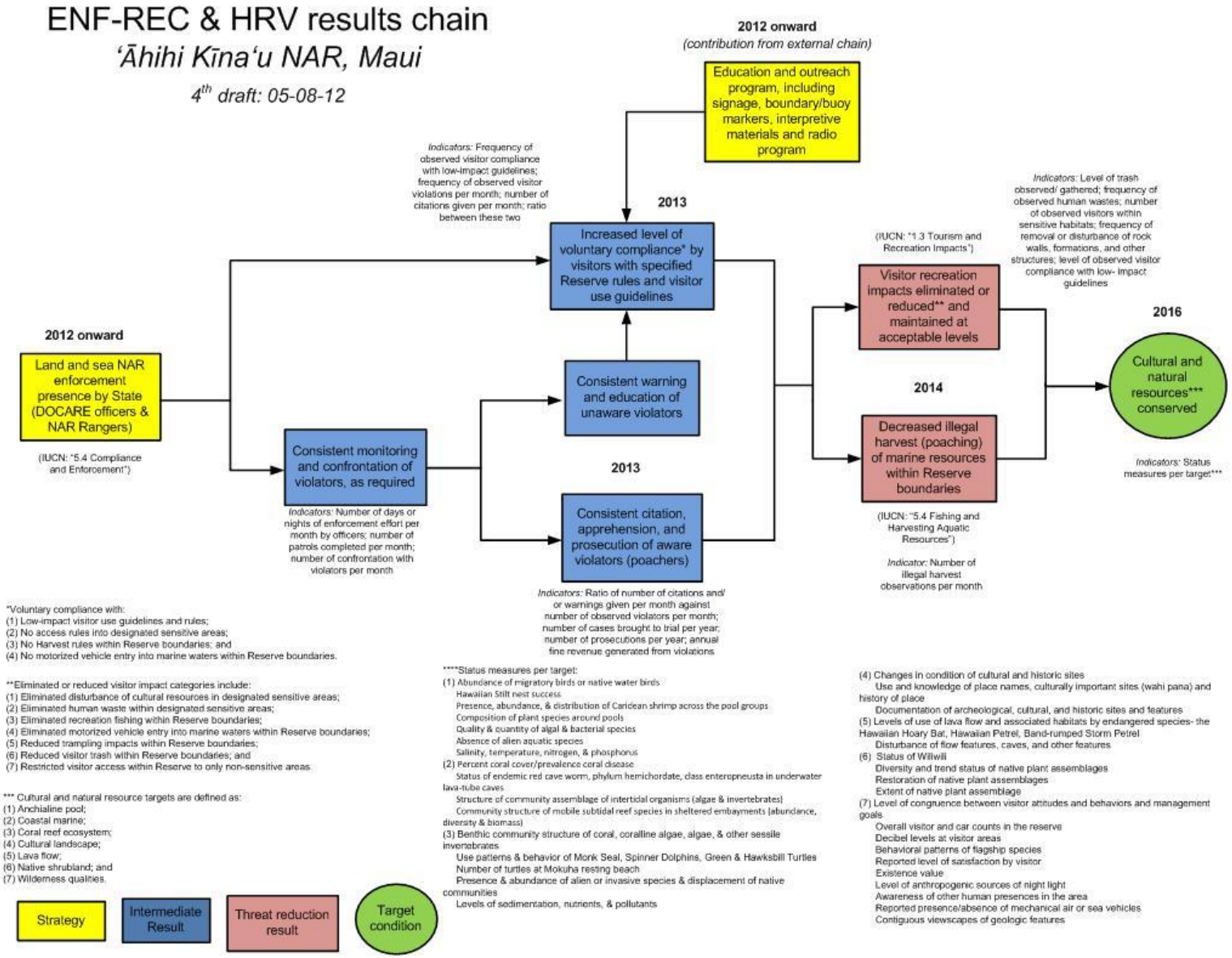

Figure 29. Results Chain for the strategy of enforcement (ENF) to address recreational (REC) and illegal harvest (HRV) threats (Roxie Sylva).

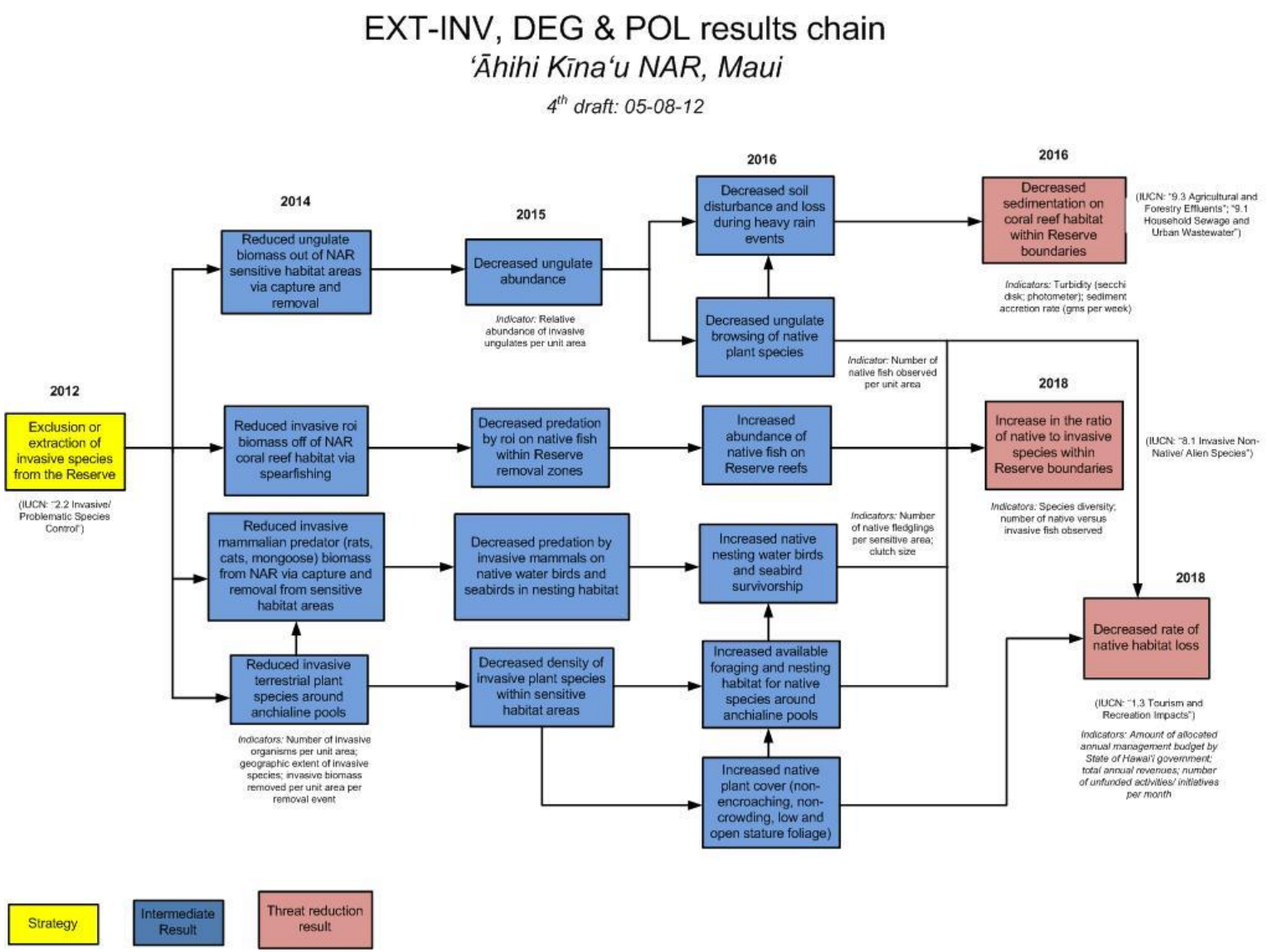

Figure 30. Results Chain for the strategy of extraction (EXT) of alien or invasive (INV) species to address threats of resource degradation (DEG) and pollution (POL) (Roxie Sylva).

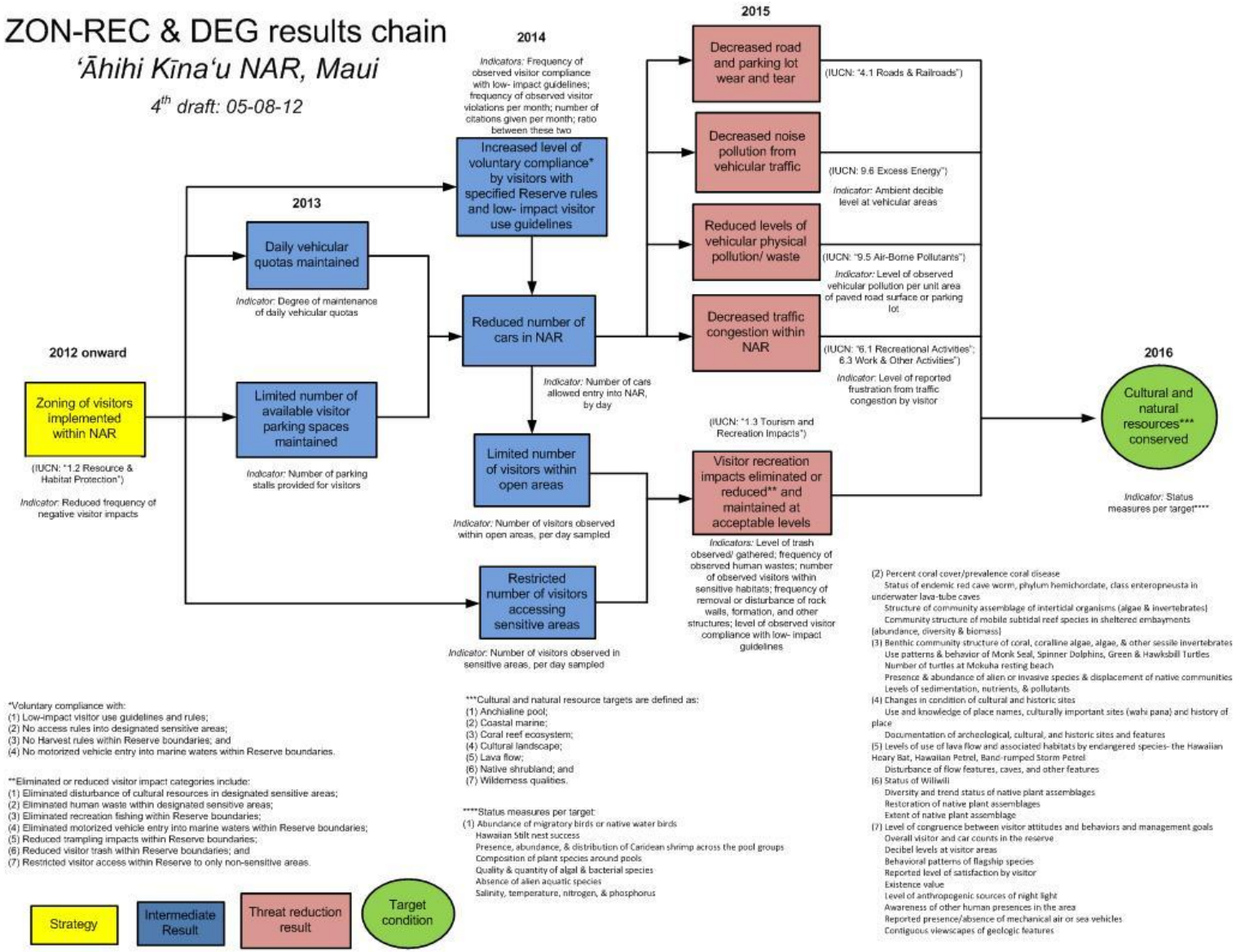

Figure 31. Results Chain for the strategy of zoning (ZON) to address threats from recreation (REC) and resource degradation (DEG) (Roxie Sylva).

Table 28. Summary of inventory and monitoring tasks under strategic actions.

Strategic Action	Inventory and Monitoring
Action H1(d) – Gather relevant information regarding visitor levels and user behavior.	(i) building on current monitoring, continue to improve human use monitoring protocol to collect visitor levels, behaviors, impacts, and relevant user information using accepted methods; (ii) periodically conduct human use monitoring in a timely manner.
Action H2(c) – Provide cultural information to increase a sense-of-place and awareness of historical significance.	(i) conduct an in-depth cultural landscape study of available archival sources, including stories, songs, maps, Hawaiian language newspapers, and other historic documents; (ii) interview and document oral histories of lineal descendants with *kuleana* over Reserve lands and other knowledgeable island residents; (iii) research and document fishing and other resource harvesting/gathering traditions of area.
Action M2(a) – Conduct biological status monitoring of terrestrial resources.	(i) periodically monitor the status and trends of native plant assemblages, invertebrates in lava-tube caves, new lava, anchialine pools, littoral areas, and shrublands; (ii) monitor the demography, status and trends of seabirds and waterbirds following baseline surveys and restoration plan development in Action A4(b).
Action M2(b) – Conduct biological status monitoring of aquatic resources.	(i) continue DAR and CRAMP at two sites, Kanahena Point and Kanahena Cove, to track status of coral reef health and trends; (ii) continue periodic monitoring of marine intertidal areas for ʻopihi, other invertebrates and algae to track status and trends according to establish standards; (iii) continue periodic monitoring of anchialine aquatic ecosystems for trends and status according to interagency standards.
Action A1(a) – Improve our understanding of ungulate impacts and controls.	(i) complete a survey to estimate ungulate population numbers and assess habitat use patterns and impacts; (ii) conduct periodic monitoring of ungulate populations and behavior.
Action A1(c) – Exclude ungulates from entering the Reserve.	(iv) monitor and maintain perimeter fence line around the Reserve.
Action A2(a) – Remove predatory animals from around priority anchialine pools and seabird nesting areas.	(iii) monitor the effects of reduced predators on native waterbird populations and nesting areas, monitor predator activity, bird demography and breeding success; (v) survey to determine presence/absence and location of nesting seabirds, automated vocalization recording devices should augment the studies, and specific management strategies should be based on results of studies.
Action A2(b) – Reduce alien plant populations in native habitats.	(iii) monitor and control recruitment of alien invasive seedlings through time; (iv) develop and explore effective methods for landscape monitoring of vegetation structure and composition in lava flow, shrublands, and anchialine areas of the Reserve.
Action A2(c) – Reduce alien invasive insect populations in native habitats.	(i) monitor effects of bio-control on alien invasive gall wasps and on *wiliwili* trees in native forest and shrubland habitat within the Reserve; (iii) conduct baseline inventory to document presence/absence of other harmful alien invertebrates.
Action A2(d) - Prevent new alien introductions	(ii) continue to identify other high priority alien or other biological threats for early detection and further study using Maui Invasive Species Committee priority species determinations. These are reviewed as needs/discoveries arise and tied to incipient species which are most economically and efficiently controlled.
Action A3(b) – Detect alien algae density and emerging threats on coral reefs and anchialine pools.	(i) conduct periodic monitoring of marine intertidal areas for alien algae according to interagency standards for early detection; (ii) conduct periodic monitoring of anchialine aquatic ecosystems according to interagency standards for early detection of the spread of alien invasive plant and animal species, as well as other changes, and to provide information for trends and for comparison to other pool sites in Hawaiʻi; (iii) conduct periodic monitoring for coral bleaching and disease, crown-of-thorns sea stars and marine invasive species in accordance with interagency standards; (v) continue to identify other high priority marine threats for early

Strategic Action	Inventory and Monitoring
	detection and further study.
Action A3(c) – Investigate the most effective ways to address aquatic invasive and emerging threats.	(i) initiate an investigation into the trends and status of diseased coral, diseased fish, and crown-of-thorns sea stars' outbreaks within the Reserve.
Action A4(a) – Replant native species at test sites in anchialine and shrubland habitat.	(iii) monitor and document survivorship rates, species diversity, and successional changes observed for restored native plant assemblages at these sites.
Action A4(b) – Implement a native habitat restoration plan for the Reserve.	(i) conduct a survey to characterize the status of native plants, native invertebrates and native wildlife within the Reserve (including spatial extent) and compare results to 1989 baseline survey; (v) monitor and maintain restored native plant assemblages and remove alien invasive plant recruits.
Action L1(a) –Prevent or minimize sources of land-based pollution into Reserve waters.	(i) assess and identify primary point and non-point source contributions of land-based pollution into Reserve waters, including nutrient loading and soil erosion from up-slope development
Action L1(d) – Monitor water quality for coral reefs within Reserve waters.	(i) conduct periodic water quality monitoring at sampling stations in Reserve waters.
Action L3(a) –Prevent or minimize sources of manmade light pollution.	(i) determine natural ambient light levels at night within Reserve boundaries and if those levels exceed county lighting ordnances; (ii) assess and identify primary sources of light pollution that contribute to altered/elevated ambient light levels.

Glossary

Aeolian:
Wind-supported

Alien:
Belonging to a foreign place

Buffer:
In GIS (geographic information system) it is a zone around a map feature measured in units of distance or time

Ecosystem:
The complex of a community and its environment functioning as an ecological unit in nature (e.g. lava tubes, coastal dunes, dry and mesic forests, wet forests, alpine shrub/grasslands, and aeolian (wind-supported))

Endemic:
A species or subspecies of plant or animal which occurs naturally nowhere else; evolving into a different species from the ancestral introduction (e.g. Haleakalā Silversword naturally occurs only on East Maui, nowhere else in the world)

Indigenous:
Organisms which arrived in Hawai'i without the assistance of humans, and are also found elsewhere (e.g. *Naupaka kahakai* or *Scaveola sericea* and *ʻEkaha* or Bird's Nest Fern can be found throughout the Pacific)

Invasive:
Tendency to spread prolifically and undesirably or harmfully

Invertebrates:
Animals without backbones (e.g. insects, spiders, shrimps, and snails)

Littoral:
Associated with the marine coast

Marine:
Saltwater habitat; referring to ocean and coastal ecosystems

Native:
A plant or animal species that got to an area without human intervention; instead it travelled by wings, wind, and/or water. Both indigenous and endemic are called native

Organic:
Derived from living organisms

Pristine:
Relatively undisturbed by humans and feral ungulates, and virtually lacking other non-native taxa (plants and animals); entirely native

Protected:
Legally dedicated to the perpetuation of native resources, if necessary

Restoration:
An attempt to remove non-native plants and animals from an area, assuming it will revert to a functioning native ecosystem; can include actual out-planting (replanting species that were once in the area, which have been propagated in a nursery), or it may entail simple removal of non-native vegetation and monitoring the area for natural re-growth

Terrestrial:
Growing in or on the land as opposed to epiphytic (to grow on other plants, rocks, or animals)

Terrigenous:
Sediment derived from the erosion of rocks on land

Ungulate:
A group of hoofed mammals (Reserve e.g. pigs, goats, deer) which are primarily herbivorous (feed on vegetation); ungulates were introduced to Hawai'i

Weed:
A plant that is not valued where it is growing; out-competes native species for light and water

Hawaiian terms:

ʻAʻā	rough, jagged, slow moving type of lava
Ahu	shrine
Ahupuaʻa	land division from the mountain to the sea
ʻĀina	land
Aliʻi	chief
ʻAumakua	family god/guardian
Heiau	religious site
Hoaʻāina	native tenant
ʻIliʻili	small stones
Kīpuka	vegetated oasis within lava beds
Kōkua	help
Konohiki	headman of an *ahupuaʻa*
Kuleana	responsibility, property, rights
Loko iʻa	fishpond
Mālama	take care of
Mauka	upland
Moku	traditional land district
Pāhoehoe	smoother, fast moving type of lava
ʻUala	sweet potato

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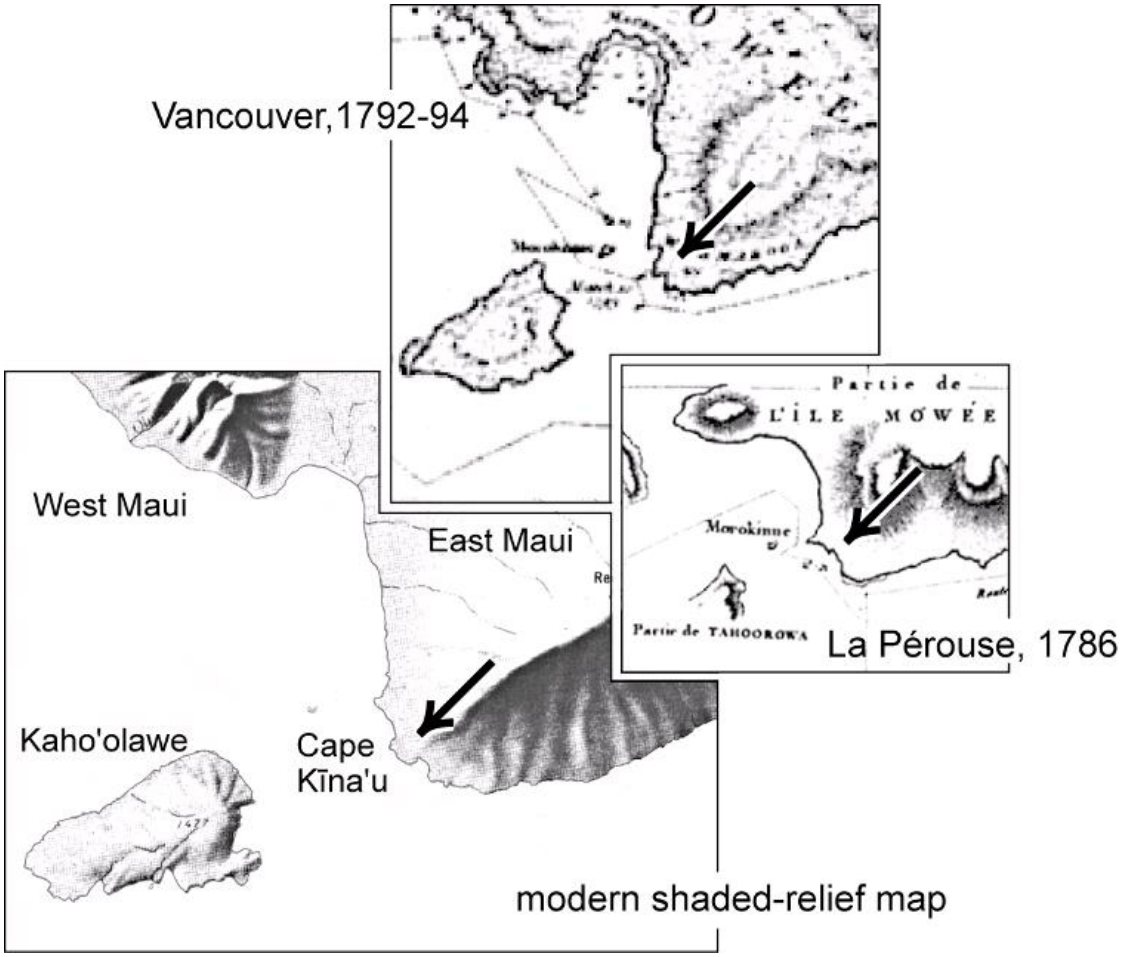
Endnotes

[1] Literally, Red-land or earth (Pukui, Elbert, and Mookini 1974)

[2] Cape Kīna'u is named for Elizabeth Kīna'u (1804-1839) the daughter of Ka-mehameha I and Ka-heihei-mālie. After her aunt Ka-ahu-manu's death she became kuhina nui (regent) for her brother Ka-mehameha III, an office she held until her death in 1839 at the age of 35. In a chant in her honor, Kīna'u is said to have been named for a mythical bird, Ka-manu- kīna'u-a-Pae. Lit., *flaw*. (Pukui, Elbert, and Mookini. 1974).

[3] Discussion of the age of Reserve lava flows: A date of A.D. 1790 was assigned previously to the Kālua o Lapa lava (Oostdam 1965). This age was interpreted from the differences between charts made by explorers La Pérouse, who visited the Hawaiian Islands briefly in 1786, and Vancouver, who made repeated voyages to the islands between 1792 and 1794. Cape Kīna'u is prominent on the Vancouver chart of 1793 but nearly indistinguishable on La Pérouse's chart of 1786 (Figure 3).



Comparison of early exploration charts and the configuration of the East Maui coastline in the vicinity of the 'Āhihi–Kīna'u Natural Area Reserve (map by Dave Sherrod).

When considered critically, however, the charts are not comparable. La Pérouse spent less than 48 hours at the Island of Maui, too little time to place much faith in the details of the coastline on his chart. Vancouver's chart has its own inadequacies; for example, the general shape of Maui is shown less realistically than the earlier presentation from

Cook's 1776 voyage (Fitzpatrick 1986). In short, the charts are too imprecise to allow the dating of shoreline features by their presence or absence on one chart or another.

Some Maui residents interviewed in the mid-1800s stated their grandparents saw the Kālua o Lapa lava actively emplaced, and a separate account in the early 1900s made reference to a father-in-law's grandfather also having seen lava flowing (Thurston 1924; Stearns and Macdonald 1942). This evidence and assumptions about generational duration led to an estimation of A.D. 1750 for the emplacement of Kālua o Lapa lava flows. The discrepancy between the oral history and radiocarbon ages for the Kālua o Lapa lava flows has no satisfactory resolution. Information about the early interviews is lost, and neither the questions asked nor intent of the respondents can be verified. The interviews were almost certainly not in the native language of the respondents. The radiocarbon ages are considered the best scientific estimation for the age of the lava flows.

[4] Discussion of the significance of Reserve resources
The criteria used to evaluate the significance of Reserve resources are, a) does the resource represent an outstanding example of a particular type of resource; and b) if so, at what level of significance, worldwide, national, or archipelagic?

Anchialine pools are of global, national and archipelagic significance: Although found in eleven locations worldwide, most abundantly in Hawaiʻi, Fiji, and the Ryukyu Islands, the total area occupied by this habitat is small, as they are restricted to highly porous substrates adjacent to the sea. These pools are highly vulnerable to human and other impacts and need management to continue to exist. Hawaiʻi is the only state in the nation to have anchialine pools and on Maui, these pools are significant, as there are only a few others, which are found south of the Reserve and in Hāna. Five of the ten shrimp species found in this habitat are listed as candidate endangered species, one of which is found only in the Reserve. Of the approximately 600 pools found in Hawaiʻi, the pool complexes of the Reserve are widely known as the healthiest, home to multiple endangered species, and numerous rare and migratory species (Brock 2004).

Coral reefs are of national and archipelagic significance: Hawaiʻi's coral reefs are an essential component of island life, providing wave breaks for surfers, food and other recreation, and acting as a buffer to protect the land. Hawaiʻi also contains the majority of the nation's coral reefs. On a statewide scale, the Reserve is the second largest marine area that enjoys the benefits of protection and management in the populated islands after Kahoʻolawe Island Reserve. The coral reefs in the Reserve are significant because they are in very good health, especially compared to other parts of the Hawaiian Islands, and have a high level of diversity and abundance of marine life. This is due in part to the long-standing protection of the area, and also because there are fewer land-based stressors than in many other areas in Hawaiʻi such as agriculture and development.

Coastal marine habitats are of archipelagic significance: The Reserve is the only rocky coastal ecosystem on Maui protected both from development and the taking of any marine organism. As a result, the marine community including algae, invertebrates such as coral and sea urchins, and fish are uniquely diverse and abundant. The costal boulder habitat also hosts unique native insects no longer found widely in Hawaiʻi such as the endemic marine cricket *Caconemobius sp.*

Cultural landscape is of archipelagic significance: The archeological record of the Reserve constitutes a significant and unique material record of the indigenous Hawaiian occupation of the southeastern coast of Maui, much like other undeveloped areas of Maui and Hawaiʻi in their state of preservation and potential for study and interpretation.

Lava flow formations and habitats are of archipelagic significance: A cultural and biologically significant cave at the Kālua O Lapa cinder cone contains an endemic spider and other invertebrates found nowhere else in Hawaiʻi or the world. Further, such caves are rare on Maui, making this habitat a unique resource in the state. The geology of the Reserve is also of island-wide significance, as it is among the youngest on the island.

Native leeward shrublands and forests are of archipelagic significance: The Reserve contains a large population of the rare *maiapilo* shrub (*Capparis sandwichiana*). *Maiapilo* is considered rare on other Hawaiian Islands, and is a candidate species for federal endangered status. There are twenty-one native dryland species documented in the Reserve, three of which are rare. The Reserve is part of the less than 2% of this habitat type left in Hawaiʻi.

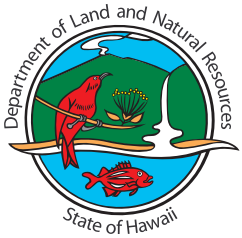
Wilderness qualities are of national and archipelagic significance: The scenic vistas of the Reserve, with 360 degree views of the land and seascape, are dramatic on many levels. At any vantage point within the Reserve, sweeping and breathtaking, unobstructed views are available from the sea up to the volcanic vent of Kālua O Lapa, and further upward towards the southwest rift zone of Haleakalā. These vistas also provide connection among varied habitats, making it possible for a wide variety of birds, bats, and insects to establish their homes among these landscapes.

[5] Handy (1991) wrote that, "From…Kahikinui, Honuaula, and Kula, the sweet potato was the staple food for a considerable population…This is the greatest continuous dry planting area in the Hawaiian Islands."

[6] The Reserve contains three small Mahele ʻĀina land claim awards, and one land grant in Kanahena *Ahupuaʻa* near the edge of the Puʻu Māhoe lava flow (Desilets et al. 2007:6-9). These four parcels are currently privately owned by parties other than the original claimants, and constitute a very small portion of the Reserve (see **Figure 22**).The bulk of Kanahena *Ahupuaʻa* was inherited by Ruth Keʻelikōlani, who later transferred the land to the government (Desilets et al. 2007), which in turn became State land, and later became the Reserve. By 1845, the Hawaiian system of land tenure was being radically altered. Prior to Western contact, all land and natural resources were held in trust by the high chiefs, with the use of lands and resources given to the *hoaʻāina* (native tenant) at the prerogative of the *aliʻi* (chief) and *konohiki* (headman of an *ahupuaʻa*). In contrast, the Mahele ʻĀina of 1848, under King Kamehameha III, instituted a system of private land ownership. As a result of the Mahele ʻĀina, all lands in the Kingdom of Hawaiʻi were placed in one of three categories: crown, government, and *konohiki*. In 1849, the Kuleana Act defined the process for *hoaʻāina* to apply for fee-simple interest in *kuleana* lands, creating a fourth category. These rights exists today under Hawaiʻi State Law.

[7] Conservation Action Planning (CAP) *is a process to guide conservation teams to develop focused strategies and measures of success. CAP* can be utilized for any project at any scale or set of natural or cultural resources. As actions are taken and outcomes are measured, conservation action plans are revised to incorporate new knowledge. The CAP process helps to: a) identify the project's biodiversity of interest and its current and desired status; b) identify the most critical threats currently or likely to degrade the biodiversity; c) recognize the social, economic, political and cultural factors contributing to the threats or representing opportunities to enhance the biodiversity; d) develop strategies to abate the threats and maintain or restore the biodiversity based on the situation at hand; and, e) implement the strategies, monitor the outcomes and use that information to adapt and learn throughout the life of the project. CAP is part of the international effort to standardize and improve conservation planning and implementation (see *Open Standards for the Practice of Conservation. http://www.conservationmeasures.org).* For more information on CAP go to http://conserveonline.org/workspaces/cbdgateway/cap/index_html.

[8]The objective of Class AA waters is for the waters to "remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. To the extent practicable, the wilderness character of these areas shall be protected. No zones of mixing shall be permitted in this class. The uses to be protected in this class of waters are oceanographic research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation, and aesthetic enjoyment" (HAR § 11-54-3).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