



# HAWAII

## CORAL REEF STRATEGY

---

### PRIORITIES FOR MANAGEMENT IN THE MAIN HAWAIIAN ISLANDS

2010 – 2020



May 14, 2010

# ABOUT THIS DOCUMENT

The State of Hawaii. 2010. *Hawai'i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands 2010-2020*. Honolulu, HI.

This document was prepared and printed with support from the NOAA Coral Reef Conservation Program.

## AUTHORS

Meghan Gombos, National Oceanic and Atmospheric Administration, Coral Reef Conservation Program

Jill Komoto, Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources

Kem Lowry, Lighthouse Consulting Group

Petra MacGowan, Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources

## ACKNOWLEDGEMENTS

The Hawai'i Coral Reef Strategy was developed by DAR in consultation with the Hawaii Coral Reef Working Group, members of the Hawai'i Local Action Strategy (LAS) Advisory groups and key community partners and stakeholders.

A special mahalo to Pam Weiant, John Parks and Kim Hum of The Nature Conservancy for their support and use of the draft marine eco-regional assessment; Kitty Courtney of Tetra Tech for assistance in facilitating and providing valuable input and guidance for the site prioritization process; and Christine Feinholz and Jamie Carter from NOAA Pacific Services Center for consultation and the development of maps for use at the prioritization workshop. Finally, this strategy could not have been completed without time, support and technical assistance from the Division of Aquatic Resources (DAR) staff.

Cover photo: © James D. Watt / Oceanstock



# Contents

<b>Glossary</b>	6
<b>Executive Summary</b>	7
<b>Section 1: Introduction</b>	9
<i>Need and Purpose of the Coral Reef Management Priorities Document</i>	9
<b>Section 2: Context</b>	10
<i>Coral Reef Ecosystem</i>	10
<i>Threats to Marine Resources</i>	11
<i>Fishing Pressure</i>	11
<i>Recreational Overuse</i>	11
<i>Land-Based Sources of Pollution</i>	12
<i>Invasive Species</i>	13
<i>Global Warming, Coral Bleaching, Ocean Acidification and Disease</i>	14
<i>Lack of Awareness</i>	14
<i>Cumulative Impacts</i>	15
<b>Section 3: Development of Goals and Objectives</b>	16
<i>Scope of the Coral Reef Management Priorities</i>	16
<i>Process for Development and Prioritization of Goals and Objectives</i>	16
<i>Background Analysis</i>	16
<i>Prioritization of Goals and Objectives</i>	16
<b>Section 4: Ten-Year Priority Goals and Objectives</b>	19
Table 1: Hawaii’s Ten-Year Priority Goals and Objectives for Coral Reef Management	19
<b>Section 5: Priority Site Selection Process</b>	20
<i>Site Selection Process</i>	20
Table 2: Criteria for Hawai’i Program Site Prioritizations	21
<i>All LAS Workshop Details</i>	21
Table 3: All LAS Meeting Site Ranking Results	23
<i>Site Ranking Results</i>	23
<i>Immediate Next Steps</i>	23
Table 4: Hawaii’s MHI Priority Coral Reef Strategy Objectives, Activities and Outcomes	24
<b>Section 6: Capacity Gaps</b>	33
<i>Enforcement</i>	33
<i>Management Funding</i>	34
<i>Intergovernmental and Interagency Collaboration</i>	34
<i>Personnel Capacity</i>	34

<b>References</b>	35
<b>Appendix A: Hawai'i Coral Program Structure 2010</b>	39
<b>Appendix B: Long-Term Goals and Objectives</b>	40
<b>Appendix C: Overview of the Marine Ecoregional Assessment for the Main Hawaiian Islands</b>	43
<b>Appendix D: Hawaii's Coral Reef Strategy Site Prioritization Map</b>	46
<b>Appendix E: CRWG Ranking Results</b>	53

# Glossary

<b>AIS:</b>	Aquatic Invasive Species
<b>CCMD:</b>	Climate Change and Marine Disease (LAS)
<b>CRWG:</b>	Coral Reef Working Group
<b>CTAHR:</b>	College of Tropical Agriculture and Human Resources
<b>CZM:</b>	State of Hawai'i, Coastal Zone Management Program (Department of Business, Economic Development and Tourism)
<b>DAR:</b>	DLNR–Division of Aquatic Resources
<b>DLNR:</b>	State of Hawai'i, Department of Land and Natural Resources
<b>DOA:</b>	State of Hawai'i, Department of Agriculture
<b>DOBOR:</b>	DLNR–Division of Boating and Ocean Recreation
<b>DOCARE:</b>	Division of Conservation and Resource Enforcement
<b>DOFAW:</b>	DLNR–Division of Forestry and Wildlife
<b>DOH:</b>	State of Hawai'i, Department of Health
<b>EPA:</b>	U.S. Environmental Protection Agency
<b>FLASH:</b>	Fishing Local Action Strategy Hawai'i
<b>GPS:</b>	Global Positioning System
<b>HAR:</b>	Hawai'i Administrative Rule
<b>HCRS:</b>	<i>The Hawai'i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands, 2010–2020</i>
<b>HRS:</b>	Hawai'i Revised Statute
<b>LAS:</b>	Local Action Strategy
<b>LBSP:</b>	Land-Based Sources of Pollution (LAS)
<b>LPA:</b>	Lack of Public Awareness (LAS)
<b>MHI:</b>	Main Hawaiian Islands (Ni'ihau, Kaua'i, O'ahu, Moloka'i, Lāna'i, Kaho'olawe, Maui and Hawai'i)
<b>NRCS:</b>	USDA–Natural Resources Conservation Service
<b>NWHI:</b>	Northwestern Hawaiian Islands
<b>OCCL:</b>	DLNR–Office of Coastal and Conservation Land
<b>PMNM:</b>	Papahānaumokuākea Marine National Monument
<b>RIR:</b>	Recreational Impacts to Reefs (LAS)
<b>SMART:</b>	Specific, Measurable, Attainable, Realistic and Timely (as applied to goals and objectives)
<b>UH:</b>	University of Hawai'i
<b>USDA:</b>	U.S. Department of Agriculture
<b>USFWS:</b>	U.S. Fish and Wildlife Service



# Executive Summary



*Hanauma Bay is one of Oahu's most popular reef sites. Photo Credit: Dave Burdick*

The State of Hawai'i Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR) is the primary agency responsible for coordinating Hawaii's reef management efforts in the Main Hawaiian Islands (MHI). The Coral Reef Working Group (CRWG), made up of key state and federal partners involved in coral reef management, was established to help provide guidance for the State of Hawaii's coral program.

There are numerous parallel strategies and programs for managing the coral reef resources of the MHI. Over the past eight years, DAR led the development of six multi-agency Local Action Strategies (LAS) under guidance from the U.S. Coral Reef Task Force: Climate Change and Marine Disease, Lack of Public Awareness, Coral Reef Fisheries, Land-Based Sources of Pollution, Recreational Impacts to Reefs and Aquatic

Invasive Species. Other related ocean resource management plans include: The Comprehensive Wildlife Conservation Strategy, Hawaii's Marine Managed Areas Framework (DLNR-DAR) and the Hawai'i Ocean Resources Management Plan (DBEDT-CZM). All of these efforts have overlapping goals, projects, personnel and funding.

While DAR has sought to coordinate these efforts, each strategy was developed somewhat independently. In order to provide a more cohesive strategy for coral reef management in Hawai'i, DAR and local coral program partners began development of *The Hawai'i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands, 2010–2020 (HCRS)* in May 2007. The process began with numerous stakeholder interviews and an analysis of recent public meetings and related ocean/coral reef strategies.

Recent NOAA initiatives to develop coral reef management priorities in the jurisdictions also provided additional impetus for the HCRS.

Four goals and thirty objectives were developed based on the background research and analysis conducted by the coral strategy planner and consultation with the LAS advisory groups. These objectives were prioritized by the CRWG, with the top five identified as priorities for coral reef management in the next ten years. Intended outputs and outcomes were identified by LAS advisory groups for each of the priority objectives.

The goals of The Hawai'i Coral Reef Strategy are:

GOAL 1: Coral reefs undamaged by pollution, invasive species, marine construction and marine debris.

GOAL 2: Productive and sustainable coral reef fisheries and habitat.

GOAL 3: Coral reef ecosystems resilient to climate change, invasive species and marine disease.

GOAL 4: Increased public stewardship of coral reef ecosystems.

The five priority objectives for the next ten years (2010–2020):

1. Reduce key anthropogenic threats to two priority near-shore coral reef sites by 2015 and five by 2020 using ahupua'a<sup>1</sup> based management.
2. Prevent new AIS introductions and minimize the spread of established AIS populations by 2020.

3. Increase the abundance and average size of ten targeted coral reef fisheries species critical to reef health and ecological function by 2020.
4. Designate a sufficient area of marine waters under effective conservation by 2020 to ensure sustainable and resilient coral reef ecosystems.
5. Reduce anchor damage and trampling on coral reefs through the implementation of no-anchor zones, utilization of day-use mooring buoys and other means by 2020.

Since one of the top priority objectives mandates site-based actions, the CRWG decided to prioritize key coral reef sites for management activities. The top two sites selected as priorities for Hawaii's coral program for the next 3–5 years are: (1) Kahekili-Ka'anapali (Maui), and (2) Pelekane Bay-Puako-Anaeho'omalu Bay (Hawai'i). Each location will have a site-based coordinator, planning team and associated action plan.

The extensive planning process used to develop the Hawai'i Coral Strategy has led to increased participation of key stakeholders and an enhanced dialogue between DAR staff, partner agencies and other statewide ocean initiatives. Through the collaboration of the CRWG, LAS advisory groups and other stakeholders a more strategic approach to addressing threats to coral reefs in Hawai'i has been developed.

---

<sup>1</sup> Ahupua'a is the principal land division running from mountains seaward; basic unit of Hawaiian socioeconomic organization.



# Section 1: Introduction

## NEED AND PURPOSE OF THE CORAL REEF MANAGEMENT PRIORITIES DOCUMENT

This document identifies a set of goals and objectives designed to serve as a framework for management activities affecting coral reefs in the Main Hawaiian Islands (MHI) for the next decade (2010–2020). This priorities framework is the result of the analysis of relevant ocean management plans, past public meetings and interviews of key stakeholders.

The state of Hawai'i Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR) is the primary agency responsible for coordinating Hawaii's reef management efforts in the MHI. Over the past several years, DAR has:

- Led the development of six multi-agency LAS (under guidance from the U.S. Coral Reef Task Force): Climate Change and Marine Disease, Lack of Public Awareness, Coral Reef Fisheries, Land-Based Sources of Pollution (supported by the U.S. EPA), Recreational Impacts to Reefs, and Aquatic Invasive Species. The LAS were developed as three-year strategic documents and included goals, objectives and activities to abate respective threats.
- Completed the marine component of the Comprehensive Wildlife Conservation Strategy.
- Developed a framework for Marine Protected Areas (MPA) to provide clarity on the goals, objectives and key activities that currently exist in a suite of different types of marine managed sites.

While DAR has sought to coordinate these efforts, each strategy was developed somewhat independently. This has resulted in several redundancies and gaps. For example, since each LAS was developed by a different contractor at different times, activities that addressed multiple threats were sometimes included in several LAS and/or sometimes not mentioned at all. In addition, other components of overall coral reef management (e.g., protocols governing bio-prospecting) are not mentioned in any of the LAS or other strategies.

To address these gaps and provide a more cohesive strategy for coral reef management in Hawai'i, DAR began development of its new priorities for reef management in May 2007. Draft priorities were completed with an initial set of goals, objectives and actions in 2008.

Recent federal initiatives have provided additional impetus to the development of Hawaii's coral reef management priorities. The National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program, which provides substantial funding for reef management activities, has mandated each jurisdiction to develop reef management priorities for the years 2010–2020 addressing key threats to coral reefs. NOAA's national-level goals and objectives have special emphasis on climate change, fishing impacts and land-based sources of pollution. NOAA will use this document to direct its investment in activities in each jurisdiction through grants, cooperative agreements and internal funding. NOAA will prioritize investments where actions will address the national level goals and objectives as well as the jurisdictional priorities.

# Section 2: Context



Many species of reef fish found on Hawaii's reefs are endemic to the Hawaiian Islands. Photo Credit: Luiz Rocha

## CORAL REEF ECOSYSTEM

As one of the most isolated archipelagos on earth, Hawai'i has estimated rates of endemism of 25 % or greater for most coral fish and invertebrate species. This unique marine life is found nowhere else in the world (DLNR DAR 2005). This isolated island chain consists of two regions: the Main Hawaiian islands (MHI) and the Northwestern Hawaiian Islands (NWHI). The MHI, where the state's 1.3 million residents reside, consists of high volcanic islands with non-structural reef communities and fringing reefs abutting the shore. In contrast, the NWHI consists of mostly uninhabited atolls, islands and banks that span over 2,000 kilometers (km) northwest of the MHI (Friedlander et al., 2005).

Historically, coral reefs played an important role in Hawaiian culture and subsistence agriculture (Friedlander et al., 2008). Native Hawaiians had

intimate knowledge of their ocean resources and employed a relatively sophisticated system to manage resources in ways that reduced waste and ensured long-term use. Some of these methods included the "kapu" system in which the chiefs would decree an area off limits to regulate fishing during certain times (e.g., spawning season). Species restrictions were also practiced (DLNR DAR 2005). Over time, these practices have eroded due to cultural, political and demographic changes that have affected water rights, land use and land ownership. These changes have disrupted ecosystem functions and sustainable management practices over just a few generations (Friedlander, 2004).

Notwithstanding these changes, reefs remain extremely important as habitats, natural buffers, sites for recreation and cultural practices and as a key component of the marine economy. In addition to providing protection from large

ocean swells and providing food for sustenance and commerce, it is estimated that the state's coral reefs generate approximately \$800 million annually in added value to the state's economy from marine tourism (Friedlander et al., 2008). Reef species also provide medical benefits, including the development of new medicines, some of which are applied to the treatment of HIV, cancer, ulcers and cardiovascular diseases. Hawaii's physical setting and extensive marine science research facilities have made the state a significant player in the marine biotechnology industry.

## THREATS TO MARINE RESOURCES

According to the Status of *Coral Reefs in the World* report (Friedlander et al., 2008), the condition of marine resources has generally degraded in the MHI over the past 20 years. While Hawaii's reefs are still in fair to good condition, many near-shore ecosystems adjacent to urban areas and popular destinations have suffered from land-based sources of pollution, fishing pressure, recreational overuse and invasive species.

### Fishing Pressure

Coral reef fisheries are an integral part of life in Hawai'i, providing food, recreation, commerce and cultural resources. However, there is evidence from both researchers and resource users that coral reef fisheries have been steadily declining over the past century. Friedlander and DeMartini's 2002 study showed that the numerical density, size and biomass of fish that inhabit shallow reefs are dramatically lower in the MHI compared to the remote and lightly fished NWHI. This same comparative study revealed "dramatic differences" in abundance, size and species composition:

- Standing fish stock in the NWHI was more than 260% greater than in the MHI.
- More than 54% of the total fish biomass in the NWHI consisted of apex predators, compared to less than 3% in the MHI.

- Most of the dominant species by weight in the NWHI were either rare or absent in the MHI and the target species that were present, regardless of trophic level, were nearly always larger in the NWHI.

A trend of declining catches despite increasing effort has been observed in several studies of time series data. In a review of commercial landings data between 1980 and 1990, the DAR found that "while catch per unit effort (CPUE) was declining... an equivalent amount of landings was being shared among an increasing number of fishermen" (Smith, 1993). This indicated the decline was due to decreasing fish stocks and not decreased fishing effort. Also, CPUE for species that are harvested by recreational and subsistence users has declined dramatically over time, despite new developments in fisheries technology (Friedlander, 2003).

The quantitative evidence of declining reef fisheries is corroborated by qualitative information from public surveys, oral histories and interviews with members of fishing communities. In 1997, DAR surveyed 863 fishermen and found reports of "a decline in the amount of fish that they're able to catch now compared with what they were able to catch 20 or 30 years ago." (Hawai'i Division of Aquatic Resources, 1998). In a compilation of over 130 oral history interviews with *kupuna* ("elders") and *kama'aina* (Hawaiian residents; literally "those who are of the land"), the majority of interviewees reported changes in the quality of the fisheries as well as a significant decline in fish abundance, and they attributed these trends to overfishing (Maly, K. and Maly, O. 2003).

### Recreational Overuse

Hawaii's Local Action Strategy to Address Recreational Impacts to Reefs (2005) identifies the ways in which marine recreational activities, such as snorkeling, diving and boating, may affect coral reefs, as:



Careless or uninformed snorkelers and divers, such as this individual standing on a reef in Molikini on Maui, contribute to recreational impacts to Hawaii's reefs. Photo Credit: Liz Foote

- Breakage of coral skeletons and tissue from direct contact, such as walking, touching or gear contact;
- Breakage of coral skeletons and tissue from boat anchors;
- Alteration in the behavior of marine life from feeding or harassment; and
- Potential introduction of pollution from discharged grey water or sunscreen or transfer of aquatic invasive species (AIS).

Coral reefs in the MHI are under increasing strain from recreational use as Hawaii's resident population and thriving marine tourism industry continue to grow at nearly exponential rates. From 1990 to 2007, there was a 59% increase in tourism, which represents almost four million visitors. Slightly over half of these visitors from the U.S. West and Canada went snorkeling or diving (Hawaii Department of Business, Economic Development and Tourism, 2007). There are over 1,000 ocean tourism companies in Hawaii, generating an estimated \$700 million in gross revenues annually. This increase in visitors and ocean tourism companies places additional pressure on marine resources, as many visitors seek calmer waters in areas with corals in shallow areas. A study by Holland and Meyers

(2003) found that the greatest concentration of human-substrate contact occurred at shoreline entry points, where people tend to congregate. Although long-term impacts of heavy recreational use of reefs in Hawaii are not fully understood and the relative impacts of different activities have not been evaluated, negative impacts from recreational activities are well documented.

### Land-Based Sources of Pollution

Land-based sources of pollution, such as sediment, nutrients and other pollutants, represent one of several factors threatening the quality of coral reef ecosystems in Hawaii. These pollutants are transported in surface-water runoff and by groundwater seepage into coastal waters. While the complex interrelationship between land-based sources of pollution, water quality, aquatic invasive species, overfishing and the health and integrity of coral reef ecosystems is not well understood, enough is known to require management policies that minimize polluted surface-water runoff and prevent overfishing (Davidson et al., 2003).



Sediment runoff in Maunalua Bay on Oahu threatens local reefs with the potential for partial burial in sediment and the potential introduction of toxins and disease. Photo Credit: Malama Maunalua



Sediment is probably the leading land-based pollutant causing alteration of reef community structure in the MHI (Friedlander et al., 2008). Although some major sources of erosion have been removed or reduced with the closure of several large mono-crop plantations, recent years have seen additional damage to near-shore coral reefs due to coastal construction projects. Other significant pollutants include pesticides, petroleum hydrocarbons, pharmaceuticals, heavy metals, pathogens and excess nutrients. These pollutants can cause or exacerbate the deleterious effects of watershed transport of pollutant constituents onto coral reefs (Richmond, 1993). There are an estimated 100,000 cesspools in Hawai'i that contribute to nutrient and pathogen runoff onto reefs. Excess nutrients, including dissolved nitrogen and phosphorus from sewage, wastewater and fertilizers, promote the growth of algae that compete with juvenile and adult corals for space on benthic reef surfaces and can affect success of coral settlement (Sammarco, 1996). Many near-shore areas of Hawai'i are comprised of a mix of seawater and freshwater from submarine groundwater discharge or surface-water runoff. Groundwater in Hawai'i typically contains two to three orders of magnitude higher concentrations of dissolved nitrogen and phosphorus than seawater (Friedlander, et al., 2008).

### Invasive Species

Invasive species are organisms not native to a region that, when introduced either accidentally or intentionally, outcompete native species for available resources, reproduce prolifically, and dominate regions and ecosystems. Invasive species are particularly damaging to Hawaiian marine ecosystems, which are ecologically fragile due to their geographic isolation. Introduced aquatic species can arrive in Hawai'i from anywhere in the world, often transported by maritime traffic but also sometimes deliberately introduced in a misguided attempt to supplement local fisheries and aquaculture.



*Invasive algae, such as Kappaphycus spp., outcompete coral on many reefs in the main Hawaiian islands. Photo Credit: Russell Sparks, DAR*

Once they arrive, these new introductions can wreak havoc by displacing and outcompeting native plants and animals, upsetting the delicate balance of reef species that have evolved to inhabit Hawaiian reef ecosystems.

Coral reefs in Hawai'i are currently struggling with numerous invasive species, including algae, fish and invertebrates. Several different species of alien algae have smothered acres of reefs around O'ahu, while floating mats of algae have taken over large areas off of Maui. Some introduced fish have caused the decline of native species through competition for food and habitat. Non-native invertebrates, such as snowflake coral (*Carijoa riisei*) and orange keyhole sponge (*Mycale armata*) have been shown to impact coral reefs in Hawai'i (Grigg, 2003). When native coral reef species have been smothered or displaced by an invasive species the damaged, sometimes non-functioning ecosystem can be very difficult or impossible to restore. The import of new species, both deliberate and accidental, is a large threat. State efforts also work to control the spread and distribution of existing alien species so that impacted reefs can eventually be restored.

## Global Warming, Coral Bleaching, Ocean Acidification and Disease

Ocean warming is a result of global climate change and can be extremely dangerous to coral organisms, which are very sensitive to changes in temperature. Coral bleaching can occur in response to several different stressors such as changes in salinity, light irradiance or temperature fluctuation. Usually though, mass bleaching events are associated with increased sea-surface temperature. The first large-scale coral bleaching in the Hawai'i region occurred in 1996 predominantly in Kāne'ohe Bay on the island of O'ahu (Jokiel and Brown, 2004). The bleaching event was attributed to increases in sea-surface temperature and high light during a cloudless period. Bleaching has also been documented in the NWHI in both 2002 and 2004 (Kenyon et al., 2006; Kenyon and Brainard, 2006).

Ocean acidification is also a risk. Worldwide, oceans absorb approximately one-third of the additional CO<sub>2</sub> generated every year by human activities, making the ocean more acidic (Caldeira and Wickett 2003). This uptake of CO<sub>2</sub> results in changes to the chemistry of ocean waters by

decreasing pH levels, impacting the calcification cycle and various organisms, including corals. Calcification rates in reef-building and reef associated organisms have already been reduced due to ocean acidification, with mass coral bleaching events occurring worldwide. (De'ath et al., 2009).

Disease can be defined as any impairment of vital body functions, systems or organs. There has been a worldwide increase in the reports of diseases affecting marine organisms. Outbreaks of disease in corals may be aggravated or caused by the introduction of novel pathogens to an environment or shifts in environmental conditions. Water quality and habitat deterioration have also been identified as potential environmental drivers of coral disease (Kaczamrski et. al, 2005; Harvell et al., 2007). Because temperatures modulate the metabolic rate and growth of organisms, pathogens can become more virulent at higher temperatures. Thus, disease conditions can be facilitated by opportunistic infectious pathogens whose virulence is enhanced during increased temperature episodes. Although the study of coral disease within Hawai'i is still in its infancy, a number of patterns are starting to emerge.



*Bleaching, such as this Montipora sp. from Lanai, is primarily attributed to the effects of climate change, and exacerbated by other local threats.. Photo Credit: Jean Kenyon, NOAA PIFSC CRED*

## Lack of Awareness

A lack of public awareness and appreciation regarding the significance of coral reef communities and how they can be harmed is another threat to reefs. While Hawai'i is an ocean state, many residents and visitors are not aware of the direct or indirect impacts their activities have on ocean environments. Several surveys of Hawai'i residents conducted with regards to public awareness found high levels of public awareness of the declining reefs (Ward Research, 2001). However, in another study, focus group participants had a difficult time connecting their personal behavior to the impacts on local reefs and had little knowledge as to what caused the reefs to decline or how to preserve



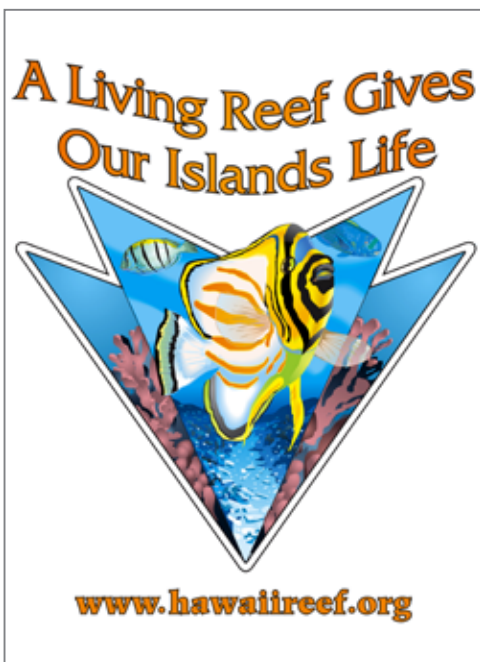
them. Participants did state a need to be given specific instructions and directions to save or help protect coral reefs (Ward Research, 2007). In 2004, a major outreach campaign with the slogan “A living reef gives our islands life” aimed to build and increase general public awareness of the importance of the coral reef ecosystem to Hawaii’s lifestyle. This statewide campaign was based on the belief that increased public knowledge and community involvement in the protection of coral reefs will help to decrease the threats to this valuable natural resource.

Active community involvement in marine resource management often results in locally acceptable resolution of resource management issues, increased conservation and compliance with the rules, and greater capabilities within the community to influence resource management decisions. Opportunities for communities to become involved in coastal and marine stewardship projects in Hawai’i have resulted in a network of at least 32 communities statewide taking action. Many of these groups are also interested in preserving traditional knowledge and have incorporated mechanisms to document

this knowledge into their resource management actions. As a result of lessons learned from coral reef awareness outreach campaigns and community stewardship projects, the current outreach efforts through the Hawai’i Coral Program are focused on specific audiences with key messages.

### Cumulative Impacts

While each of these threats is described separately, it is nearly impossible to separate only one as the main threat to coral reefs in the Hawaiian Islands. For example, excessive nutrient runoff increases macro-algae (often invasive) blooms. The problem is exacerbated through overfishing with the removal of herbivores, which normally control algal populations. Collectively, threats reduce coral fitness, which in turn reduces the organism’s ability to withstand and recover from impacts such as elevated water temperatures and the resulting bleaching. To improve ecosystem health these threats have to be managed comprehensively and in a holistic manner.



# Section 3: Development of Goals and Objectives

## SCOPE OF THE CORAL REEF MANAGEMENT PRIORITIES

The scope of these priorities covers coral reef ecosystems and related land management activities in the MHI from 2010–2020.

## PROCESS FOR DEVELOPMENT AND PRIORITIZATION OF GOALS AND OBJECTIVES

### Background Analysis

To provide a more cohesive strategy for coral reef management in Hawai'i, DAR began development of The Hawai'i Coral Reef Strategy (HCRS) in May 2007. One of the first steps completed in the development of the HCRS involved extensive background research conducted by the coral strategy planner. A review of numerous ocean, coral reef, watershed, coastal zone management and ecosystem-based management plans from around Hawai'i and the world was completed. A list of these plans can be found in the Reference section of this document. The DLNR-DAR administrator, program managers and biologists were interviewed to gather their insights regarding gaps in coral reef conservation, new policies needed, emerging priorities and key management tasks necessary to improve overall coral reef conservation in Hawai'i. Similar

questions were asked of members of the Coral Reef Working Group (CRWG) members and Local Action Strategy (LAS) advisory groups and other key stakeholders. Comments from public meetings on marine protected areas held around the state were reviewed and analyzed. A flowchart of the Hawai'i Coral Program Structure can be found in Appendix A. Draft goals and objectives were developed by the coral strategy planner based on the background research and analysis and consultations with the LAS advisory groups.

### Prioritization of Goals and Objectives

Refining and ranking goals and objectives for the HCRS began in November 2008. DAR partnered with the NOAA Coral Reef Conservation Program (CRCP) consultant, and local NOAA staff to design and implement a priority-setting process for the ten-year strategy. The CRWG, made up of key state and federal partners involved in coral reef management, was reorganized to participate in the planning process and to provide guidance for the HCRS throughout implementation.

The process of refining and ranking goals included an ongoing exchange of expert opinion between the Hawai'i CRWG, LAS advisory groups and DAR biologists. See process timeline below for further details:



An ulua cruises the shallow waters of a Hawaiian reef. Photo Credit: Claire Fackler, CINMS, NOAA

#### July 2008–September 2008

- Reorganization of the Hawai'i CRWG
- Development of CRWG mission and charter
- Commitment by the CRWG to guide the development of The Hawai'i Coral Reef Strategy
- Addition of key CRWG members identified by the CRWG and NOAA

#### November 2008–March 2009

- Development of four goals and thirty objectives based on the background research and analysis conducted by the coral strategy planner and consultation with the LAS advisory groups

#### January 2009

- The Hawai'i CRWG reviewed the draft goals and objectives and approved the goals
- Revised draft objectives were sent to the LAS advisory groups for further review

#### February 2009–March 2009

- LAS advisory groups reviewed and refined objectives
- DAR staff and the NOAA consultant refined objectives to make them more specific and measurable
- CRWG members ranked the objectives into high, medium and low priority groups in terms of their impact on key threats to reefs and other criteria.

#### April 2009

- The CRWG reviewed the ranking results
- Five priority objectives for The Hawai'i Coral Reef Strategy were selected and refined
- The CRWG determined that given limited management resources, greater emphasis should be placed on the management of activities in a limited number of reef areas with high biological value and that were subject to manageable threats
- Process for site prioritization began

#### July–August 2009

- “All LAS Meeting” held with CRWG members, LAS advisory group members and key biologists to share knowledge about and rank 43 sites identified in preliminary results of the The Nature Conservancy Hawaii’s *Marine Ecoregional Assessment for the Main Hawaiian Islands*. Top nine sites sent to CRWG for further ranking
- CRWG reconvened to narrow results of July meeting based on information gathered at “All LAS Meeting” biological and criteria and opportunities for partnership (see Section 5: Priority Site Selection Process and Next Steps)
- LAS advisory groups developed and ranked activities and outcomes for top five objectives and top two priority sites

#### September 2009

- Held meetings on Maui and Hawaii Islands with local experts to provide recommendations on the scope of the site for program focus
- CRWG reviewed and evaluated feedback from local experts to define site boundaries for grant funding and planning purposes

#### May 2010

- Completed The Hawai‘i Coral Reef Strategy with input and approval of CRWG



Honu are one of the most popular creatures found on Hawaii’s reefs. Photo Credit: Claire Fackler, CINMS, NOAA



# Section 4: Ten-Year Priority Goals and Objectives

The intent of *The Hawai'i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands, 2010–2020* is to identify medium-term goals and objectives for conserving Hawaii's coral reefs.

The goals of The Hawai'i Coral Reef Strategy are:

- GOAL 1: Coral reefs undamaged by pollution, invasive species, marine construction and marine debris.
- GOAL 2: Productive and sustainable coral reef fisheries and habitat.
- GOAL 3: Coral reef ecosystems resilient to climate change, invasive species and marine disease.
- GOAL 4: Increased public stewardship of coral reef ecosystems.

These priority objectives listed in Table 1 will guide coral reef management activities in the MHI over the next ten years. The objectives address the goals identified in the left-hand column of the table. The complete list of draft “Long-Term Goals and Objectives” for coral conservation developed and considered through this process can be found in Appendix B.

**Table 1: Hawaii’s Ten-Year Priority Objectives for Coral Reef Management**

GOAL	OBJECTIVE
G1/G2 G3/G4	Reduce key anthropogenic threats to two priority near-shore coral reef sites by 2015 and five by 2020 using ahupua‘a based management.*  <i>* Two sites—Ka‘anapali-Kabekili (Maui) and Pelekane Bay-Puako-Anaeho‘omalu Bay (Hawai‘i)—were identified as 3–5 year priority areas for the program funding support.</i>
G1/G3	Prevent new AIS introductions and minimize the spread of established AIS populations by 2020. **  <i>**Common priority developed in collaboration with the Papahānaumokuākea Marine National Monument (PMNM)</i>
G2	Increase the abundance and average size of ten targeted coral reef fisheries species critical to reef health and ecological function by 2020.***  <i>***Species to be determined by FLASH advisory group</i>
G2/G3	Designate a sufficient area of marine waters under effective conservation by 2020 to ensure sustainable and resilient coral reef ecosystems.
G2/G3	Reduce anchor damage and trampling on coral reefs through the implementation of no-anchor zones, utilization of day-use mooring buoys and other means by 2020.

# Section 5: Priority Site Selection Process



*An ariel view of Puako, one of Hawaii's priority sites. Photo Credit: Rob Shallenberger*

## SITE SELECTION PROCESS

The CRWG recognized early in the planning process that many of the management activities identified in the goals and objectives need to be implemented at a site specific level to effectively and realistically show success (e.g., reduction of sediment and nutrient runoff, sufficient areas under effective conservation, etc.). For this reason, the group decided that identifying at least two priority sites to implement specific ridge-to-reef management activities was critical.

To do this a process was developed to utilize the expertise of LAS advisory groups, the CRWG and key biologists to assess and prioritize reef sites for future Hawai'i Coral Reef Program funding and technical support. Site prioritization was guided by (1) criteria developed by the CRWG (see Table 2 below), and (2) the priority goals and objectives for The Hawai'i Coral Reef Strategy.

Several current efforts by agencies and conservation organizations to rank watersheds, streams, coastal and marine areas were reviewed by program staff. With the support of the CRWG,



**Table 2: Criteria for Hawai'i Program Site Prioritizations**

Biological value	Degree of threat	Conservation viability
Coral cover	AIS presence/absence	Watershed partnerships
Species richness	Sedimentation	Number of active agencies/ groups
Representative habitat/areas facing the greatest threats	Wastewater discharge	Availability of watershed or other management plans
Unique habitats and species (endemism)	Pathogens/disease	Opportunity to leverage funding
Spawning sites, nursery habitats, or other areas critical to particular life-history stages	Accessibility; vulnerability to: <ul style="list-style-type: none"> <li>• Fishing pressure</li> <li>• Recreational use</li> </ul>	Within or next to managed area
Critical function of ecosystem	Shoreline development	Existing monitoring data
Species diversity/biodiversity hotspots	Vulnerability to impacts of climate change	Existing LAS site/partnership
Resilience to climate change		Community support



*Ta'ape (blue line snapper) is an alien fish species introduced from the Marquesas in 1958. This picture was taken within the Ahihi Kinau Natural Area Reserve. Photo Credit: Russell Sparks, DAR*

it was decided to utilize the results of the *Marine Ecoregional Assessment for the Main Hawaiian Islands*, recently completed by The Nature Conservancy (TNC), as a starting point for site prioritization. This plan identified 43 areas of biological importance for long-term resiliency of coral reefs based on similar criteria as the CRWG, extensive databases of scientific information, rigorous analyses and expert reviews. A detailed description of the TNC process can be found in Appendix C.

### All LAS Workshop Details

As stated earlier in this document, in June 2009 an "All LAS Meeting" was held to obtain input from key stakeholders on priority coral reef areas for the HCRS focus. Invitees included all members of the LAS advisory groups (out-of-state members could not attend because of prohibitive travel expenses), the CRWG and key partner organizations. Participants were asked to assess the proposed reef sites in terms of biological value, degree and type of threats and conservation viability.



*Pennantfish within the Molokini Marine Life Conservation District. Photo Credit: Russell Sparks, DAR*

Five island groups were formed from meeting participants: Kaua'i, O'ahu, Maui and Lāna'i, Moloka'i, and Hawai'i. O'ahu, Maui/Lāna'i, and Hawai'i were further divided into two groups. Kaho'olawe Island was not considered in the prioritization process due to the extensive protection of the island and current plans already underway by the Kaho'olawe Island Reserve Commission (KIRC). A worksheet was developed to capture additional information about each area identified by the TNC *Marine Ecoregional Assessment for the MHI*. Meeting participants shared information on the proposed sites: threats, supporting mechanisms, other challenges, unique features, adjacent areas that should be included and then ranked priority areas for the HCRS. After the information-sharing session, each person selected two priority areas on his/her island work group with a rationale for their choice. Then they placed two yellow dots on large maps of the area(s) to signify their vote for one or two sites. Participants could place both dots on the same area if they felt strongly about the area. The groups were then brought together in a plenary discussion and were asked why they collectively chose particular areas with many

dots, or why an area was not selected. After this discussion, the participants each placed two red dots on any of the areas to identify priority areas throughout the MHI for program focus. Again, participants could use their dots or votes at one site or at more than one, and were allowed to select any site statewide. Table 3 on the following page summarizes the results of the site prioritization exercise at the All LAS Meeting and subsequent follow-up meetings with DAR biologists on Maui and O'ahu who could not attend the All LAS Meeting.

In July 2009, based on the information provided by participants at the All LAS Meeting, reef profiles were developed for the nine top-ranked reef areas. The CRWG was convened to evaluate the results from the All LAS Meeting and, using the profiles developed, members were asked to identify the top two reef areas for management focus during the first three to five years of The Hawai'i Coral Reef Strategy. After discussion of the nine sites, working group members further ranked in terms of "readiness" (availability of information, ability to leverage funding, availability of potential partners and

**Table 3. Top Nine Sites Ranked by the CRWG and Level of Support Available**

Site	Level of Support Available
Ka'anapali-Kahekili (M-7)	HCRS Priority Site 3–5 years to receive funding and technical assistance
Pelekane Bay-Puako-Anaeho'omalu Bay (H-1)	
Maunaloa Bay (O-4)	Technical support from DAR, LAS advisory groups and partner organizations LAS projects through 2010
Kāne'ohe Bay (O-2)	
Olowalu (M-6)	
Hā'ena-Hanalei (K-2)	
Kealahou (H-9)	No action at this time/reevaluate site after 3 years/ sites in need of additional community/agency engagement
Wai'anae (O-6)	
South Shore Moloka'i (MO-4)	

existing plans), “urgency” (current or potential threats such as land based pollution, AIS, over-fishing, near-shore development, etc.), “cross-LAS potential” (opportunities for LAS to collaborate) and “potential for effective management” (potential for success in maintaining or improving reef health). Two sites—Ka’anapali-Kahekili (Maui) and Pelekane Bay-Puako-Anaeho’omalu Bay (Hawai’i)—were identified as priority areas for the program. See appendix E for detailed results and priority site profiles.

### Site Ranking Results

Table 3 above lists all nine sites considered by the CRWG and levels of support that will be provided based on the ranking results. The two priority two sites will receive program funding and technical assistance support from the Hawai’i Coral Management Grant in the initial three to five years. Some sites will continue to have technical support and also receive funds for implementation of LAS projects throughout 2010. Several sites identified have received large amounts of LAS funds in the past and there is a continued desire on the part of several LAS advisory groups to support initiatives in these areas when possible. The final group of sites are in need of additional community/agency

engagement before designation as a HCRS priority site. Sites will be reevaluated in 2013 and additional sites could be added as priorities at that time.

### Immediate Next Steps

In 2010 the CRWG has worked to initiate site-based management planning for Ka’anapali-Kahekili and Pelekane Bay-Puako-Anaeho’omalu Bay. Some of the initial tasks have included: further defining the scope of the site, assembling a planning team and coordinator, and carrying out a stakeholder analysis. The development of strategies and activities for objectives not related to site-based management are being led by the LAS advisory groups. Table 4 on the following page summarizes the HCRS primary objectives as well as key activities and outcomes identified by the LAS advisory groups.

Table 4: Hawaii’s MHI Priority Coral Reef Strategy Objectives, Activities and Outcomes

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G1/G2 G3/G4	<p><b>Reduce key anthropogenic threats to two priority near-shore reef areas by 2015 and five by 2020 using ahupua‘a based management</b></p> <p>Priority Sites: Ka‘anapali- Kahekili and Pelekane Bay-Puako- Anaeho‘omalu Bay</p>	<ul style="list-style-type: none"> <li>• Development of a conservation action plan for addressing specific threats that includes the following steps:               <ul style="list-style-type: none"> <li><u>Identification of people involved in the project</u> <ul style="list-style-type: none"> <li>o Select core project team members and assign roles</li> <li>o Hire coordinators for each priority site</li> <li>o Identify steering committee members and advisors</li> </ul> </li> <li><u>Definition of project scope and focal conservation targets</u> <ul style="list-style-type: none"> <li>o Statement developed on overall vision of project</li> <li>o Complete literature review/gather basic info on each site including:                   <ul style="list-style-type: none"> <li>▪ Compilation of GIS layers</li> <li>▪ Identification of development and land-use plans</li> <li>▪ Identification of cultural uses of sites</li> <li>▪ Identification of public monitoring data sources</li> <li>▪ Historical impacts due to weather and other natural cycles</li> <li>▪ Economic analysis of the area</li> <li>▪ Identification of key stakeholders                       <ul style="list-style-type: none"> <li>▫ Land and water managers/owners</li> <li>▫ Existing community efforts</li> </ul> </li> </ul> </li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Identification of process leader</li> <li>• Creation of jurisdictional maps</li> <li>• Shared vision for stakeholders and managers created</li> <li>• Determination of conservation targets</li> <li>• Baseline data on coral reef and water quality conditions either available or being collected</li> <li>• Economy of area and impact on marine resource uses understood</li> <li>• Brief description of project area and scope completed</li> <li>• Basic map of project area using computer-based GIS program</li> <li>• “State of the Reef” for priority area understood</li> <li>• Major human uses and impacts of areas are understood</li> <li>• Historical impacts due to fluctuations in weather and other natural cycles are better understood</li> </ul>	<ul style="list-style-type: none"> <li>• All Hawai‘i Coral Program priority sites are being guided by a reef-to-ridge management plan including implementation, outreach, biological and social monitoring and enforcement/compliance programs.</li> <li>• Stakeholders and landowners are actively engaged in watershed activities to address LBSP threats</li> <li>• Pollution reduced and conservation targets remain within acceptable range of variation               <ul style="list-style-type: none"> <li>o Increase in population of priority species at specific sites</li> <li>o Reef quality is maintained or improved (increased living coral cover, reproduction, recruitment and reduced algal cover)</li> </ul> </li> <li>• Reduction of anthropogenic pollutant load to surface water and groundwater through site-specific actions and best management practices</li> <li>• Entry/exit points used</li> <li>• Enforcement personnel are able to detect at least 75% of incidents of noncompliance with rules and laws</li> </ul>



GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
<p><b>G1/G2 G3/G4</b> <i>(continued from previous page)</i></p>	<p><i>(continued from previous page)</i>  <b>Reduce key anthropogenic threats to two priority near-shore reef areas by 2015 and five by 2020 using ahupua‘a based management</b></p> <p>Priority Sites:            Ka‘anapali-            Kahekili and            Pelekane            Bay-Puako-            Anaeho‘omaluu            Bay</p>	<p><i>(continued from previous page)</i></p> <ul style="list-style-type: none"> <li>▫ Area stewardship activities</li> <li>▫ Development of conservation targets</li> </ul> <p><u>Assessment of the viability of focal conservation targets</u></p> <ul style="list-style-type: none"> <li>○ Compile baseline measurements of coral cover, diversity and fish abundance, water quality</li> <li>○ Conduct rapid LBSP appraisals by LBSP committee members/USGS including remote sensing and walking the watershed</li> <li>○ Complete use-pattern maps showing: existing and future permits, recreation activities location and intensity, moorings, temporal and seasonal use and projected future use</li> <li>○ Standardization of public monitoring efforts and compilation of data in an accessible database</li> </ul> <p><u>Identification of critical threats</u></p> <ul style="list-style-type: none"> <li>○ Analysis and prioritization of specific threats for each conservation target</li> <li>○ Conduct Knowledge Attitudes Perceptions (KAP) survey to gauge support and knowledge for Marine Managed Area (MMA) and recreation rules</li> <li>○ LBSP specific information needs               <ul style="list-style-type: none"> <li>▪ Nutrient budget (including golf courses and agriculture)</li> <li>▪ Sediment erosion analysis (causes and sources)</li> </ul> </li> </ul>	<p><i>(continued from previous page)</i></p> <ul style="list-style-type: none"> <li>• Identification and prioritization of threats to conservation targets</li> <li>• Pollution controls are developed and implemented</li> <li>• Watershed plans developed</li> <li>• Completion of priority rule revisions</li> <li>• Development of a list of realistic indicators to measure and track effectiveness of site-based actions</li> <li>• Summary of project capacity and gaps</li> </ul>	<p><i>(continued from previous page)</i></p> <ul style="list-style-type: none"> <li>• All priority sites have initiated watershed plan implementation in the form of land management and pollution control activities</li> <li>• Precautionary approach used in giving permits for special use or commercial activity</li> <li>• Partnerships with community stewardship and monitoring groups are strengthened</li> <li>• Management actions and funding at the site directed to threats posing greatest impact</li> <li>• All site-based administrative rules for recreational use and fishing are based on best available biological and social science</li> <li>• Degree of primary threats is measurably lessened</li> <li>• Community understands threats to the site and impacts of human activities and is engaged with other users, scientists and managers in implementing actions to improve resource condition</li> </ul>

Table 4 continued

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
<p><b>G1/G2 G3/G4</b> <i>(continued from previous page)</i></p>	<p><i>(continued from previous page)</i>  <b>Reduce key anthropogenic threats to two priority near-shore reef areas by 2015 and five by 2020 using ahupua‘a based management</b></p> <p>Priority Sites:            Ka‘anapali-Kahekili and Pelekane Bay-Puako-Anaeho‘omalu Bay</p>	<p><i>(continued from previous page)</i></p> <ul style="list-style-type: none"> <li>▪ Watershed processes               <ul style="list-style-type: none"> <li>▫ Land cover</li> <li>▫ Condition of streams</li> <li>▫ Existing data</li> <li>▫ Stream and ground-water discharge</li> </ul> </li> <li>○ FLASH specific needs:               <ul style="list-style-type: none"> <li>▪ Quantify resource violations in representative areas</li> <li>▪ Quantify and qualify presence of DOCARE officers at key sites.</li> </ul> </li> </ul> <p><u>Completion of a situation analysis</u></p> <p>Development of strategies</p> <ul style="list-style-type: none"> <li>○ Examples include:               <ul style="list-style-type: none"> <li>▪ Development of site based fisheries enforcement plans (FLASH)</li> <li>▪ Identification and prioritization of needed rule revisions</li> <li>▪ Establishment and marking of recreation entry/exit points for (RIR)</li> <li>▪ Development of place-based rules for permit holders for special events (RIR)</li> <li>▪ Identification of needed watershed plans (LBSP)</li> <li>▪ Creation or expansion of Makai Watch program</li> </ul> </li> </ul> <p><u>Development of a work plan for actions and measurement of results</u></p>		

Table 4 continued



GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G1/G3	<p><b>Prevent new AIS introductions and minimize the spread of established AIS populations by 2020</b></p> <p><b>*Overlapping MHI and PMNM objective</b></p>	<ul style="list-style-type: none"> <li>• Mitigate the dispersal of established AIS               <ul style="list-style-type: none"> <li>◦ Restoration actions: super sucker, native grazer replenishment</li> <li>◦ Temporal and spatial mapping of AIS infestations</li> </ul> </li> <li>• Identify vectors and pathways of AIS with regard to likelihood of transmission and establishment of aquatic invasive species</li> <li>• Risk Assessment: Identify and prioritize threat level, invasiveness and practicality of eradication or control of non-native organisms</li> <li>• Development of prevention policy operational interdiction plans in partnership with federal and state agencies</li> <li>• Development of sustainable funding strategies for AIS efforts</li> <li>• Prioritize species of concern for Eyes of the Reef volunteers to monitor</li> </ul>	<ul style="list-style-type: none"> <li>• Vectors and pathways of AIS are prioritized for program focus</li> <li>• Develop restoration tools, both mechanical and biological, and evaluate for efficacy</li> <li>• Identify vulnerable sites for increased monitoring</li> <li>• Early detection system in place to notice and identify accidental introductions</li> <li>• Approval of a coordinated approach to eradication using the best possible means.</li> </ul>	<ul style="list-style-type: none"> <li>• No marine aquatic invasive species introduced to Hawai'i</li> <li>• Targeted reefs cleared of invasive species</li> <li>• Native grazers employed to control alien algae</li> <li>• Existing invasive algae distributions are contained</li> <li>• Ecologically sensitive marine areas are identified for protection and monitoring</li> <li>• Accidental introductions are controlled with rapid response</li> <li>• Implementation of new public policies that prevent AIS introduction and allow for efficient eradication</li> </ul>
G2	<p><b>Increase the abundance and average size of ten targeted coral reef fisheries species critical to reef health and ecological function by 2020.</b></p>	<ul style="list-style-type: none"> <li>• Analyze and validate the existing commercial coral reef fisheries data and produce a report detailing coral reef fisheries catch, effort and economic information either by island or for the state as a whole (use the most recent 5 years of data)</li> <li>• Conduct cost/benefit analysis of fishing license in Hawai'i, comparison among states</li> </ul>	<ul style="list-style-type: none"> <li>• Key coral reef species are identified and prioritized</li> <li>• Fishing management strategies are developed</li> <li>• Funding sources are identified and accessed</li> <li>• Operational plans are developed and implemented</li> </ul>	<ul style="list-style-type: none"> <li>• To have statistically valid and useful knowledge for management on all catch and effort for Hawai'i's CR fisheries by 2012</li> </ul>

Table 4 continued

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
<p>G2 (continued from previous page)</p>	<p>(continued from previous page)  <b>Increase the abundance and average size of ten targeted coral reef fisheries species critical to reef health and ecological function by 2020.</b></p>	<p>(continued from previous page)</p> <ul style="list-style-type: none"> <li>• Develop recommendations to revamp the Hawai'i Marine Recreational Fishing Survey (HMRFS) surveys to increase the use of data for local management efforts</li> <li>• Revise commercial catch reports to be more spatially explicit</li> <li>• Collect information on the catch and bycatch of certain gears and CPUE (recreational)</li> <li>• Collect information on the commercial export of near-shore fishes from Hawai'i</li> </ul>		
		<ul style="list-style-type: none"> <li>• Identify five pono and five non-pono fishery management practices for each island based on guidance from cultural experts, kupuna and other culturally recognized sources of information</li> <li>• Assess the Biological, Social and Economic (BSE) impacts and benefits of implementing these practices</li> <li>• Identify research/surveys completed on public perceptions of DOCARE</li> <li>• Evaluate DOCARE's compliance with legislative audit</li> <li>• Analyze DOCARE's volunteer program, (what were the pitfalls, what happened to the program, are there volunteer programs in other states, are they successful?)</li> <li>• Research options for DLNR to be able to issue tickets/ fines</li> <li>• Research and provide information to DOCARE on programs and options to deputize volunteers/citizens</li> </ul>	<ul style="list-style-type: none"> <li>• Stakeholder engagement compliance is increased</li> </ul>	<ul style="list-style-type: none"> <li>• Three communities are implementing pono fishing practices and eliminating non-pono fishing practices on each island by end of 2012</li> <li>• Eight Makai Watch programs are trained to effectively assist DOCARE and DAR in public compliance with fisheries rules and regulations</li> </ul>

Table 4 continued

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
<p>G2 (<i>continued from previous page</i>)</p>	<p>(<i>continued from previous page</i>)  <b>Increase the abundance and average size of ten targeted coral reef fisheries species critical to reef health and ecological function by 2020.</b></p>	<p>(<i>continued from previous page</i>)</p> <ul style="list-style-type: none"> <li>• Develop consultation process between DAR, DOCARE and judicial system on rules and enforcement</li> <li>• Establish a natural resource court (land board)—administrative fines, no DOCARE involvement</li> <li>• Translate fisheries rules into more than one language—priority Pacific Island languages, Filipino, Samoan, etc.</li> <li>• Develop an education and outreach program on fishery rules</li> </ul>	<p>(<i>continued from previous page</i>)</p> <ul style="list-style-type: none"> <li>• Stakeholder engagement compliance is increased</li> </ul>	<p>(<i>continued from previous page</i>)</p> <ul style="list-style-type: none"> <li>• Three communities are implementing pono fishing practices and eliminating non-pono fishing practices on each island by end of 2012</li> <li>• Eight Makai Watch programs are trained to effectively assist DOCARE and DAR in public compliance with fisheries rules and regulations</li> </ul>
		<ul style="list-style-type: none"> <li>• Increase number of extension/outreach officers</li> <li>• Determine the most effective and appreciated ways to contact or communicate with fishermen</li> <li>• Develop and implement a decentralized and consistent communication process/plan</li> <li>• Determine top subjects/issues that fishermen/stakeholders are interested in and develop outreach information and materials</li> <li>• Set up a kiosk at different fishing tournaments</li> <li>• Pre-introduction consultative process between DAR and legislature for potential bills on marine resource related topics</li> <li>• Identify and support a place/agency for resource users to obtain reliable, credible and unbiased information on fisheries related issues within Hawai'i</li> <li>• Semiannual fishers forum for consistent reliable information exchange</li> <li>• Develop target outreach to increase community understanding of key FLASH topics (translation from scientific materials for public audiences)</li> </ul>	<ul style="list-style-type: none"> <li>• Public stakeholder understanding of fishing impacts is increased</li> <li>• Policy maker understanding of fishing impacts is increased</li> </ul>	<ul style="list-style-type: none"> <li>• To have a process that more effectively collects and disseminates information between managers and resource users by December 2008</li> <li>• Effective management options of fishing impacts on coral reefs are supported by the public and policy makers</li> </ul>

Table 4 continued

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G2/G3	<b>Designate a sufficient area of marine waters under effective conservation by 2020 to insure sustainable and resilient coral reef ecosystems</b>	<ul style="list-style-type: none"> <li>• Complete a quantification of the benefits of MPAs in terms of coral reef fisheries population fecundity, reproductive output</li> <li>• Identify, characterize and rank priority areas for protection within the MHI</li> <li>• Conduct a socioeconomic assessment on value and potential impacts of a range of MPA networks in Hawai'i</li> <li>• Conduct benefits/costs analysis of area management vs. species specific management</li> <li>• Classify habitat types and identify areas socially, economically and culturally appropriate for area management; prioritize sites based on output</li> <li>• Quantify and characterize public opinion on MPA in Hawai'i</li> <li>• Develop a comprehensive marine zoning plan for West Hawai'i and the MHI</li> <li>• Assessment of Biological, Social and Economic (BSE) effectiveness of community based marine co-management/ahu-moku council (select pilot area)</li> <li>• Assess the recovery process of MPA impacted by natural and anthropogenic disturbance</li> <li>• Assess the scope of marine managed areas to restore herbivore stocks and effect on ecological processes</li> <li>• Assess the ecosystem services of MPA</li> <li>• Assess the effects of de-establishing a MPA—West Hawai'i and Waikiki</li> </ul>	<ul style="list-style-type: none"> <li>• A statewide plan that prioritizes sites for conservation zoning is developed</li> <li>• Community stewardship programs are developed or supported at priority sites</li> <li>• DAR/DLNR and resources users have an understanding of the applicability of an MPA network in Hawai'i, including data on its potential biological, social and economic effects</li> </ul>	<ul style="list-style-type: none"> <li>• Restoration of specific coral species</li> <li>• Improved habitat conditions</li> <li>• Increased biomass</li> <li>• Areas for increased resilience to climate change</li> <li>• At least 10% of MHI near-shore waters are designated as conservation areas by 2015</li> </ul>

Table 4 continued



GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G2/G3	<b>Reduce anchor damage and trampling of coral reefs through the implementation of no-anchor zones, utilization of day-use mooring buoys and other methods by 2020.</b>	<p><u>Minimize anchor damage</u></p> <ul style="list-style-type: none"> <li>• Implement no-anchor zones at important sites</li> <li>• Create a task force to resolve conflict between recreation users and fishers and other stakeholders</li> <li>• Develop a DLNR protocol for Day Use Mooring Buoy (DUM) site selection</li> <li>• Develop a MOU with operators tied to permits to formalize compliance with agreements currently informal user agreements</li> <li>• Map and chart all moorings, make information available online and at vessel registration</li> <li>• Complete DLNR DUM Strategic Plan Parts I &amp; II to address management issues such as site and rules ( surface vs. non-surface, overnight use, commercial and public access)</li> <li>• Establish protocols for managing moorings in areas with seasonal surf</li> <li>• Develop consistent and repeated education for boaters, fishers and other users</li> </ul>	<ul style="list-style-type: none"> <li>• Strategic management plan based on best available science is implemented by DLNR</li> <li>• Rules for permitted day-use moorings are codified in Hawai'i Administrative Rules.</li> <li>• A sustainable funding mechanism is developed for installing and maintaining day-use mooring buoys</li> </ul>	<ul style="list-style-type: none"> <li>• Important near-shore habitat protected from anchoring</li> <li>• Fishing areas are protected and respected</li> <li>• Increased collaboration between fishers and recreation users</li> <li>• DUM rules revised, are comprehensive and appropriate</li> <li>• All legal moorings covered by DLNR rules</li> <li>• Illegal moorings removed</li> <li>• Access to fishing areas is retained</li> <li>• Boaters and ocean users are aware of DUM system and its appropriate uses</li> <li>• DUM use rules are effectively enforced</li> <li>• The purpose of DUMs as a management tool is widely understood by recreational users and fishers</li> </ul>
		<p><u>Minimize trampling</u></p> <ul style="list-style-type: none"> <li>• Develop strong incentives for good reef etiquette for commercial and independent recreational users</li> <li>• Incorporate user protocols into permits for commercial operations and for special events</li> <li>• Identify and clearly mark entry and exit points for shore-based recreation</li> </ul>	<ul style="list-style-type: none"> <li>• Partnerships with industry groups like PADI are used to improve user behavior and education</li> <li>• Good reef etiquette is established as the norm for recreation business operation through incentives and legal means such as permits</li> </ul>	<ul style="list-style-type: none"> <li>• Recreation protocols are followed by a significant number of commercial operations</li> <li>• Recreation protocols are clearly posted at high use sites</li> <li>• Better understanding of impacts of high use events (e.g., canoe races)</li> </ul>

Table 4 continued

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G2/G3 <i>(continued from previous page)</i>	<i>(continued from previous page)</i> <b>Reduce anchor damage and trampling of coral reefs through the implementation of no-anchor zones, utilization of day-use mooring buoys and other methods by 2020.</b>	<i>(continued from previous page)</i> <ul style="list-style-type: none"> <li>• Display information on reef etiquette at airports or on all entering planes or both</li> <li>• Identify dive and snorkel training areas for inexperienced users</li> </ul>	<i>(continued from previous page)</i> <ul style="list-style-type: none"> <li>• Independent travelers and resident recreational users are given the information and tools to voluntarily reduce their impact to coral reefs</li> </ul>	<i>(continued from previous page)</i> <ul style="list-style-type: none"> <li>• Entry and exit points are used exclusively at high use sites</li> <li>• 100% of commercial recreation staff are trained in cultural protocols, mooring use and reef etiquette</li> <li>• Visitor industry also educated in cultural, social and biological reef issues</li> <li>• Introductory and certification dives happen at resilient sites without no fragile habitat</li> </ul>

Table 4 continued

# Section 6: Capacity Gaps



*Pupukea Makai Watch observation and compliance coordinators working with DOCARE officer to improve enforcement efforts. Photo Credit: DLNR*

The HCRS cannot be implemented effectively without addressing capacity gaps in coral reef management. This section summarizes some of the key current issues of governance capacity identified in a recent analysis of coral reef management in Hawai'i (Komoto, 2009).

## **Enforcement**

One of the primary issues associated with protecting marine resources in Hawai'i is the lack of enforcement due to lack of funding, staff and enforceable rules. At present, conservation officers with the DLNR–Division of Conservation and Resource Enforcement (DOCARE) are

assigned to a variety of areas of responsibilities that cover vast geographic regions from the mountains to the sea. In addition, they respond to other criminal activities including tasks associated with homeland security. There are simply not enough officers to witness and catch every violator or even to respond to every reported incident. In some areas, site-specific rangers have been hired, but are responsible for outreach and education and do not have police powers. Local communities are also providing a presence in several coastal areas around the state, working closely with their local DOCARE officer. Specifically, Makai Watch community volunteers are being trained by DOCARE

officers in identifying, reporting on and, if safe, documenting violations so that authorities have information to catch violators and pursue fines or charges. Also, DLNR is slowly implementing a new enforcement approach where certain violations result in tickets similar to traffic tickets, rather than a misdemeanor charge that must be prosecuted in court.

## Management Funding

The economic value of Hawaii's coral reefs states that the State's coral reef ecosystem provides an average annual value of \$364 million (Cesar et al., 2002). However, DLNR receives only 0.6% of the State General Fund budget. In addition, existing funds may not be utilized in the most effective manner. Increased staffing for both resource monitoring and enforcement would improve the prospects for improved coral reef conditions. The development of a coral reef mitigation fund is currently being discussed with local organizations, state and federal agencies. However, a coral reef mitigation fund should be developed in conjunction with a financial sustainability plan for coral reef management. This financial plan should incorporate a diversity of national, regional and international funding sources and mechanisms.

## Intergovernmental and Interagency Collaboration

The current management framework has resulted in various local, state and federal agencies responsible for specific natural resource sectors. This fragmentation of authority leaves gaps in management effort and responsibility. Strategic plans developed by different agencies may indicate the value of collaboration, but lack specific details about how authority and resources can be more effectively shared. Collaboration and communication among and within agencies is particularly important for the protection of coral reef ecosystems. The LBSP-LAS has been a successful partnership

effort to address threats to coral reefs, however, continued support is needed for continued development and operations of regional alliances of government agencies (local, state and federal), nongovernmental organizations and communities that manage resources, mauka to makai (mountain to sea).

## Personnel Capacity

Effective management of coral reef resources includes planning, coordination, education/ outreach and analysis of monitoring data. Unfortunately, at DLNR and its key partners, these positions are funded on a year-to-year basis using several different funding sources. These funding sources must be approached each year, requiring significant staff time to re-negotiate contracts. Experienced personnel are lost due to this uncertainty in funding. In the recent economic crisis, some positions have lost general funding, been eliminated or been filled by personnel unfamiliar with coral reef management. One critical area for management is a full time, regular staff biostatistician for the Division of Aquatic Resources. Without the analysis of monitoring data, management decisions cannot be made or rules developed without the support of valid data. Sustainable funding for key positions would result in consistency for the program, retention of institutional knowledge and more staff time available for implementation and oversight of management actions.

# References

## HAWAI'I LOCAL ACTION STRATEGIES

Department of Land and Natural Resources, Division of Aquatic Resources with CCMD Steering Committee (2006). *Hawaii's Climate Change and Marine Disease Local Action Strategy*. 38pp.

Department of Land and Natural Resources, Division of Aquatic Resources, NOAA Fisheries, Pacific Islands Regional Office and Western Pacific Regional Fisheries Management Council (2004). *Main Hawaiian Islands Coral Reef Fishery Management Local Action Strategy*. 53pp.

Department of Land and Natural Resources, Division of Aquatic Resources and Hawai'i Ecotourism Association (2005). *Hawaii's Local Action Strategy to Address Recreational Impacts to Reefs*. 66pp.

Land-Based Sources of Pollution Local Action Strategy members, with technical assistance from Tetra Tech, Inc. (2004). *Hawaii's Local Action Strategy to Address Land-Based Pollution to Coral Reefs*. 83pp.

Shluker, A. (2003). *State of Hawai'i Aquatic Invasive Species Management Plan*. Prepared for Department of Land and Natural Resources, Division of Aquatic Resources. A publication of the State of Hawai'i Division of Aquatic Resources, Department of Land and Natural Resources, The Nature Conservancy of Hawai'i, and relevant partners through a grant from the Hawai'i Community Foundation. 205pp.

## HAWAI'I PLANS AND REPORT

Bryant, K. (2003). *Department of Land and Natural Resources, Division of Aquatic Resources Strategic Planning Framework*. 13pp.

CSV Consultants (2007). *Report to the Hawai'i Department of Land and Natural Resources: Recommended Strategies for Addressing Ocean Recreation User Conflicts*. 60pp. A report of the Hawai'i Office of Planning, State of Hawai'i, Department of Business, Economic Development and Tourism and

Department of Land and Natural Resources pursuant to National Oceanic and Atmospheric Administration Award No. NA05NOS4191060. 65pp.

Fletcher, C. Hawai'i Department of Land and Natural Resources, Land Division—Coastal Lands Program (2003). *Hawaii's Coastal Erosion Management Plan*. 90pp.

Grober-Dunsmore, R, M. Ridgley and L. Tran (2000). *Integrating Science and Policy for an Uncertain and Conflictive World: Developing and Operational Methodology for Strategic Multi-objective Coral Reef Management*. Prepared for the Hawai'i Coral Reef Initiative. 91pp.

Hawai'i 2050 Sustainability Task Force (2008). *Hawai'i 2050 Sustainability Plan: Charting a Course for Hawai'i's Sustainable Future*. 99pp.

Hawai'i Coastal Zone Management Program (1996). *Hawaii's Coastal Nonpoint Pollution Control Program Management Plan Volume 1*. A publication of the Hawai'i Office of State Planning, pursuant to National Oceanic and Atmospheric Administration Award Nos. NA47OZ0264 and NA57OZ0270. 445pp.

Hawai'i Coastal Zone Management Program (2000). *Hawaii's Implementation Plan for Polluted Runoff Control*. A publication of the Hawai'i Office of Planning, Coastal Zone Management Program, pursuant to National Oceanic and Atmospheric Administration Award No. NA97OZ0161, and the Hawai'i Department of Health, Polluted Runoff Control Program, pursuant to Federal Clean Water Act Section 319(h) funds from the U.S. Environmental Protection Agency. 181pp.

Hawai'i Department of Business, Economic Development and Tourism (2006). *Planning for Sustainable Tourism, Part 1 Summary report*. 93pp.

Hawai'i Department of Health (1999). *Strategic Plan for Hawaii's Environmental Protection Programs*. 109pp.

Hawai'i Department of Health (2001). *Strategic Plan Update For Hawaii's Environmental Protection Programs*.  
Komoto, J. (2006). *Revised Recommendations to Integrate*



and Improve Hawaii's Marine Managed Areas for the Conservation of Aquatic Resources: Recommendations from the Division of Aquatic Resources. Prepared for the Department of Land and Natural Resources, Division of Aquatic Resources. 53pp.

Mitchell C., C. Ogura, D. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, A. McClung (2005). *Hawaii's Comprehensive Wildlife Conservation Strategy*. Department of Land and Natural Resources. Honolulu, HI. 722pp.

*Papahānaumokuākea Marine National Monument Management Plan* (2008). Honolulu, HI.

Tetra Tech, Inc. (2006). *Hawai'i Ocean Resources Management Plan*. Prepared for the Hawai'i Coastal Zone Management Program. 73pp.

Tetra Tech EM, Inc. (2006). *Defining Elements of a Moku Management Plan*. Prepared for: Hawai'i State Department of Business and Economic Development-Office of Planning, Coastal Zone Management Program. 33pp.

University of Hawai'i Sea Grant Extension Service and State of Hawai'i Department of Land and Natural Resources Office of Conservation and Coastal Lands (2004). *Draft Erosion Management Alternatives for Hawai'i*. 6pp.

## HAWAI'I WATERSHED PRIORITIZATION PROCESSES

The Nature Conservancy, Marine Eco-Regional Plan, Hawaiian High Islands Ecoregion Plan, Coastal Ecoregion Plan.

Terrestrial: <http://www.hawaiiecoregionplan.info/home.html>

Coastal: <http://www.hawaiiecoregionplan.info/coastalsystem.html>

DLNR-DAR Hawai'i Watershed Atlas: <http://www.hawaiiwatershedatlas.com/>

CZM Watershed Priorities: <http://hawaii.gov/dbedt/czm/initiative/nonpoint.php>

## NATIONAL CORAL REEF PLANS

National Oceanic and Atmospheric Administration (2007). *Draft 2007 NOAA Guidance on Coral Reef Local*

*Action Strategies*. U.S. Coral Reef Task Force. (2000) *National Action Plan to Conserve Coral Reefs*. 41pp.

National Oceanic and Atmospheric Administration, Coral Reef Management Program (2008.) *NOAA Coral Reef Conservation Program Roadmap: A Plan for Developing CRCP Through 2015*. Washington, D.C. 12 pp.

NOAA Coral Reef Conservation Program (2009). *NOAA Coral Reef Conservation Program Goals and Objectives 2010–2015*. Silver Spring, MD:NOAA.

## MEETING REPORTS

Ferguson, O. (2007). *Envisioning the Future of Coastal Management, Hawai'i Stakeholder Meeting Summary*. National Oceanic and Atmospheric Administration. 13pp.

## MULTI-CRITERIA DECISION MAKING AND PRIORITIZATION

Angelidisa, M. and G. Kamizoulis (2005). "Rapid Decision-Making Method for the Evaluation of Pollution-Sensitive Coastal Areas in the Mediterranean Sea." *Environmental Management* Vol. 35, No. 6, pp. 811–820.

Lahdelma, R., P. Salminen and J. Hokkanen (2000). "Using Multicriteria Methods in Environmental Planning and Management." *Environmental Management* Vol. 26, No. 6, pp. 595–605

## OTHER AREA PLANS

The California Ocean Protection Council (2006). *A Vision for Our Ocean and Coast: Five Year Strategic Plan*. 60pp.

ESSIM Planning Office (2006). *Coral Conservation Plan, Maritimes Region* (2006–2010). Oceans and Coastal Management Division Oceans and Habitat Branch Maritimes Region Fisheries and Oceans Canada Bedford Institute of Oceanography. 71 pp.

Ferns, L. (2003). *Victoria's System of Marine National Parks and Marine Sanctuaries; Management Strategy 2003–2010*. Parks Victoria and the Department of Sustainability and Environment.

Great Barrier Reef Marine Park Authority (1994). *Keeping it Great: A 25 year Strategic Plan for the Great Barrier Reef World Heritage Area*. 74pp.

Gulf of Mexico Alliance (2006). *Governors' Action Plan For Health and Resilient Coasts*. 34pp.

Hennessey, J. (ed.), H. Ballash, M. Culver, K. Drew, S. Dzinbal, J. Hansen, M. Hershman, D. Larman, and B. Lynn (2006). *Washington's Ocean Action Plan: Enhancing Management of Washington State's Ocean and Outer Coasts*. Volume 2: Final Report of the Washington State Ocean Policy Work Group. 184pp.

National Resource Management Ministerial Council, Commonwealth of Australia (2006). *National Cooperative Approach to Integrative Coastal Management: Framework and Implementation Plan*. (Queensland) 57pp.

Shea, E.L, G. Dolcemascolo, C.L. Anderson, A. Barnston, C.P. Guard, M.P. Hamnett, S.T. Kubota, N. Lewis, J. Loschnigg, and G. Meehl. 2001. *Preparing for a Changing Climate: The potential Consequences of Climate Variability and Change*. East-West Center, Honolulu, Hawai'i. 100 pp.

## COASTAL PLANNING BOOKS

Clark, R and J. Alder. (2005) *Coastal Planning and Management* (2nd ed.). Taylor & Francis. 400pp.

## FUNDING

Emerton, L., Bishop, J. and Thomas, L. (2006). *Sustainable Financing of Protected Areas: A global review of challenges and options*. Gland, Switzerland and Cambridge, UK.: IUCN. x + 97pp.

Hawai'i Department Of Land And Natural Resources Division of Forestry And Wildlife. (2007). *Final Report To The Twenty-Fourth Legislature Regular Session of 2008 Requesting The Department Of Land And Natural Resources To Conduct An Analysis Of Incentives To Promote Landowner Protection Of Important Mauka Lands*. In response to House Concurrent Resolution 200, House Draft 1, Regular Session of 2006 State of Hawai'i, Honolulu, Hawai'i. 17pp.

Spergel, B and M. Moyer. (2004) *Financing Marine Conservation: A Menu of Options*. Center for Conservation Finance, Building Conservation Capital For The Future. Washington, DC: World Wildlife Fund. 76pp.

## ADAPTIVE MANAGEMENT

University of Michigan. (2003). *Measuring Progress: A guide to the development, implementation, and interpretation of an evaluation plan*. A publication of the Ecosystem Management Initiative, School of Natural Resources and Environment, University of Michigan. Development of this guide was partially supported by a grant from the William and Flora Hewlett Foundation and the McIntire-Stennis Forestry Research Program administered by the USDA-Cooperative State Research Service. 131pp.

## SECTION 2 REFERENCES

Caldeira, K., and M.E. Wickett. 2003. Anthropogenic Carbon and Ocean pH. *Nature* 425: 365.

De'ath, G., J.M. Lough, and K.E. Fabricius. 2009. Declining Coral Calcification on the Great Barrier Reef. *Science* 323: 116-119.

Friedlander, A.M. and DeMartini, E.E. 2002. Contrasts in density, size, and biomass of reef fishes between the northwestern and main Hawaiian islands: The effects of fishing down apex predators. *Marine Ecology Progress* 230: 253-264.

Friedlander, A.M. and Ziemann, D.A. 2003. Impact of hatchery releases on the recreational fishery for Pacific threadfin in Hawai'i. *Fishery Bulletin* 101:32-43.

Friedlander, Alan M. 2004. *Status of Hawaii's coastal fisheries in the new millennium: proceedings of the 2001 Fisheries Symposium*. Honolulu, HI: American Fisheries Society, Hawai'i Chapter.

Friedlander, A., G. Aeby, E. Brown, A. Clark, S. Coles, S. Dollar, C. Hunter, P. Jokiel, J. Smith, W. Walsh, I. Williams, and W. Wiltse. 2005. The State of Coral Reef Ecosystems of the Main Hawaiian Islands. pp. 222-269. In: J. Waddell (ed.), *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*. NOAA Technical Memorandum NOS NCCOS 11. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, MD. 522 pp.

Friedlander, A., G. Aeby, R. Brainard, A. Clark, E. DeMartini, S. Godwin, J. Kenyon, R. Kosaki, J. Maragos, and P. Vroom. 2005. The State of Coral Reef Ecosystems of the Northwestern Hawaiian Islands. pp. 270-311. In:

- J. Waddell (ed.), *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*. NOAA Technical Memorandum NOS NCCOS 11. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, MD. 522 pp.
- Friedlander, A. G. Aeby, R. Brainard, E. Brown, K. Chaston, A. Clark, P. McGowan, T. Montgomery, W. Walsh, I. Williams and W. Wiltse. (2008). The State of Coral Reef Ecosystems of the Main Hawaiian Islands. pp. 219-261. In: Waddell, J.E. and A.M. Clarke (eds.), 2008. *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008*. NOAA Technical Memorandum NOS NCCOS 73. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, MD. 569 pp.
- Grigg, R. 2003. Invasion of a deep black coral bed by an alien species, *Carijoa riisei*, off Maui, Hawai'i. *Coral Reefs*. 22: 121-122.
- Hawai'i Department of Business, Economic Development and Tourism. 2007 Visitor Statistics. Honolulu, HI.
- Hawai'i Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR). (2005). *Marine Protected Areas in Hawai'i*. Honolulu: Custom Publishing Group of the Honolulu Advertiser, March 9, 2005.
- Hawai'i Division of Aquatic Resources. 1988. Main Hawaiian Islands marine resources investigation: 1988 survey (DAR, Honolulu, HI).
- Holland, K.M., & Meyer, C.G. 2003. *Human Activities in Marine Protected Areas, Impact on Substrates; Final Report (Final Report)*. Kāne'ohe: Hawai'i Institute of Marine Biology.
- Jokiel, P. L. and Eric K. Brown. 2004. Global warming, regional trends and inshore environmental conditions influence coral bleaching in Hawai'i. *Global Change Biology* 10:1627-1641.
- Kenyon, J.C., Aeby, G.S., Brainard, R.E., Chojncaki, J.D., Dunlap, M.J., Wilkinson, C.B. 2006. Mass coral bleaching on high-latitude reefs in the Hawaiian Archipelago. Proceedings of the 10th International Coral Reef Symposium, June 28 to July 2, 2004, Okinawa, JAPAN: 631-643;
- Kenyon, J., and Brainard, R.E. 2006. Second recorded episode of mass coral bleaching in the NWHI, Atoll Res. Bull. 543: 505-523.
- Maly, K. and Maly, O. 2003. *A history of fishing practices and marine fisheries of the Hawaiian Islands*. Kumu Pono Associates LLC: Hilo, HI.
- Richmond, R.H. 1993. Coral reefs: present problems and future concerns resulting from anthropogenic disturbance. *American Zoologist* 33: 524-536.
- Sammarco, P.W. 1996. Comments on coral reef regeneration, bioerosion, biogeography, and chemical ecology: Future directions, *J. Exp. Mar. Biol. Ecol.* 200: 135-168.
- Smith, M.K. 1993. An ecological perspective on inshore fisheries in the Main Hawaiian Islands. *Marine Fisheries Review*, 55(2): 34-49.
- Ward Research Inc., 2001. Public Attitudes Towards Conservation: Research Among Statewide Residents. Prepared for Malama Hawai'i.
- Ward Research Inc., 2007. Perceptions of Hawaii's Living Reef Program: A Qualitative Study. Prepared for the Hawai'i State Department of Land and Natural Resources, Division of Aquatic Resources.

### SECTION 3 REFERENCES

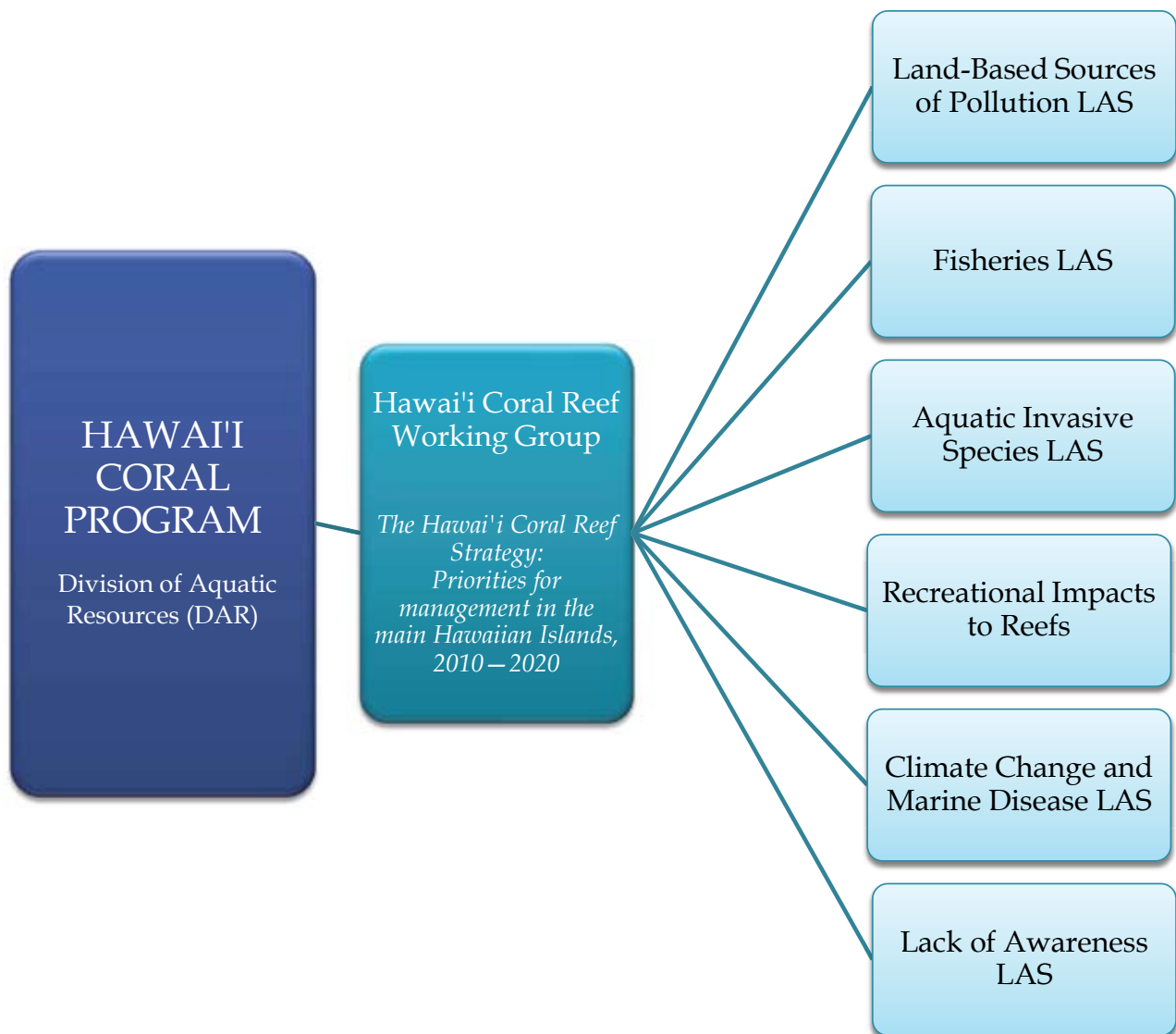
- Davidson, K., M. Hamnett and C. Minato (eds). 2003. *The First Four Years: Hawai'i Coral Reef Initiative Research Program, 1998-2002*. Social Science Research Institute, University of Hawai'i at Manoa. 72 pp.

### SECTION 6 REFERENCES

- Cesar, H., P. van Beukering, S. Pintz, and J. Dierking, 2002: *Economic valuation of Hawaiian reefs*. Cesar Environment Economics Consulting, Arnham, The Netherlands, 123 pp.

- Komoto, J. (2009) *Hawai'i Coral Reef Strategy (Draft 1)*. Honolulu. Division of Aquatic Resources.

# Appendix A: Hawai'i Coral Program Structure 2010



# Appendix B: Long-Term Goals and Objectives

This section provides the full list of goals and objectives developed through Hawaii's priority setting process. While these objectives were identified by stakeholders as important actions to protect coral reefs, they were not crafted as SMART objectives and therefore should be considered in draft form.

## HAWAI'I CORAL REEF MANAGEMENT GOALS

1. Coral reefs undamaged by pollution, invasive species, marine construction and marine debris.
2. Productive and sustainable coral reef fisheries and habitat.
3. Coral reef ecosystems resilient to climate change, invasive species and marine disease.
4. Increased public stewardship of coral reef ecosystems.

Each goal has two or more objectives. The high priority objectives (next 10 years) are underlined. Other lower ranked objectives have been included. While not identified as priorities of the Coral Reef Working Group, these objectives may be the focus of management activities by other agencies, nongovernmental organizations or community groups.

## HAWAI'I CORAL REEF MANAGEMENT OBJECTIVES

**GOAL 1: Coral reefs undamaged by pollution, invasive species, marine construction and marine debris.**

### Objectives

#### Site-Based Management:

- G1.1 Reduce key anthropogenic threats to two priority near-shore coral reef sites by 2015 and five by 2020 using ahupua'a based management.\*  
*\*Two sites—Ka'anapali-Kahekili (Maui) and Pelekane Bay-Puako-Anaeho'omalu Bay (Hawai'i)—were identified as 3–5 year priority areas for the program funding support.*
- G1.2 Improve and maintain wastewater infrastructure and urban stormwater runoff to limit sewage overflows and the delivery of pathogens to waterways starting with priority watersheds.
- G1.3 Reduce the discharge of sediment from construction sites through the use of best management practices at 10 priority sites by 2020.
- G1.4 Identify and implement specific initiatives to reduce sediment, nutrient and pathogen discharge from agriculture activities, including animal facilities in priority watersheds by 2020.

#### Pollution Control:

- G1.5 Double the existing monitoring and enforcement capacity for pollution control by 2020.
- G1.6 Double the volume of hazardous chemicals, pesticides and herbicides deposited at state disposal centers by 2020.



- G1.7 Analyze and update existing water quality standards by 2010 such that metrics developed for the designated use (standards) of coral reef conservation are met or exceeded.
- G1.8 Partner with other organizations to implement the Land-Based Debris Prevention objectives of the Hawai'i Marine Debris Action Plan.

*Alien Invasive Species:*

- G1.9 Prevent new AIS introductions and minimize the spread of established AIS populations by 2020.\*\*

*\*\*Common priority developed in collaboration with the Papahānaumokuākea Marine National Monument (PMNM)*

- G1.10 Mitigate the effects of three priority established marine alien species that threaten coral reefs by 2019.

*Native Ecosystems:*

- G1.11 Revise regulations to increase protection of critical native ecosystems, including wetlands, coastal lands, dunes, freshwater streams, riparian areas and native forests by 2020.
- G1.12 Implement at least five landowner conservation plans and land purchases for the protection of critical native ecosystems including wetlands, coastal lands, dunes, freshwater streams, riparian areas and native forests by 2016.
- G1.13 Implement at least five restoration plans for existing protected native ecosystems including wetlands, coastal lands, dunes, freshwater streams, riparian areas and native forests by 2020.

## GOAL 2: Productive and sustainable coral reef fisheries and habitat

### Objectives

*Fishing:*

- G2.1 Increase the abundance and average size of ten targeted coral reef fisheries species critical to reef health and ecological function by 2020.\*\*\*

*\*\*\*Species to be determined by FLASH advisory group*

- G2.2 Designate a sufficient area of marine waters under effective conservation by 2020 to ensure sustainable and resilient coral reef ecosystems.

- G2.3 Using valid catch, effort data and stock status, improve the basis on which fisheries management system decisions are made by 2020.

- G2.4 Improve collaboration and information-sharing among reef management agencies and between agencies and stakeholders by 2020.

*Recreation:*

- G2.5 Reduce anchor damage and trampling on coral reefs through the implementation of no-anchor zones, utilization of day-use mooring buoys and other means by 2020.
- G2.6 Design and implement culturally appropriate recreational management plans based on social and biological science for five sites by 2020.
- G2.7 Design and implement effective strategies to minimize impacts to coral reef ecosystems, endangered marine species and species of concern caused by recreational activities 2020.

*Other Habitat:*

- G2.8 Support research on the impacts on coral reefs and coastal processes, from changes to freshwater stream flows and ensure the

integrity of freshwater systems are restored and maintained in five priority sites by 2020.

- G2.9 Ensure regulatory oversight of near-shore ocean development, including aquaculture, mariculture and ocean energy that fully analyzes the potential impacts on reefs and reef systems by 2020.

### **GOAL 3: Coral reef ecosystems resilient to climate change, invasive species and marine disease.**

#### **Objectives**

- G3.1 Develop and implement protocols for interagency collaboration in the identification and response to incidents of coral bleaching, disease and aquatic invasive species by 2010.
- G3.2 Identify, prioritize and quantify the probable threats or effects to reefs and marine protected areas from climate change and alien species by 2020.
- G3.3 Partner with organizations to prepare climate change resiliency initiatives for coastal communities by 2020.

### **GOAL 4: Increased public stewardship of coral reef ecosystems.**

#### **Objectives**

- G4.1 Consolidate, develop and disseminate education materials for specific threats to targeted audiences.
- G4.2 Develop a social marketing campaign that improves the public stewardship of reefs and disseminates educational information about the ecological, social, cultural and economic significance of reef systems in Hawai'i by 2020.
- G4.3 Partner with the network of community organizers and Hawaiian cultural practitioners to provide cultural and

technical support to community-level reef management efforts consistent with traditional ahupua'a principles.

- G4.5 Increase the percentage of the visitor industry involved in coral reef stewardship projects by 2020.
- G4.6 Establish programs and curricula to build youth capacity for reef management by 2020.



*A manta ray gets cleaned by cleaner wrasse at a cleaning station off Maui. Photo Credit: Ed Lyman*

# Appendix C: Overview of the Marine Ecoregional Assessment for the Main Hawaiian Islands

Prepared by The Nature Conservancy of Hawai'i (2009)

**The purpose** of the marine ecoregional assessment conducted by The Nature Conservancy (TNC) from 2007–2009 was to identify a collection of biologically important areas that optimally reflect the diversity of habitat types and marine life found within the waters of the main Hawaiian Islands (MHI) portion of the Hawaiian Archipelago. To do this, three products were developed by TNC and a working group of government, academic and individual experts: (1) a spatial database of the ecoregion's biodiversity and factors affecting it, (2) a decision-support framework to evaluate conservation alternatives and (3) identification of biologically important areas.

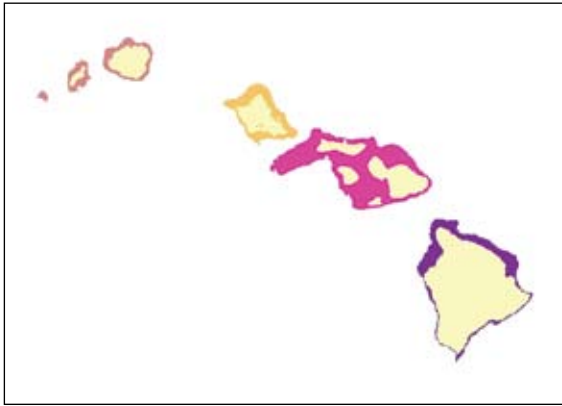
**The MHI ecoregion** supports a diverse array of marine habitats, encompassing estuaries, tidepools and other rocky intertidal habitat, sandy beaches, seagrass beds, extensive fringing reef and barrier reef systems and deep-water coral reefs. Coral reef communities fringe the entire Hawaiian archipelago, totaling more than 140,000 acres of reefs around the main islands alone—an area comparable in size to the island of Moloka'i. Hawai'i has one of the most unique marine ecosystems on earth because of the high endemism across multiple taxa (algae, coral and fish). It also supports some of the nation's most endangered marine species, including Hawksbill sea turtles and Hawaiian monk seals. In addition to biological significance, the vast coral reef ecosystem is a valuable asset that contributes culturally and economically to Hawaii's future. The coral reefs create habitat for many fish and invertebrate species with commercial value, support tourism and recreational industries and shelter coastlines from natural disturbances. Life in Hawai'i depends upon a healthy and thriving marine environment.

**THE PROCESS.** The ecoregional assessment follows a standard process developed and used by TNC to analyze and identify a collection of biologically important areas that, if effectively managed, would collectively represent and conserve the biodiversity found within the ecoregion. The three main phases of such ecoregional assessments include: (1) laying the foundation by defining goals and geography; (2) collecting, analyzing and creating geo-referenced data relating to conservation targets and threats; and (3) identifying biologically important areas that would represent the optimal collection of all conservation targets, as generated through GIS analysis and expert focus group review and consensus.

## Principal Steps in the Process

1. Define ecoregional boundaries
2. Identify and map biological resources
3. Assess viability of these resources
4. Establish conservation goals & targets
5. Assess and define critical threats
6. Identify biologically important areas
7. Choose sites for collaborative action
8. Implement ecoregional strategies

**Phase 1: Laying the foundation.** During this initial phase, an internal project team was established to set project goals for the ecoregional assessment. An assessment framework was then developed as the foundation for the project, including a clear geographic definition of ecoregional boundaries and units of analysis at various scales. The project team also established an external advisory group to guide the overall ecoregional assessment process.



Under this framework, the MHI ecoregion was divided into “stratification” units to ensure that adequate representation of existing biodiversity throughout the region was reflected in the analysis and results. Four stratification units were identified for the MHI assessment: (1) Kaua’i-Ni’ihau, (2) O’ahu, (3) the Maui Niu Complex (Maui-Moloka’i-Lāna’i) and (4) Hawai’i Island.

**Phase 2: Data collection and analysis.** During the second phase of the project, the team reviewed existing literature and technical reports and consulted with biological experts in order to collect all existing relevant information on conservation targets—the specific elements of biodiversity in the MHI (e.g., systems, species or processes) used to define geographic areas. A representative set of the ecoregion’s conservation targets were selected and spatially mapped using GIS. For each target, a conservation goal was set—e.g., the amount of relevant habitat that must be preserved to protect viable target populations and communities representing the full range of diversity within the ecoregion.

Factors likely to affect the viability of a target or suitability of a specific area were also identified and mapped (e.g., presence of invasive alien algae). For each conservation target, experts provided information on the primary sources of stress, which were then cumulatively ranked. For each source, spatial data were compiled and experts determined the intensity and sphere of influence of each stress. A suitability index was generated by tallying the total number of impacts within any given planning unit. If there were multiple options for places to capture

### Suite of Targeted Biological Resources

**Coarse Filter:** estuarine, rocky and sandy intertidal, seagrass bed, halimeda meadow, unconsolidated sediment (sand), nearshore coral reef ecosystem, deepwater benthic habitat

**Fine Filter:** green turtle nesting, hawksbill turtle nesting and foraging, humpback whale wintering, manta ray feeding and cleaning, monk seal pupping beaches, spinner dolphin resting

the same quality of targets, the ones with the lower threats were considered more viable.

### Phase 3: Identifying biologically important areas.

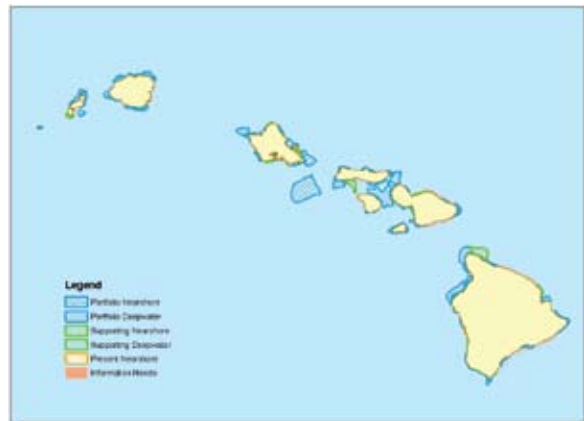
The selection of biologically important areas that optimally represented all conservation targets across the ecoregion was achieved using two tools: (1) a computer modeling program (MARXAN) that uses GIS data; and (2) scientific expert focus group review and consensus building. The computer program MARXAN is an established and commonly used decision-support tool used to dynamically analyze georeferenced information on targets, goals, suitability and other factors so that they can be spatially optimized and represented under different scenarios. The inputs of MARXAN analysis include:

Dozens of scenarios were run using MARXAN to generate the optimal and most realistic collection of sites that meet the stated conservation goals within the ecoregion. Once an optimal, representative set of biologically important sites within the MHI ecoregion was generated out of MARXAN, these sites were presented to scientific expert focus groups by stratification unit for their review, discussion, revision and consensus. This expert review was critical not only because it helped to validate and refine the MARXAN results through expert opinion, but also because the review process helped the project team to identify issues regarding data quality and information gaps within the analysis.

**THE RESULT.** Based on the expert review and the stated design principles (e.g., delineate sites to encompass entire biological units and focus on areas of highest biological suitability), a final collection of biologically important areas was delineated. The end result was the identification of a set of 65 biologically important areas that collectively represent the most viable examples of conservation targets, including both habitats and species, which exist across the four stratification units. Details of the number of sites and coverage by planning unit are in the table below.

**ACKNOWLEDGEMENTS.** The marine ecoregional assessment involved many partners in academia, state and federal agencies, nongovernmental and community organizations and individuals. Contributions by biological experts from the following agencies were critical to the success of the assessment outcome: U.S. Fish & Wildlife Service; Hawai'i Department of Land & Natural Resources, Division of Aquatic Resources; National Oceanic and Atmospheric Administration; and the University of Hawai'i.

Stratification Unit	Ecoregion (to 500m)	
	Number of Sites	Percent of Waters Encompassed
All	65	33%
Hawai'i	14	40%
Maui Nui	24	34%
O'ahu	12	31%
Kaua'i Ni'ihau	15	36%



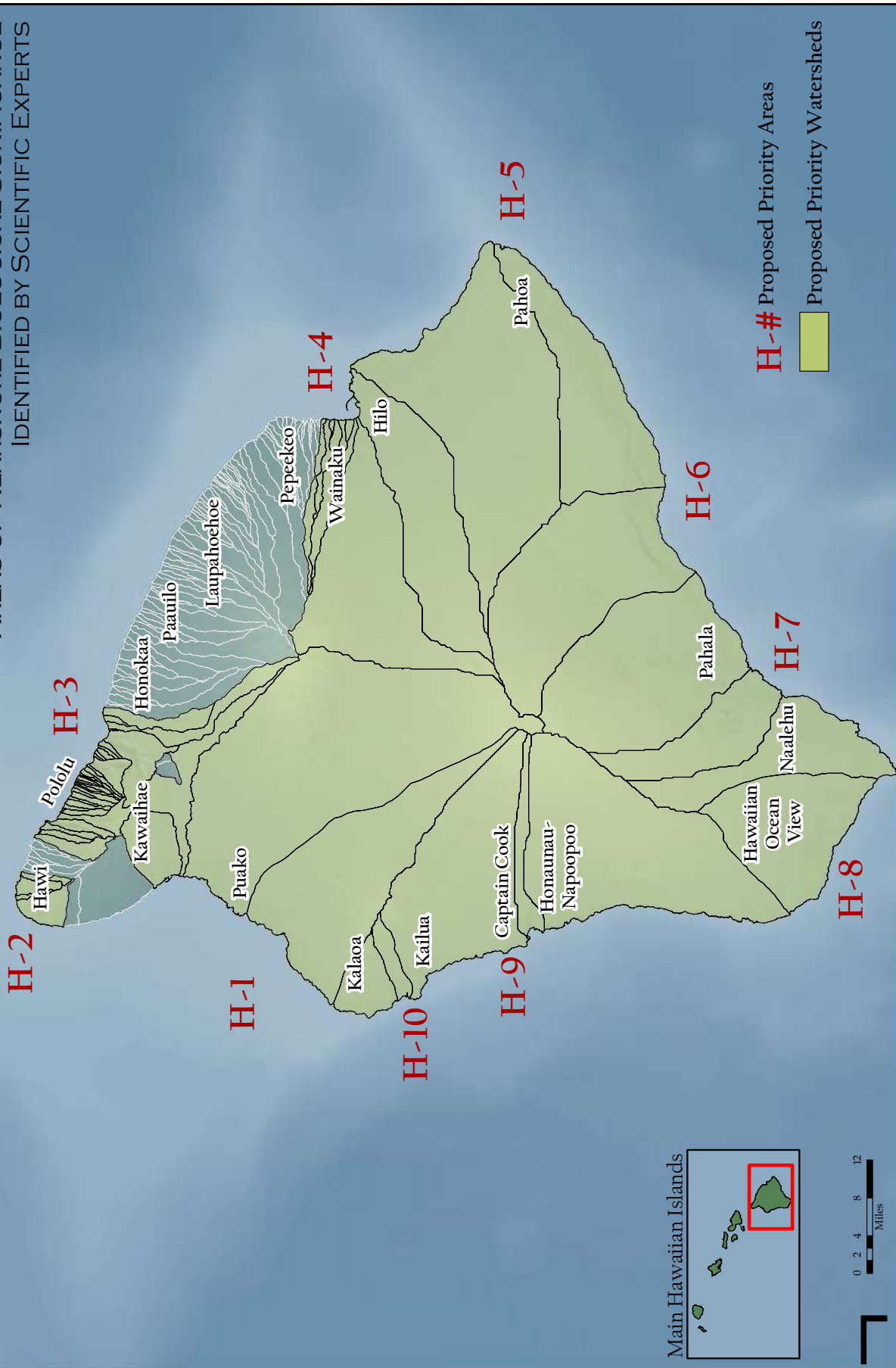



# Appendix D: Hawaii's Coral Reef Strategy Site Prioritization Map



# HAWAII'S CORAL REEF STRATEGY SITE PRIORITIZATION MAP

AREAS OF NEARSHORE BIOLOGICAL SIGNIFICANCE IDENTIFIED BY SCIENTIFIC EXPERTS

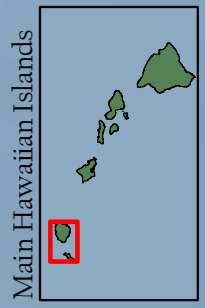
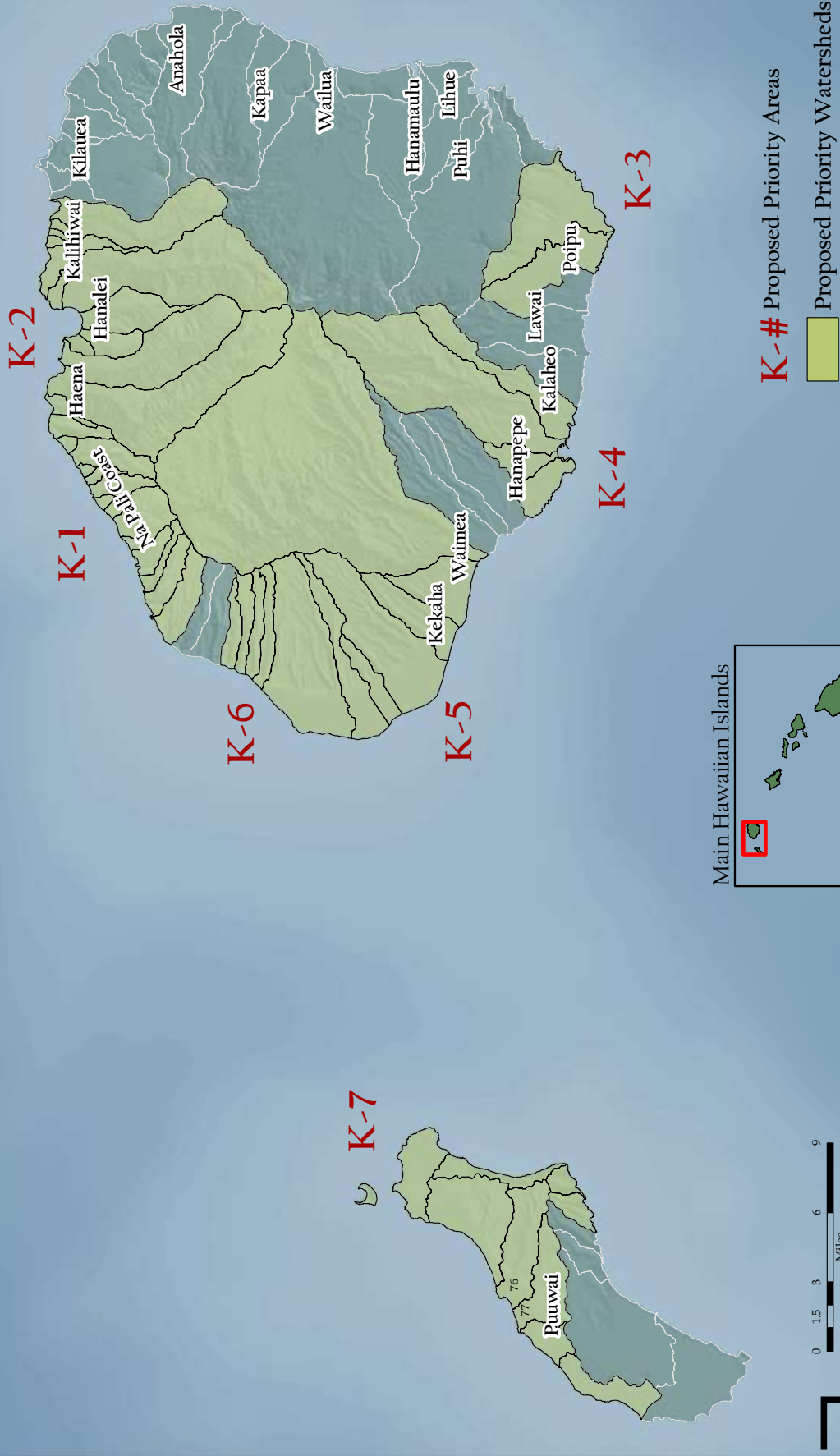


**H-#** Proposed Priority Areas  
 Proposed Priority Watersheds



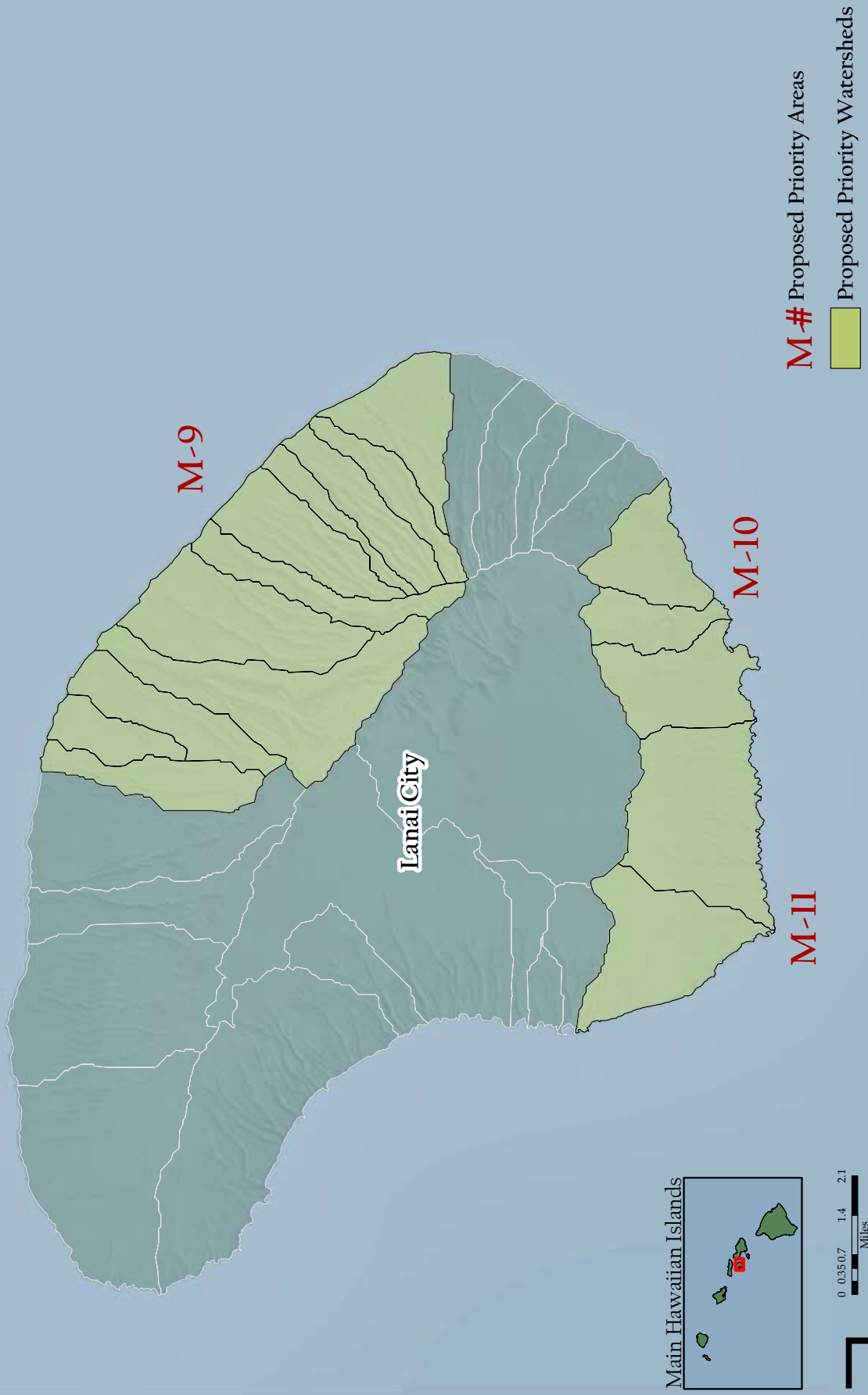
# HAWAII'S CORAL REEF STRATEGY SITE PRIORITIZATION MAP

AREAS OF NEARSHORE BIOLOGICAL SIGNIFICANCE IDENTIFIED BY SCIENTIFIC EXPERTS



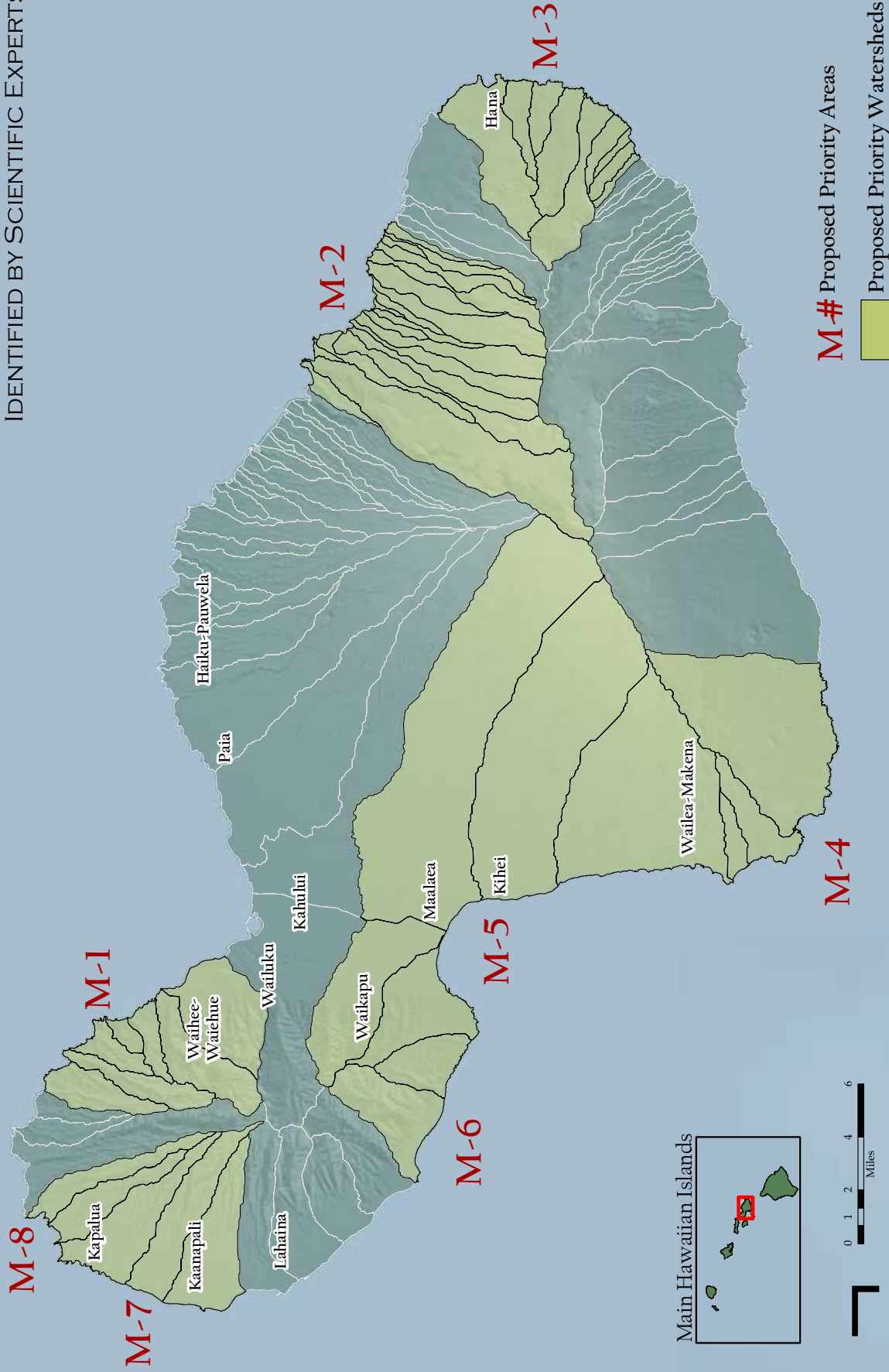
# HAWAII'S CORAL REEF STRATEGY SITE PRIORITIZATION MAP

AREAS OF NEARSHORE BIOLOGICAL SIGNIFICANCE IDENTIFIED BY SCIENTIFIC EXPERTS



# HAWAII'S CORAL REEF STRATEGY SITE PRIORITIZATION MAP

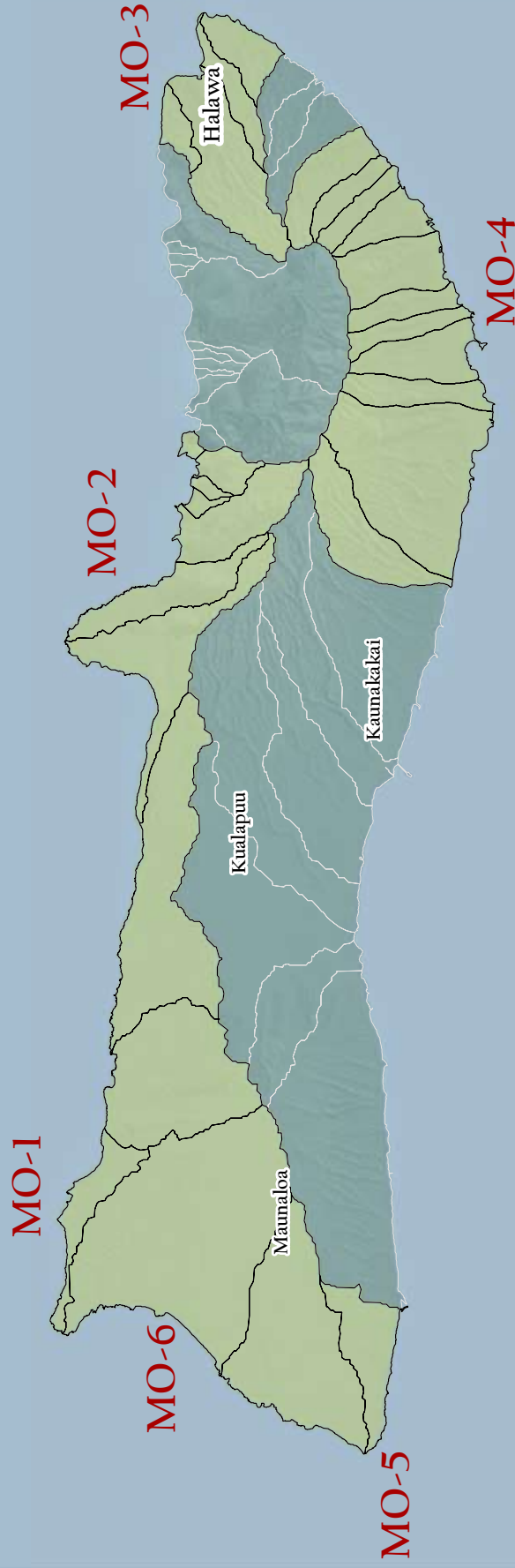
AREAS OF NEARSHORE BIOLOGICAL SIGNIFICANCE IDENTIFIED BY SCIENTIFIC EXPERTS





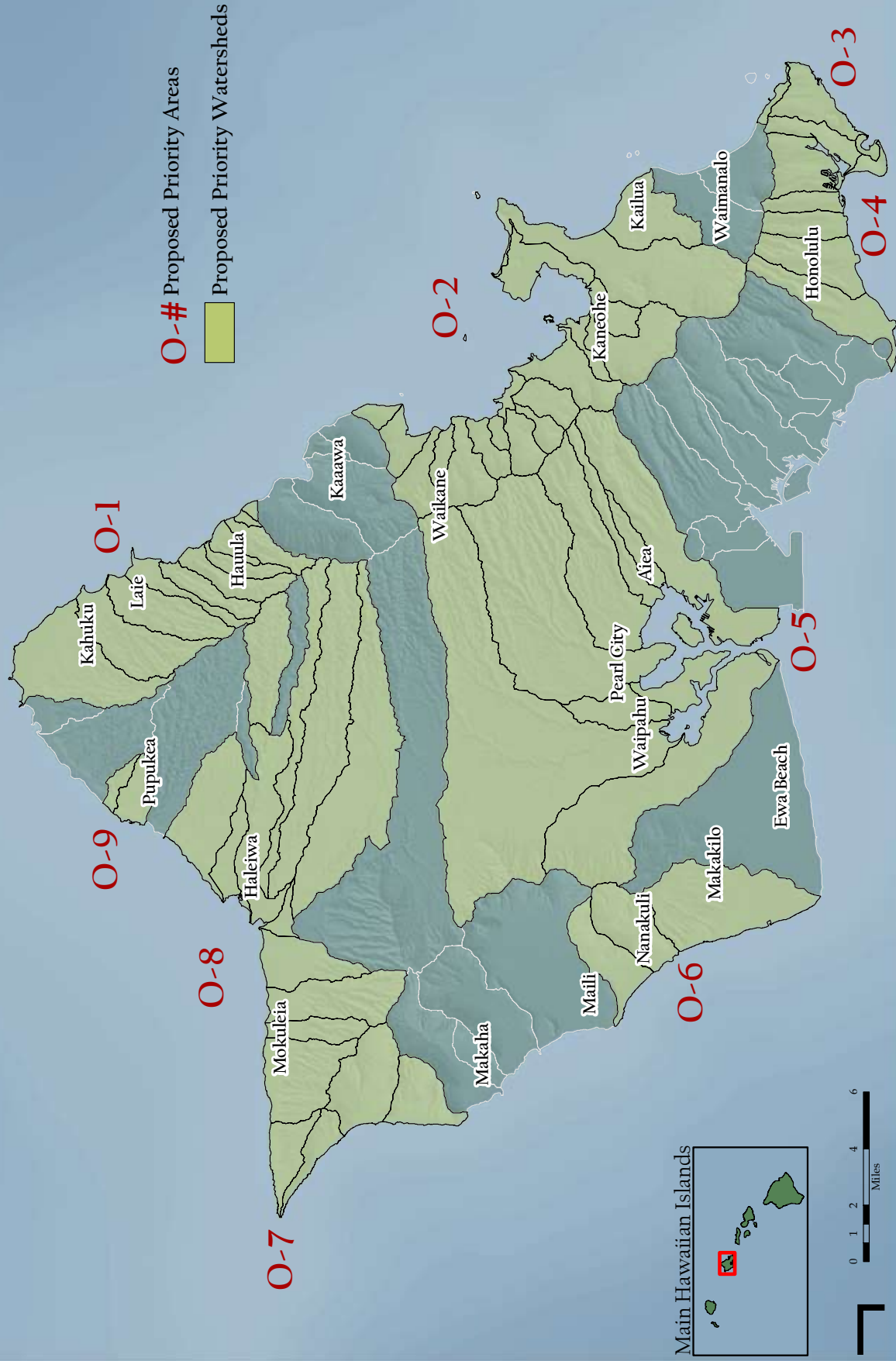
# HAWAII'S CORAL REEF STRATEGY SITE PRIORITIZATION MAP

AREAS OF NEARSHORE BIOLOGICAL SIGNIFICANCE IDENTIFIED BY SCIENTIFIC EXPERTS



# HAWAII'S CORAL REEF STRATEGY SITE PRIORITIZATION MAP

AREAS OF NEARSHORE BIOLOGICAL SIGNIFICANCE IDENTIFIED BY SCIENTIFIC EXPERTS



# Appendix E:

## CRWG Ranking Results

Two sites—Ka'anapali-Kahekili and Pelekane Bay-Puako-Anaeho'omalū Bay—were identified as priority areas for the program.

Hawai'i Coral Reef Strategy Priority Sites (As ranked by the Hawai'i Coral Reef Working Group, July 2009)							
	SITE	READINESS	URGENCY	CROSS-LAS POTENTIAL	Likelihood of Success	Total Score	Average Score
1	Ka'anapali- Kahekili (M-7)	64	66	70	61	261	18.6
2	Puako- Kalaoa (H-1)	59	48	58	54	219	16.8
3	Maunalua Bay (O-4)	66	59	64	31	220	15.7
4	Kāne'ohe Bay (O-2)	48	65	67	31	211	15.1
5	Olowalu (M-6)	36	51	53	47	187	14.4
6	Hā'ena- Hanalei (K-2)	42	47	57	38	184	14.2
7	Kealakekua (H-9)	47	33	39	46	165	12.7
8	Wai'anae (O-6)	27	48	58	35	168	12.0
9	South Shore Moloka'i (MO-4)	30	49	51	27	157	11.2

All LAS Meeting Site Ranking Results				
Island	General Area	% total of yellow	% total of red	% of island votes (yellow)
H-9	Kealakekua	10.32%	14.14%	54.17%
O-2	Kāne'ohe Bay	14.29%	13.13%	45.00%
M-7	Ka'anapali_Kahekili	13.49%	11.11%	50.00%
M-6	Olowalu	9.52%	11.11%	35.29%
MO-4	South Shore Moloka'i	4.76%	10.10%	60.00%
O-6	Wai'anae	4.76%	8.08%	15.00%
K-2	Hā'ena_Hanalei	8.73%	6.06%	61.11%
H-1	Puako_Kalaoa	4.76%	6.06%	25.00%
O-4	Maunaloa Bay	4.76%	6.06%	15.00%
O-9	Pūpūkea	3.97%	3.03%	12.50%
O-3	Hanauma_Makapu'u	1.59%	3.03%	5.00%
M-3	Hana	0.79%	3.03%	2.94%
MO-1	Mo'omomi	3.17%	1.01%	40.00%
O-5	Pearl Harbor	0.79%	1.01%	2.50%
K-4	Hanapepe	0.00%	1.01%	0.00%
M-11	South Shore Lāna'i	0.00%	1.01%	0.00%
M-10	Manele_Hulopoe	0.00%	1.01%	0.00%
H-4	Hilo Bay	3.97%	0.00%	20.83%
K-1	Nā Pali	3.17%	0.00%	22.22%
K-3	Po'ipū	2.38%	0.00%	16.67%
M-8	Honolua	2.38%	0.00%	8.82%
M-4	'Ahihi Kina'u	0.79%	0.00%	2.94%
O-1	Kahuku_Hau'ula	0.79%	0.00%	2.50%
O-7	Ka'ena Point	0.79%	0.00%	2.50%

\*Site identifier corresponds with The Hawai'i Coral Reef Strategy Site Prioritization Maps (Appendix D)





