PRIORITIES FOR CORAL REEF MANAGEMENT IN THE HAWAIIAN ARCHIPELAGO 2010–2020

Hawai‘i Coral Reef Working Group
Papahānaumokuākea Marine National Monument
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Glossary

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

Section 1: Introduction

Need and Purpose of an Archipelagic Coral Reef Management Priorities Document

Recent federal initiatives by the National Oceanic and Atmospheric Administration (NOAA) have provided an impetus for the development of this Hawaiian Archipelago Coral Reef Management Priorities document. While NOAA's national level goals and objectives have special emphasis on addressing the impacts of climate change, fishing and land-based sources of pollution, it was recognized that state and territory priorities also needed to be identified to effectively manage coral reefs in the United States. As such NOAA's Coral Reef Conservation Program (CRCP), which provides substantial funding for reef management activities, has facilitated initiatives within each jurisdiction and in consultation with site managers to develop reef management priorities for the years 2010–2020 addressing key threats to coral reefs. NOAA CRCP will use this document to direct its investment and 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. NOAA will also make the document available to other potential funders (NGOs, federal partners, etc.) and encourage leverage and partnership to build common coral reef conservation goals.

Hawaiian Archipelago Coral Reef Management Priorities Document Process

The Hawaiian Islands Archipelago has often been divided into two separate geographic regions when developing management strategies: the Main Hawaiian Islands (MHI) and the Northwestern Hawaiian Islands (NWHI). This distinction has been made mainly due to the vast geographic scope that the archipelago represents stretching for over 1,500 miles across the Pacific, as well as the distinct differences in threats in the larger eight populated islands versus the smaller non-populated islands to the northwest. However, this document is aimed at representing the coral reef resource management priorities throughout the entire archipelago, recognizing the value and importance of managing reefs at an ecoregional scale as well as coordinating and leveraging management efforts among both regions. The Hawaiian Archipelago has been designated as its own distinct Large Marine Ecosystem.

To coordinate and leverage management efforts at an ecoregional scale, this document identifies a set of goals and objectives designed to serve as a framework for management activities affecting coral reefs in the Hawaiian Archipelago for the next decade. This priorities framework is the result of the analysis of relevant ocean management plans, numerous past public meetings and interviews of key stakeholders representing input by hundreds of individuals and organizations. There are two specific processes and plans that significantly inform the scope of this document. They are:

1. *The Hawai'i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands, 2010–2020*, and

2. The Papahānaumokuākea Marine National Monument Management Plan

In addition, recent efforts made by the Hawai‘i Conservation Alliance to address climate change are referenced as they will provide valuable leverage throughout the archipelago in addressing this threat.

The Hawai‘i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands, 2010–2020

The eight main Hawaiian Islands support over 140,000 acres of coral reef habitat. On the most southern and largest island—Hawai‘i—reefs are still forming around an island that continues to grow in size due to an active volcano. The types and variety of marine habitats are highly varied from island to island, from coral communities to fringing reefs, to unique patch reefs, reef slopes and barrier reefs. Reefs around population centers in the urban areas have been heavily impacted by development, runoff and overuse, experiencing increasing stress from human and land-based impacts due to ever-increasing population pressures (Friedlander et al., 2008).

The State of Hawai‘i Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR) is the primary agency responsible for managing Hawaii's aquatic resources and coordinating Hawaii's reef management efforts in the main Hawaiian Islands. Over the past 10 years, DAR has 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 (supported by the EPA), Recreational Impacts to Reefs, and Aquatic Invasive Species. LAS were developed as three-year strategic documents and included goals, objectives and activities to abate respective threats. DAR also completed the marine component of the Comprehensive Wildlife Conservation Strategy, and developed a draft Marine Protected Areas (MPA) framework 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. In order to provide a more cohesive strategy for coral reef management in Hawai‘i, DAR began development of *The Hawai‘i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands 2010–2020* (HCRS) in May 2007. 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 and in 2008 restructured to advise the development of The Hawai‘i Coral Reef Strategy.

Initial steps in the strategic planning process included review and analysis of numerous ocean, coral reefs, watershed, coastal zone management and ecosystem-based management plans. The DLNR–DAR administrator, program managers and biologists were interviewed to gather their insights regarding gaps in coral reef conservation, emerging priorities and key management tasks necessary to improve overall coral reef

conservation in Hawai‘i. Similar questions were asked of members of the CRWG, LAS Advisory Groups and other key stakeholders. Draft priorities were completed with an initial set of goals, objectives and actions in 2008.

The process of refining and ranking goals and objectives for The Hawai‘i Coral Reef Strategy began in November 2008 and was guided by the CRWG. DAR partnered with the NOAA CRCP consultant and local NOAA staff to design and implement a priority setting process for the ten-year strategy. The process included an ongoing exchange of expert opinion between the CRWG, LAS Advisory Groups, and DAR biologists. Further details on the process for development of goals and objectives can be found in Appendix 1 (HCRS, Section 3: Scope, Development and Prioritization Process of Hawaii's Coral Reef Management).

Papahānaumokuākea Marine National Monument Management Plan

In addition to the eight main islands, the Hawaiian Island Archipelago also includes a chain of ten small islands and atolls. Starting 155 miles north and west of the island of Kaua‘i, these small islands and atolls, once referred to as the Northwestern Hawaiian Islands (NWHI), were recently designated as the Papahānaumokuākea Marine National Monument (PMNM). Extending over 1,200 miles and encompassing an area of approximately 140,000 square miles, Papahānaumokuākea is one of the largest MPA in the world. The abundant coral ecosystem that can be found in the subtropical waters of Papahānaumokuākea were one of the primary reasons for imposing a restrictive management system over the area. Coral covers an area of 911,077 acres within the boundaries of Papahānaumokuākea. Fifty-seven species of stony corals have been identified in the shallow subtropical waters including seventeen species found only in the Hawaiian Archipelago [Papahānaumokuākea Marine National Monument Plan, 2008, 27].

Management of the PMNM is shared by three trustees acting on behalf of the State of Hawaii's Department of Land and Natural Resources, the U.S. Department of Interior [through the Fish and Wildlife Service] and the Department of Commerce (through NOAA). Except for Midway, Laysan and Tern Islands and French Frigate Shoals, the islands of Papahānaumokuākea are uninhabited. Access to PMNM and its resources is carefully regulated by the PMNM management staff and a rigorous permitting process. Activities with potentially adverse impacts, such as commercial fishing, are being phased out by 2011. As part of this process, co-trustee agencies and their staff were consulted to identify priority coral management objectives for the NWHI.

Between 2000 and 2005, NOAA conducted an extensive information-gathering process, including over 100 meetings with jurisdictional agency partners, the Reserve Advisory Council, NGOs, fishing and other stakeholder groups with the aim of developing a range of alternatives to create a National Marine Sanctuary in the NWHI. When the Monument was designated in June 2006, the proclamation instructed the co-trustees to use the draft Sanctuary Management Plan as the basis for the development of a comprehensive Monument Management Plan. Additional public informational meetings

on each island as well as a formal request for additional input and public hearings on the draft Monument Management Plan provided significant opportunity for input into the develop of the final plan. Between 2000 and 2009, over 65,000 public comments were received, which provided the basis for the final documents.

Hawai‘i Conservation Alliance

Also to be noted in this document are recent efforts to address the current and future impacts from global climate change by the Hawai‘i Conservation Alliance (HCA). HCA is a collaboration of conservation leaders representing 15 state and federal agencies, educational institutions and nonprofit organizations. Collectively, HCA members are responsible for managing the biodiversity of Hawaii's lands and waters. HCA also represents people who work and use the land and water for social, cultural and agricultural purposes. The member organizations of HCA are at the forefront of research on climate change impacts, the development of management solutions that encompass mitigation and adaptation, and effective communications about climate change. As climate change is a threat to the entire archipelago, it is anticipated that HCA will become a strong partner in mitigating this threat to coral reefs. To do this, HCA and its members will continue:

- conducting critical research on climate change impacts to natural systems and native species;
- developing, implementing and sharing best management practices;
- crafting policy recommendations for mitigation and adaptation strategies;
- convening conferences, forums and other meetings to enable the sharing of knowledge and strategies by experts from a variety of disciplines;
- providing education and outreach to residents and visitors about climate change impacts on Hawaii's lands, waters and native species;
- coordinating between member organizations; and
- directing funding and other resources to Hawai‘i.

Section 2: Context

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 live, consists of high volcanic islands with nonstructural 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., 2005a).

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

Hawaii’s coral reef and coastal ecosystems reflect a wide variety of habitats as described above. In the Main Hawaiian Islands these habitats are impacted by a combination of natural- and human-induced events. According to the Hawai‘i section of the *Status of the Coral Reef Ecosystems of the United States* (Friedlander et al., 2008), the condition of marine resources has generally degraded in the MHI over the past 20 years. This is not the case for the more isolated and protected NWHI. While Hawaii’s reefs are still in fair to good condition, many urban areas and popular destinations have suffered from land-based sources of pollution, fishing pressure, recreational overuse and invasive species.

Land-Based Sources of Pollution

Land-based sources of pollution are not a threat to the reefs of the NWHI. However, Land-based sources of pollutants, such as sediment, nutrients and other pollutants, represent one of several factors threatening the quality of coral reef ecosystems in the MHI. 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, 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 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 damage to nearshore 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, which 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 nearshore 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. Impacts from toxic pollutants are also poorly understood but also potentially severe.

Fishing Pressure

Coral reef fisheries are an integral part of life in Hawai‘i, providing resources such as food, recreation, commerce and culture. 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:

- 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 4 million visitors. Slightly over half of these visitors from the U.S. West and Canada went snorkeling or diving (Hawai‘i Department of Business, Economic Development and Tourism, 2007). There are over 1,000 ocean tourism companies in Hawai‘i, 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 Hawai‘i are not fully understood and the relative impacts of different activities have not been evaluated, negative impacts from recreational activities are well documented.

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 boat traffic but also sometimes deliberately introduced in a misguided attempt to supplement local fisheries and aquaculture. 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 for thousands of years 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. Many introduced fish have caused the decline of native species through

competition for food and habitat. Non-native invertebrates like 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.

In sharp contrast to the MHI, which harbors at least 287 introduced invertebrates, only five introduced invertebrates have been established in the NWHI, mainly around the harbor at Midway Atoll and French Frigate Shoal—the sites with the longest histories of human activity. Only two introduced species are found throughout the NWHI archipelago: a hydroid and Taapae. The populations of AIS that have become well established and colonized in areas of the MHI are the most likely sources of invasive species in the NWHI. To address this threat, the PMNM requires hull inspections of all vessels entering these waters from the MHI.

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).

The first recorded incidents of mass coral bleaching were documented in the NWHI in 2002 and again in 2004 throughout the NWHI. In both years, the incidents of bleaching were greatest at the northern-most three atolls of Pearl and Hermes, Midway and Kure. Bleaching was most extensive on the shallow back reef flats and inner lagoon habitats, with evidence of some coral mortality.

Ocean acidification is a risk throughout the archipelago. Worldwide, oceans absorb approximately one-third of the additional CO_2 generated every year by human activities, making the ocean more acidic (Caldeira and Wickett, 2003). This uptake of CO_2 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. Aeby (in press) and Aeby and Work (unpub. data) found that the most common disease in both the Main and Northwestern Hawaiian Islands is *Porites trematodiasis* (CCMD LAS, 2006). Levels of disease appear stable throughout time in most areas of the archipelago with the exception of Acropora white syndrome at French Frigate Shoals, and Porites growth anomalies and Montipora white syndrome at sites in the MHI.

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 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. The NWHI provides a unique opportunity for some of these practitioners to experience the marine resources in a natural state, and to compare and contrast the relatively pristine areas with the resources in their own backyards. 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.

Marine Debris

Marine debris from marine and terrestrial sources continues to wash up on the shores of the islands throughout the Hawaiian Archipelago daily. Marine debris, specifically derelict fishing gear (DFG), continues to present a potentially lethal entanglement hazard to various marine species of concern, including the critically endangered Hawaiian monk seal, the threatened green turtle, several protected species of whales and other wildlife. DFG also causes significant physical damage to sensitive reef habitats, including corals and other flora and fauna, and may serve as a potential vector for invasive species. Between 2005 and 2007, over 100 tons of marine debris were removed from beaches in the MHI (Friedlander et al., 2008). The amount that washes ashore is likely much higher, as this figure only represents the documented efforts of community groups.

In the NWHI, efforts to reduce entanglements to the Hawaiian monk seal have been underway since 1982. To date, over 600 metric tons of marine debris, mainly comprised of DFG, has been removed from the reefs and beaches of the NWHI. While DFG is the main source of the marine debris, more than 70% of the smaller debris that washes ashore is made of plastic, including buoys, bottles and cigarette lighters (Morishige, 2007). There is also evidence to suggest an increase in marine debris on the shores of the NWHI during the El Niño periods (Morishige, 2007).

Cumulative Impacts

While each of these threats is described separately, it is nearly impossible to link only one as the main threat to coral reefs in the Hawaiian Islands. For example, excessive nutrient runoff increases macro-algae (often invasive) blooms. This problem is exacerbated through over-fishing with the removal of herbivores from the system who normally keep algal populations down. 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: Management Framework and Guiding Principles

Management Framework

To comprehensively and effectively address threats to coral reefs and carry out priority management goals, it is important that management agencies and organizations involved in coral reef conservation approach their work collaboratively and where appropriate with an ecoregional and/or archipelagic view. No longer is it appropriate to manage Hawaii's resources as two separate units. As such, the management framework proposed in this document is one that fosters coordination, information sharing, resource-sharing and appropriately scaled research and management to bridge solutions across the two ends of the archipelago.

Additionally, it has been established that resource management is more successful when stakeholders are engaged. As such, Hawaii's communities should be included as constituents and stakeholders of both the areas where they live and the remote, uninhabited islands, atolls and reefs of the NWHI. This management framework also promotes the engagement of communities in ways that (1) encourage an understanding of the numerous values and threats to our nearshore resources, and (2) empower them with skills to be stewards of the reefs.

Guiding Principles

In determining the management priorities for coral reefs across the archipelago, core principles and practices were identified during both MHI and PMNM planning processes as crucial for success. As such, a core set of principles have been identified that will serve as the foundation for how work will be conducted to address the primary threats to coral reefs in Hawai'i.

These principles should help guide the development of coral reef management projects and programs to maximize effectiveness of these efforts. As such, these principles can also assist decision-makers in how resources will be allocated to address the key threats. Those efforts that incorporate these principles should be considered more likely for success and therefore higher priority over those efforts that do not take these principles into consideration.

Coral reef management efforts in the Hawaiian Archipelago should aim to:

- Integrate and foster land-sea (reef-to-ridge) connections.
- Bridge indigenous, local and community knowledge with western science by directly engaging Hawaiian scholars, practitioners, ocean-users and communities.
- Involve social science as well as biophysical science in an interdisciplinary ecosystem-based management approach.
- Incorporate community needs and priorities in project planning, implementation and evaluation.
- Address priority needs and threats through an archipelago-wide and/or ecoregional approach as appropriate.
- Build local capacity, enabling on-the-ground managers and communities to increase their respective abilities to conduct local-level management.
- Foster communication that is locally/culturally appropriate, and effectively conveys information to various stakeholders.

Section 4: Ten-Year Priority 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 Hawaiian Islands from 2010–2020.

The complete list of “long-term goals and objectives” for coral conservation developed through both the MHI Coral Strategy process and Papahānaumokuākea Marine National Monument management planning process can be found in Appendix 1 (HCRS, Appendix B: Long-Term Goals and Objectives). However, the intent of this document is to identify medium-term goals and objectives for conserving Hawaii’s coral reefs. These ***Priority Goals and Objectives*** identified in Table 1 will guide Hawai‘i coral management activities over the next ten years. Those objectives identified as having a geographic focus of ARCH will be targeted for partnership activities among state agencies and PMNM. Those objectives identified as only a PMNM geographic focus will be primarily implemented by the PMNM while those identified as having a MHI geographic scope will be primarily implemented through activities funded by the Hawai'i Coral Reef Management and Monitoring grant.

Table 1: Hawaii's Ten-Year Priority Goals and Objectives for Coral Reef Management
MHI = Main Hawaiian Islands, PMNM = Papahānaumokuākea Marine National Monument, ARCH = Archipelago wide

Geographic Priority = MHI PMNM ARCH	Ten-Year Priority Goals and Objectives
	GOAL 1: Coral reefs undamaged by pollution, invasive species, marine construction and marine debris.
MHI	Reduce key anthropogenic threats to two priority nearshore coral reef sites by 2015 using ahupua'a-based management. *Two sites—Ka'anapali-Kahekili and Pelekane-Puako-Anaeho'omalu Bay—were identified as 3–5 year priority areas for the program funding support.*
ARCH/MHI	Prevent new AIS introductions and minimize the spread of established AIS populations by 2020.
PMNM	Derelict fishing gear will be removed from coral reef environments at or above the rate at which it is introduced, minimizing damage to coral reefs.
	GOAL 2: Productive and sustainable coral reef fisheries and habitat.
MHI	Increase the abundance and average size of five targeted coral reef fisheries species critical to reef health and ecological function by 2020.*** ****Species to be determined by FLASH advisory group*
MHI	Designate a sufficient area of marine waters under effective conservation by 2020 to ensure sustainable and resilient coral reef ecosystems.

MHI	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.
	GOAL 3: Coral reef ecosystems resilient to climate change, invasive species and marine disease.
PMNM	Establish a baseline and tracking of information over 10 years by which the PMNM can be used as a sentinel site for assessing impacts of climate change and ocean acidification in the MHI.
ARCH	Develop and implement protocols that enable state and federal managers to effectively and consistently assess and respond to incidents of coral bleaching, disease, aquatic invasive species and sedimentation by 2012.
	GOAL 4: Increased public stewardship of coral reef ecosystems.
ARCH	Provide at least 8 community organizations working at priority sites** with technical support needed to implement coral reef management strategies that are consistent with ahupua'a principles and that enhance ecological resilience by 2020. *** priority sites have been selected and are identified in section 5*

Section 5: Priority Site Selection Process and Next Steps

Site Selection Process and Results

It was recognized early in the HCRS 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 CRWG decided that identifying "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 activities. Site prioritization was guided by (1) criteria developed by the Coral Reef Working Group (see Appendix 1 [HCRS, Section 5, Table 2: Criteria for Hawai'i Program Site Prioritizations]) and (2) the Priority Goals and Objectives for the Hawai'i Coral Strategy. The Hawai'i Coral Program also utilized 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 (see Appendix 1 [HCRS, Appendix C: Overview of the Marine Ecoregional Assessment for the Main Hawaiian Islands]). 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. From this plan, a preliminary set of nine priority sites were identified by all of the LAS Advisory Groups, the CRWG and personnel from key partner organizations. Full details on the process for site prioritization can be found in Appendix 1 (HCRS, Section 5: Priority Site Selection Process and Next Steps).

These nine sites were further ranked by the CRWG in terms of "readiness" (availability of information, ability to leverage funding, availability of potential partners and existing plans), "urgency" (current or potential threats such as land-based sources of pollution, AIS, over-fishing, nearshore 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 3–5 year priority areas for the program funding support.

Table 2 below lists all nine sites considered by the CRWG and levels of support that will be provided based on the ranking results. Tier A identifies the two priority sites that will receive program funding and technical assistance support from the Hawai'i Coral Management Grant during the initial 3–5 years. Tier B sites will have continued technical support from the Hawai'i Coral Program and some sites will also be receiving funds for implementation of LAS projects throughout 2010. Several sites in Tier B 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. Tier C sites are in need of additional community/agency engagement before designation as a Hawai‘i Coral Program priority site. Sites will be reevaluated in 2013 and additional sites could be added as priorities at that time.

Table 2: Ranked Sites and Level of Support Available

Tier Level	Site	Level of Support Available
A	Ka‘anapali-Kahekili (M-7)*	Hawai‘i Coral Program Priority Site 3–5 years to receive funding and technical assistance
	Pelekane Bay-Puako-Anaeho‘omalu Bay (H-1)	
B	Maunalua Bay (O-4)	Technical support, continued LAS projects through 2010
	Kāne’ohe Bay (O-2)	
	Olowalu (M-6)	
	Hā'ena-Hanalei (K-2)	
	Kealakekua (H-9)	
C	Wai‘anae (O-6)	No action at this time/re evaluate site after 3 years/ Sites in need of additional community/agency engagement
	South Shore Moloka‘i (MO-4)	

*Site identifier corresponds with maps in The Hawai'i Coral Reef Strategy Site Prioritization Maps Appendix 1 (HCRS, Appendix D).

Immediate Next Steps

Starting in early 2010, the CRWG will be working for the next few months to initiate site-based management planning for Ka‘anapali-Kahekili and Pelekane Bay-Puako-Anaeho‘omalu Bay. Some of the initial tasks will include: 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 will be carried out by the LAS Advisory Groups.

The extensive planning process used to develop the HCRS has led to increased participation of key stakeholders and an enhanced dialogue between DAR, partner agencies and other statewide ocean initiatives. Throughout this process the CRWG, LAS Advisory Groups and other stakeholders worked towards a more strategic approach to address threats to coral reefs in Hawai‘i. Full details on the proposed strategies for implementation of priority objectives can be found in the attached HCRS document (see Appendix 1 [HCRS, Section 5, Table 5: Hawaii’s MHI Priority Coral Reef Management Objectives, Activities and Outcomes).

Section 6: Relationship Between Hawaii's Reef Management Priorities and Those of NOAA CRCP

The NOAA CRCP Roadmap identifies three key priority threats to coral reef ecosystems:

1. Understanding and addressing the impacts of fishing.
2. Understanding and addressing land-based sources of pollution.
3. Understanding and addressing the impacts of climate change (NOAA CRCP, 2008).

This document reflects these national priorities. The threats to reefs posed by fishing, land-based sources of pollution and climate change are incorporated in Hawaii's goals. Two of Hawaii's priority objectives directly address the CRCP's priorities. Hawai'i has committed to a watershed-based approach to addressing critical land-based sources of pollution at critical sites. Hawai'i has also committed to reducing fishing impacts on reefs through education, new regulations, more rigorous enforcement and improved habitat protection.

Table 3 shows how Hawaii's Priority Goals and Objectives correlate to NOAA CRCP's National Goals and Objectives for coral reef conservation. Table 3 was developed to explicitly identify potential partnerships between the managers in Hawai'i and NOAA CRCP. Addressing both local jurisdictional priorities and national goals and objectives will increase efficiency and leveraging of the resources available for coral reef conservation. NOAA CRCP will use this table to inform future investments in coral reef conservation in Hawai'i.

Table 3: Correlation between Hawaii's Ten-Year Priority Goals and Objectives and NOAA CRCP's National Goals and Objectives for Coral Reef Conservation

Geographic Priority = MHI PMNM ARCH	Hawaii's Ten-Year Priority Goals and Objectives	NOAA CRCP's National Goals and Objectives for Coral Reef Conservation	Explanation of Correlation (as needed)
	HAWAI'I GOAL 1: Coral reefs undamaged by pollution, invasive species, marine construction and marine debris.		
MHI	G1. Objective 1: Reduce key anthropogenic threats to two priority nearshore coral reef sites by 2015 using ahupua'a-based management. *Two sites—Ka'anapali-Kahekili and Pelekane Bay-Puako-Anaeho'omalu Bay —were identified as 3–5 year priority areas for the program funding support.*	LBSP Impacts Objective 1.3: Implement watershed management plans and relevant Local Action Strategies (LAS) within priority coral reef ecosystems and associated watersheds to improve water quality and enhance coral reef ecosystem resilience. Where needed, develop (or update) watershed management plans that incorporate coral reef protection measures. Fishing Impacts Objective 2.4: Work with relevant agencies, offices, and communities to create, implement, and improve the management of MPAs that protect key coral reef ecosystem components and functions.	The intent of the Hawai'i objective is to reduce anthropogenic threats to key reef areas, regardless of their origin (land or water). The correlation to national goals and objectives therefore includes objectives found in both the Land-Based Sources of Pollution (LBSP) section and Fishing Impacts sections. The first objective identifies the need to develop and implement watershed management plans to reduce LBSP and the second identifies improving management of MPAs for coral reef protection.
ARCH/MHI	G1. Objective 9: Prevent new AIS introductions and minimize the spread of established AIS populations by 2020.	None	
PMNM	Derelict fishing gear will be removed from coral reef environments at or above the rate at which it is introduced, minimizing damage to coral reefs.	None	
	HAWAI'I GOAL 2: Productive and sustainable coral reef fisheries and habitat.		
MHI	G2. Objective 1: Increase the abundance and average size of five	Fishing Impacts Goal 1 Increase the abundance and average size of	No explanation needed.

	targeted coral reef fisheries species critical to reef health and ecological function by 2020.*** ****Species to be determined by FLASH advisory group*	key[1] coral reef fishery species to protect trophic structure and biodiversity and improve coral reef ecosystem condition. Objective 1.1: Support the creation or improvement of coral reef fisheries management plans that address ecological, social, and economic considerations. Objective 1.2: Prioritize key coral reef associated species or functional groups (e.g. herbivores, apex predators, etc.) on which to focus management, research and monitoring activities for each jurisdiction or managed area. Objective 1.3: Obtain essential life history and ecological information on key species or functional groups to support management actions. Objective 1.4: Obtain necessary information on fishing effort in U.S. coral reef ecosystems by measuring fishing intensity, fishing mortality, frequency, area coverage, community dependence, etc. to inform management activities. Objective 1.5: Predict appropriate levels of extraction for key species or groups by developing and utilizing valid, precise, place-based and realistic ecosystem dynamics models.	
MHI	G2. Objective 2: Designate a sufficient area of marine waters under effective conservation by 2020	Fishing Impacts Goal 2 Support effective implementation and management of marine protected areas[2]	No explanation needed.

[1] Key coral reef species (or functional groups) should be identified by each jurisdiction or managed area, and are defined as the composite of species essential to effective ecosystem-based function. Key species/groups may be those most affected by extractive activities, those that serve as indicator or keystone species or other criteria.
[2] Marine Protected Area (MPA): An area of the marine environment that has been designated by law or regulation to provide lasting protection for part or all of the resources therein.

	to ensure sustainable and resilient coral reef ecosystems.	(MPAs) and ecological networks[3] of MPAs that protect key coral reef ecosystem components and functions. Objective 2.1: Identify, characterize and rank priority areas for protection within each jurisdiction, including (but not limited to): · spawning sites, nursery habitats, or other areas critical to particular life-history stages · biodiversity hotspots · areas with greatest resilience or potential for restoring resilience · areas facing greatest threats Objective 2.2: Synthesize research on the performance of MPAs that protect key coral reef ecosystem components and functions. Objective 2.3: Using outputs of Objective 2.1 and 2.2, appropriate models, and socioeconomic considerations, identify MPAs that require increased protections or improved management, and areas to be considered for siting of new MPAs that protect key coral reef ecosystem components and functions. Objective 2.4: Work with relevant agencies, offices, and communities to create, implement, and improve the management of MPAs that protect key coral reef ecosystem components and functions. Objective 2.5: Conduct biological and socioeconomic research and monitoring to assess the performance of MPAs with respect	

[3] Ecological Network: A set of MPAs that are connected through ecological processes and that share complementary purposes and synergistic protections.

		to protection and restoration of key coral reef ecosystem components and functions.	
MHI	G2. Objective 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.	None	
	HAWAI'I GOAL 3: Coral reef ecosystems resilient to climate change, invasive species and marine disease.		
PMNM	Establish a baseline and tracking of information over 10 years by which the PMNM can be used as a sentinel site for assessing impacts of climate change and ocean acidification in the MHI.	Climate Change Impacts Objective 2.1: Characterize physical and chemical changes in coral reef environments by enhancing question-based monitoring to fill gaps in our current observations. This both establishes a baseline to assess climate change impacts on coral reef ecosystems and reveals changes through time.	No explanation needed.
ARCH	Develop and implement protocols that enable state and federal managers to effectively and consistently assess and respond to incidents of coral bleaching, disease, aquatic invasive species and sedimentation by 2012.	Climate Change Impacts Objective 1.3: Develop and implement climate-related crisis response plans in all U.S. coral reef jurisdictions to provide a framework for early warning, communication, monitoring, research, and management response to protect coral reef ecosystems from acute events such as coral bleaching, infectious disease outbreaks, tropical storm impacts, and major rainfall events.	The intent of the jurisdictional objective is to develop tools for managers responding to coral bleaching, disease and aquatic invasive species. The national objective that correlates to this jurisdictional objective calls on jurisdictional crisis response planning for acute events related to climate change. However, it does not identify response to aquatic invasive species introductions as that is not a priority across all jurisdictions.
	GOAL 4: Increased public stewardship of coral reef ecosystems.		
ARCH	Provide at least 8 community organizations working at priority sites** with technical support needed to implement coral reef management strategies that are consistent with ahupua'a principles and that enhance ecological resilience by 2020. ** *priority sites have been selected*	Climate Change Objective 1.5: In collaboration with reef managers, develop, test, and apply the best available science to provide new and innovative tools to help managers prepare and respond to climate change and ocean acidification related impacts. Fishing Impacts Objective 2.4: Work with relevant agencies, offices, and communities to	The jurisdictional priority objective refers to technical support to community organizations for coral reef management consistent with ahupua'a principles. In a ridge-to-reef approach, you must integrate technical assistance and capacity building for all three threats to coral reef ecosystems. Therefore, there are four associated national goals and objectives that correlate to the jurisdictional

	and are identified in section 5	create, implement, and improve the management of MPAs that protect key coral reef ecosystem components and functions. Fishing Impacts Objective 3.2: Strengthen local agency and community capacity for effective and consistent enforcement of regulations or behaviors that reduce impacts of fishing on coral reef ecosystems. LBSP Impacts Objective 3.2: Build partnerships among local, state, federal, and non-governmental entities to identify, leverage, and apply financial and other resources to facilitate improved coastal and upland watershed management to protect coral reef ecosystems from impacts of land-based sources of pollution.	objective.

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Appendix 1

The Hawai'i Coral Reef Strategy: Priorities for Management in the Main Hawaiian Islands, 2010–2020

THE HAWAIʻI CORAL REEF STRATEGY: PRIORITIES FOR MANAGEMENT IN THE MAIN HAWAIIAN ISLANDS, 2010–2020

HAWAIʻI CORAL REEF WORKING GROUP

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Glossary

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

Executive Summary

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 recently 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[1] 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 five 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.

[1] *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

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:

- 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 (Hawai'i Department of Business, Economic Development and Tourism, 2007). There are over 1,000 ocean tourism companies in Hawai'i, 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 Hawai'i 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 Hawai'i. 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 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. 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_2 generated every year by human activities, making the ocean more acidic (Caldeira and Wickett 2003). This uptake of CO_2 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.

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: Scope, Development and Prioritization Process of Hawaii's Coral Reef Management 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 established 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:

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

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.* ** 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/G3	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)*
G2	Increase the abundance and average size of five targeted coral reef fisheries species critical to reef health and ecological function by 2020.*** ****Species to be determined by FLASH advisory group*
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 and Next Steps

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.

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: • Fishing pressure • Recreational use	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

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, 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.

Five island groups were formed from meeting participants: Kauaʻi, Oʻahu, Maui and Lānaʻi, Molokaʻi, and Hawaiʻi. Oʻahu, Maui/Lānaʻi, and Hawaiʻi were further divided into two groups. Kahoʻolawe Island was not considered in the prioritization process due to the extensive protection of the island and current plans already underway by the Kahoʻolawe 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 below summarizes the results of the site prioritization exercise at the All LAS Meeting and subsequent follow-up meetings with DAR biologists on Maui and Oʻahu who could not attend the All LAS Meeting.

Table 3: 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	Kaʻanapali_Kahekili	13.49%	11.11%	50.00%
M-6	Olowalu	9.52%	11.11%	35.29%
MO-4	South Shore Molokaʻi	4.76%	10.10%	60.00%
O-6	Waiʻanae	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	Maunalua 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%

Island	General Area	% total of yellow	% total of red	% of island votes (yellow)
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 Lānaʻi	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 Hawaiʻi Coral Reef Strategy Site Prioritization Maps (Appendix D)

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 Hawaiʻi 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 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—Kaʻanapali-Kahekili (Maui) and Pelekane Bay-Puako-Anaehoʻomalu Bay (Hawaiʻi)—were identified as priority areas for the program. See Appendix E for detailed CRWG ranking results and priority site profiles.

Site Ranking Results

Table 4 below lists all nine sites considered by the CRWG and levels of support that will be provided based on the ranking results. Tier A identifies the two priority two sites that will receive program funding and technical assistance support from the Hawaiʻi Coral Management Grant in the initial three to five years. Tier B sites will have continued technical support and some sites will also receive funds for implementation of LAS projects throughout 2010. Several sites in tier B 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. Tier C 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.

Table 4. Top Nine Sites Ranked by the CRWG and Level of Support Available

Tier Level	Site	Level of Support Available
A	Kaʻanapali-Kahekili (M-7)	HCRS Priority Site 3–5 years to receive funding and technical assistance
	Pelekane Bay-Puako-Anaehoʻomalu Bay (H-1)	
B	Maunalua Bay (O-4)	Technical support from DAR, LAS advisory groups and partner organizations LAS projects through 2010
	Kāneʼohe Bay (O-2)	
	Olowalu (M-6)	
	Hā'ena-Hanalei (K-2)	
	Kealakekua (H-9)	
C	Waiʻanae (O-6)	No action at this time/reevaluate site after 3 years/sites in need of additional community/agency engagement
	South Shore Molokaʻi (MO-4)	

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

Immediate Next Steps

Starting in early 2010, the CRWG will be working for the next few months to initiate site-based management planning for Kaʻanapali-Kahekili and Pelekane Bay-Puako-Anaehoʻomalu Bay. Some of the initial tasks will include: 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 will be carried out by the LAS advisory groups. Table 5 on the following page summarizes the HCRS primary objectives as well as key activities and outcomes identified by the LAS advisory groups.

Table 5: Hawaii's MHI Priority Coral Reef Strategy Objectives, Activities and Outcomes

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G1/G2 G3/G4	**Reduce key anthropogenic threats to two priority near-shore reef areas by 2015 and five by 2020 using *ahupua'a* based management** *Priority Sites: Ka'anapali-Kahekili and Pelekane Bay-Puako-Anaeho'omalu Bay*	• Development of a conservation action plan for addressing specific threats that includes the following steps: <u>Identification of people involved in the project</u> o Select core project team members and assign roles o Hire coordinators for each priority site o Identify steering committee members and advisors <u>Definition of project scope and focal conservation targets</u> o Statement developed on overall vision of project o Complete literature review/gather basic info on each site including: • Compilation of GIS layers • Identification of development and land-use plans • Identification of cultural uses of sites • Identification of public monitoring data sources • Historical impacts due to weather and other natural cycles • Economic analysis of the area • Identification of key stakeholders § Land and water managers/owners § Existing community efforts	• Identification of process leader • Creation of jurisdictional maps • Shared vision for stakeholders and managers created • Determination of conservation targets • Baseline data on coral reef and water quality conditions either available or being collected • Economy of area and impact on marine resource uses understood • Brief description of project area and scope completed • Basic map of project area using computer-based GIS program • "State of the Reef" for priority area understood • Major human uses and impacts of areas are understood • Historical impacts due to fluctuations in weather and other natural cycles are better understood • Identification and	• 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. • Stakeholders and landowners are actively engaged in watershed activities to address LBSP threats • Pollution reduced and conservation targets remain within acceptable range of variation o Increase in population of priority species at specific sites o Reef quality is maintained or improved (increased living coral cover, reproduction, recruitment and reduced algal cover) • Reduction of anthropogenic pollutant load to surface water and groundwater through site-specific actions and best management practices • Entry/exit points used • Enforcement personnel are able to detect at least 75% of

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
		§ Area stewardship activities § Development of conservation targets <u>Assessment of the viability of focal conservation targets</u> o Compile baseline measurements of coral cover, diversity and fish abundance, water quality o Conduct rapid LBSP appraisals by LBSP committee members/USGS including remote sensing and walking the watershed o Complete use-pattern maps showing: existing and future permits, recreation activities location and intensity, moorings, temporal and seasonal use and projected future use o Standardization of public monitoring efforts and compilation of data in an accessible database <u>Identification of critical threats</u> o Analysis and prioritization of specific threats for each conservation target o Conduct Knowledge Attitudes Perceptions (KAP) survey to gauge support and knowledge for Marine Managed Area (MMA) and recreation rules o LBSP specific information needs • Nutrient budget (including golf courses and agriculture) • Sediment erosion analysis (causes and sources • Watershed processes	prioritization of threats to conservation targets • Pollution controls are developed and implemented • Watershed plans developed • Completion of priority rule revisions • Development of a list of realistic indicators to measure and track effectiveness of site-based actions • Summary of project capacity and gaps	incidents of noncompliance with rules and laws • All priority sites have initiated watershed plan implementation in the form of land management and pollution control activities • Precautionary approach used in giving permits for special use or commercial activity • Partnerships with community stewardship and monitoring groups are strengthened • Management actions and funding at the site directed to threats posing greatest impact • All site-based administrative rules for recreational use and fishing are based on best available biological and social science • Degree of primary threats is measurably lessened • 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

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
		§ Land cover § Condition of streams § Existing data § Stream and groundwater discharge o FLASH specific needs: § Quantify resource violations in representative areas § Quantify and qualify presence of DOCARE officers at key sites. <u>Completion of a situation analysis</u> <u>Development of strategies</u> o Examples include: • Development of site based fisheries enforcement plans (FLASH) • Identification and prioritization of needed rule revisions • Establishment and marking of recreation entry/exit points for (RIR) • Development of place-based rules for permit holders for special events (RIR) • Identification of needed watershed plans (LBSP) • Creation or expansion of Makai Watch program <u>Development of a work plan for actions and measurement of results</u>		

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G1/G3	**Prevent new AIS introductions and minimize the spread of established AIS populations by 2020** ***Overlapping MHI and PMNM objective***	o Mitigate the dispersal of established AIS • Restoration actions: super sucker, native grazer replenishment • Temporal and spatial mapping of AIS infestations o Identify vectors and pathways of AIS with regard to likelihood of transmission and establishment of aquatic invasive species o Risk Assessment: Identify and prioritize threat level, invasiveness and practicality of eradication or control of non-native organisms o Development of prevention policy operational interdiction plans in partnership with federal and state agencies o Development of sustainable funding strategies for AIS efforts o Prioritize species of concern for Eyes of the Reef volunteers to monitor	• Vectors and pathways of AIS are prioritized for program focus • Develop restoration tools, both mechanical and biological, and evaluate for efficacy • Identify vulnerable sites for increased monitoring • Early detection system in place to notice and identify accidental introductions • Approval of a coordinated approach to eradication using the best possible means.	• No marine aquatic invasive species introduced to Hawai‘i • Targeted reefs cleared of invasive species • Native grazers employed to control alien algae • Existing invasive algae distributions are contained • Ecologically sensitive marine areas are identified for protection and monitoring • Accidental introductions are controlled with rapid response • Implementation of new public policies that prevent AIS introduction and allow for efficient eradication .
G2	**Increase the abundance and average size of five targeted coral reef fisheries species critical to reef health and ecological function by 2020.**	• 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) • Conduct cost/benefit analysis of fishing license in Hawai‘i, comparison among states • Develop recommendations to revamp the Hawai‘i Marine Recreational Fishing	• Key coral reef species are identified and prioritized • Fishing management strategies are developed • Funding sources are identified and accessed • Operational plans are developed and implemented	• To have statistically valid and useful knowledge for management on all catch and effort for Hawaii's CR fisheries by 2012

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
		Survey (HMRFS) surveys to increase the use of data for local management efforts • Revise commercial catch reports to be more spatially explicit • Collect information on the catch and bycatch of certain gears and CPUE (recreational) • Collect information on the commercial export of near-shore fishes from Hawai‘i		
		• 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 • Assess the Biological, Social and Economic (BSE) impacts and benefits of implementing these practices • Identify research/surveys completed on public perceptions of DOCARE • Evaluate DOCARE’s compliance with legislative audit • Analyze DOCARE’s volunteer program, (what were the pitfalls, what happened to the program, are there volunteer programs in other states, are they successful?) • Research options for DLNR to be able to issue tickets/fines • Research and provide information to DOCARE on programs and options to deputize volunteers/citizens • Develop consultation process between DAR, DOCARE and judicial system on rules and enforcement • Establish a natural resource court (land	• Stakeholder engagement compliance is increased	• Three communities are implementing pono fishing practices and eliminating non-pono fishing practices on each island by end of 2012 • Eight Makai Watch programs are trained to effectively assist DOCARE and DAR in public compliance with fisheries rules and regulations

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
		board)—administrative fines, no DOCARE involvement • Translate fisheries rules into more than one language—priority Pacific Island languages, Filipino, Samoan, etc. • Develop an education and outreach program on fishery rules		
		• Increase number of extension/outreach officers • Determine the most effective and appreciated ways to contact or communicate with fishermen • Develop and implement a decentralized and consistent communication process/plan • Determine top subjects/issues that fishermen/stakeholders are interested in and develop outreach information and materials • Set up a kiosk at different fishing tournaments • Pre-introduction consultative process between DAR and legislature for potential bills on marine resource related topics • Identify and support a place/agency for resource users to obtain reliable, credible and unbiased information on fisheries related issues within Hawai‘i • Semiannual fishers forum for consistent reliable information exchange • Develop target outreach to increase community understanding of key FLASH topics (translation from scientific materials for public audiences)	• Public stakeholder understanding of fishing impacts is increased • Policy maker understanding of fishing impacts is increased	• To have a process that more effectively collects and disseminates information between managers and resource users by December 2008 • Effective management options of fishing impacts on coral reefs are supported by the public and policy makers

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G2/G3	**Designate a sufficient area of marine waters under effective conservation by 2020 to insure sustainable and resilient coral reef ecosystems**	• Complete a quantification of the benefits of MPAs in terms of coral reef fisheries population fecundity, reproductive output • Identify, characterize and rank priority areas for protection within the MHI • Conduct a socioeconomic assessment on value and potential impacts of a range of MPA networks in Hawai‘i • Conduct benefits/costs analysis of area management vs. species specific management • Classify habitat types and identify areas socially, economically and culturally appropriate for area management; prioritize sites based on output • Quantify and characterize public opinion on MPA in Hawai‘i • Develop a comprehensive marine zoning plan for West Hawai‘i and the MHI • Assessment of Biological, Social and Economic (BSE) effectiveness of community based marine co-management/ahu-moku council (select pilot area) • Assess the recovery process of MPA impacted by natural and anthropogenic disturbance • Assess the scope of marine managed areas to restore herbivore stocks and effect on ecological processes • Assess the ecosystem services of MPA • Assess the effects of de-establishing a MPA—West Hawai‘i and Waikiki	• A statewide plan that prioritizes sites for conservation zoning is developed • Community stewardship programs are developed or supported at priority sites • 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	• Restoration of specific coral species • Improved habitat conditions • Increased biomass • Areas for increased resilience to climate change • At least 10% of MHI near-shore waters are designated as conservation areas by 2015

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
G2/G3	**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.**	<u>Minimize anchor damage</u> • Implement no-anchor zones at important sites • Create a task force to resolve conflict between recreation users and fishers and other stakeholders • Develop a DLNR protocol for Day Use Mooring Buoy (DUM) site selection • Develop a MOU with operators tied to permits to formalize compliance with agreements currently informal user agreements • Map and chart all moorings, make information available online and at vessel registration • Complete DLNR DUM Strategic Plan Parts I & II to address management issues such as site and rules (surface vs. non-surface, overnight use, commercial and public access) • Establish protocols for managing moorings in areas with seasonal surf • Develop consistent and repeated education for boaters, fishers and other users	• Strategic management plan based on best available science is implemented by DLNR • Rules for permitted day-use moorings are codified in Hawai‘i Administrative Rules. • A sustainable funding mechanism is developed for installing and maintaining day-use mooring buoys	• Important near-shore habitat protected from anchoring • Fishing areas are protected and respected • Increased collaboration between fishers and recreation users • DUM rules revised, are comprehensive and appropriate • All legal moorings covered by DLNR rules • Illegal moorings removed • Access to fishing areas is retained • Boaters and ocean users are aware of DUM system and its appropriate uses • DUM use rules are effectively enforced • The purpose of DUMs as a management tool is widely understood by recreational users and fishers
		<u>Minimize trampling</u> • Develop strong incentives for good reef etiquette for commercial and independent recreational users • Incorporate user protocols into permits for commercial operations and for special events • Identify and clearly mark entry and exit points for shore-based recreation	• Partnerships with industry groups like PADI are used to improve user behavior and education • Good reef etiquette is established as the norm for recreation business operation through incentives and legal means such as permits	• Recreation protocols are followed by a significant number of commercial operations • Recreation protocols are clearly posted at high use sites • Better understanding of impacts of high use events (e.g., canoe races)

GOAL	Priority Objective	Activities	Immediate Outcomes	Long-Term Outcomes
		• Display information on reef etiquette at airports or on all entering planes or both • Identify dive and snorkel training areas for inexperienced users	• Independent travelers and resident recreational users are given the information and tools to voluntarily reduce their impact to coral reefs	• Entry and exit points are used exclusively at high use sites • 100% of commercial recreation staff are trained in cultural protocols, mooring use and reef etiquette • Visitor industry also educated in cultural, social and biological reef issues • Introductory and certification dives happen at resilient sites without no fragile habitat

Section 6: Preliminary Identification of Capacity Gaps

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.

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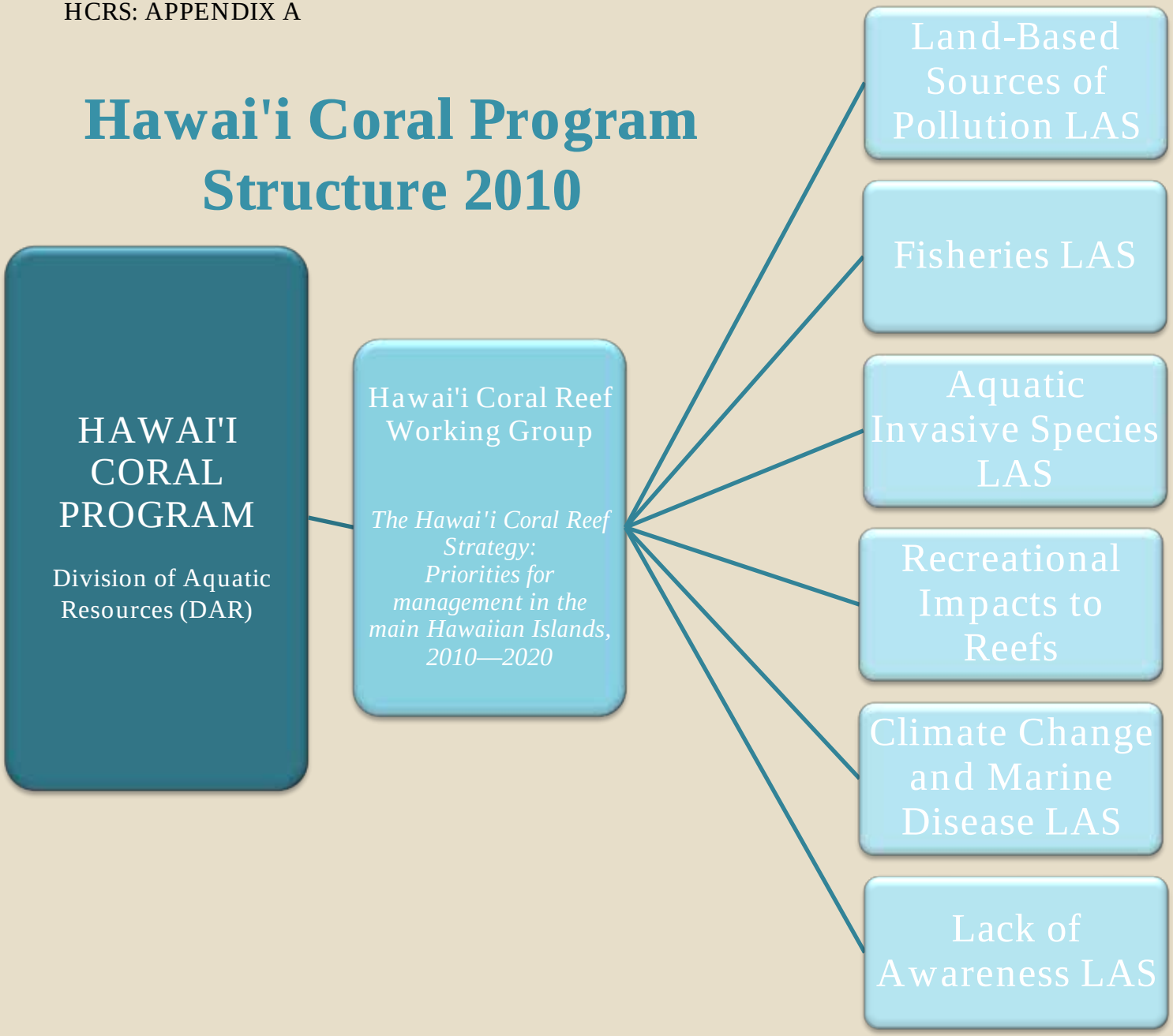
Hawai'i Coral Program Structure 2010



COMPLETE

HCRS: 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 Coal 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 five 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.

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.

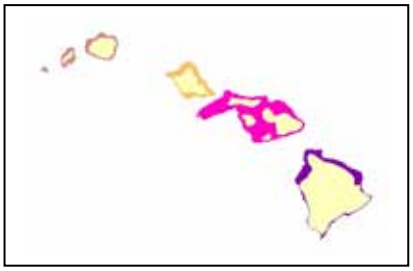
The MHI ecoregion supports a diverse array of marine habitats, encompassing estuaries, tidepools and other rocky intertidal habitat, sandy beaches, seagrass beds, extensive fringing reef and barrier reef systems and deep-water coral reefs. Coral reef communities fringe the entire Hawaiian archipelago, 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 the same quality of targets, the ones with the lower threats were considered more viable.

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

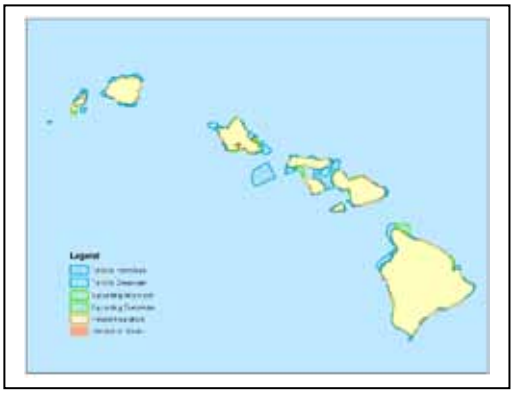
Phase 3: Identifying biologically important areas. The selection of biologically important areas that optimally represented all conservation targets across the ecoregion was achieved using two tools: (1) a computer modeling program (MARXAN) that uses GIS data; and (2) scientific expert focus group review 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:

- The amount and distribution of a biological conservation target in each planning unit
- The specific goal for each target and general design principles
- The cost factors for each planning unit
- The stratification unit boundaries
- The planning unit boundaries

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.

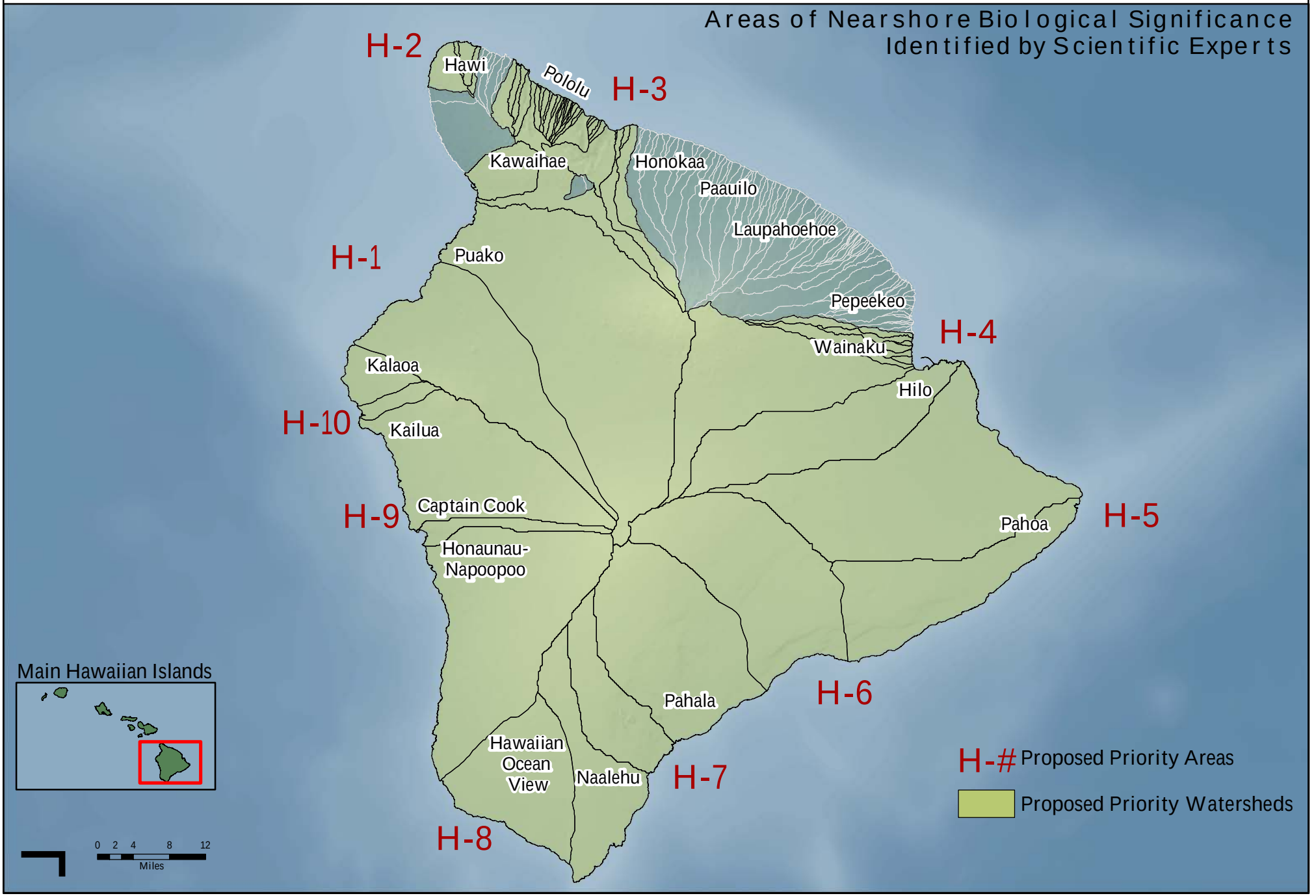
THE RESULT. Based on the expert review and the stated design principles (e.g., delineate sites to encompass entire biological units and focus on areas of highest biological suitability), a final collection of biologically important areas was delineated. The end result was the identification of a set 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.

	Ecoregion (to 500m)	
Stratification Unit	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%

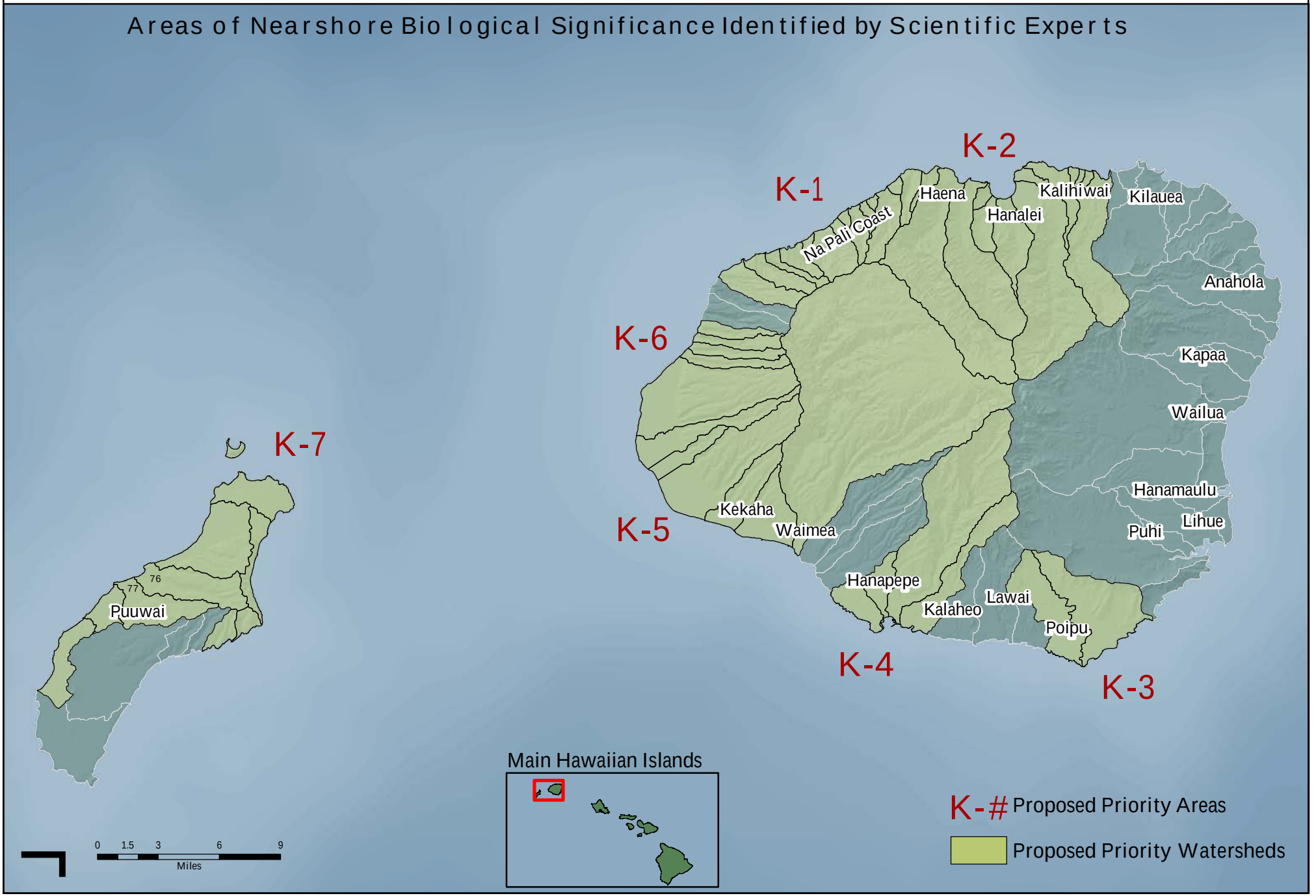


ACKNOWLEDGEMENTS. The marine ecoregional assessment involved many partners in academia, state and federal agencies, nongovernmental and community organizations and individuals. Contributions by biological experts from the following agencies were critical to the success of the assessment outcome: U.S. 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.

Hawaii's Coral Reef Strategy Site Prioritization Map

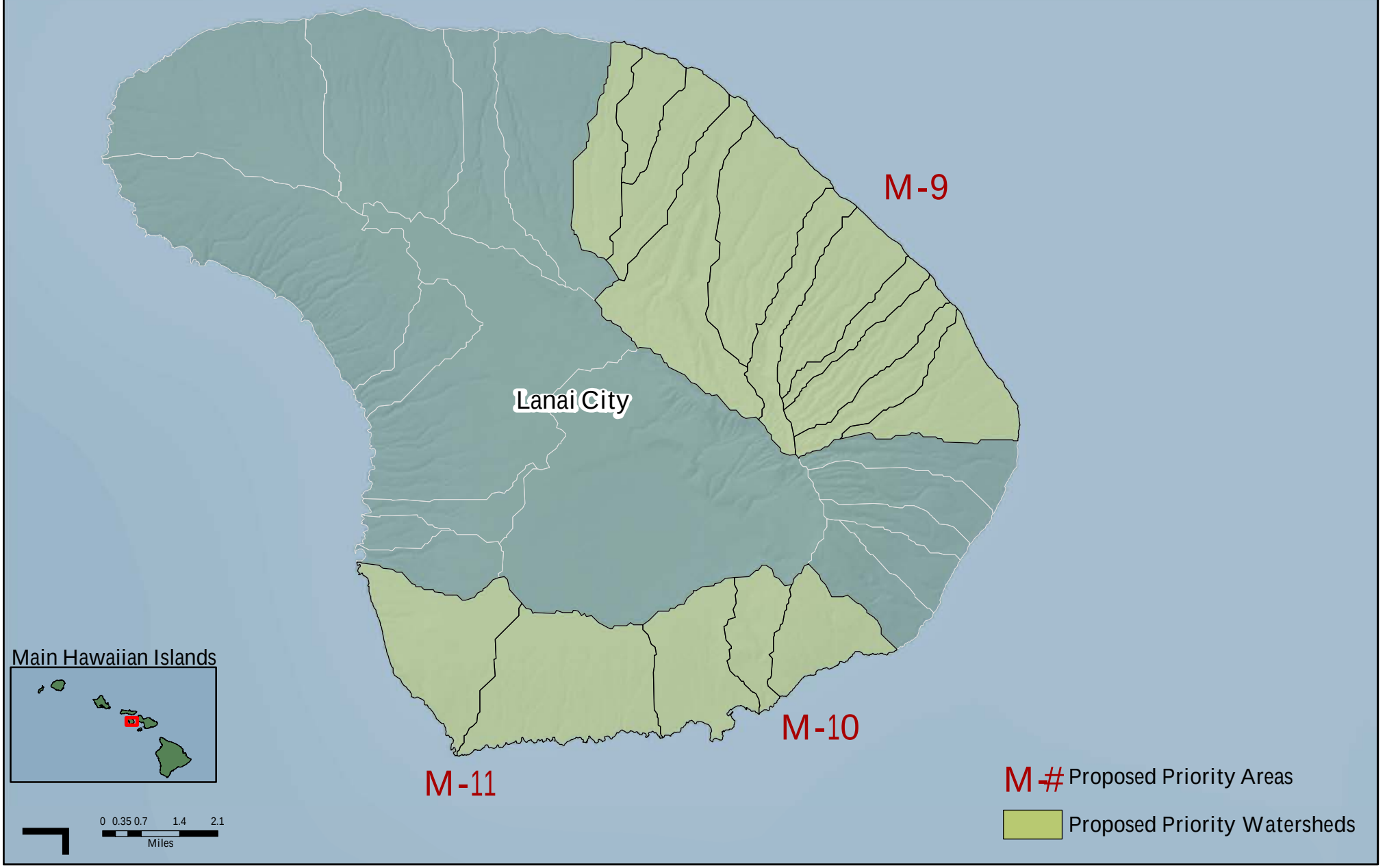


Hawaii's Coral Reef Strategy Site Prioritization Map



Hawaii's Coral Reef Strategy Site Prioritization Map

Areas of Nearshore Biological Significance Identified by Scientific Experts



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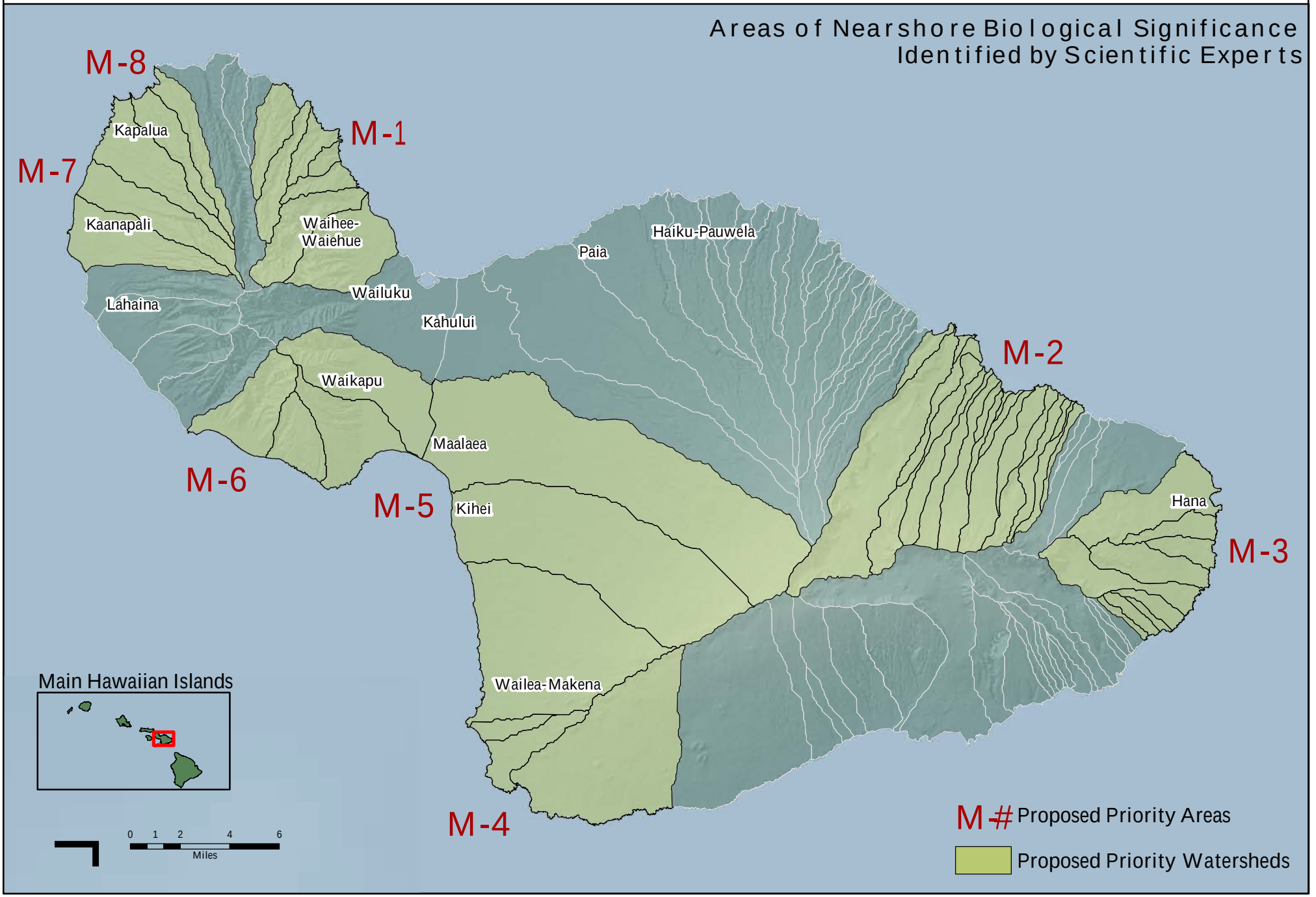

Hawaii's Coral Reef Strategy Site Prioritization Map

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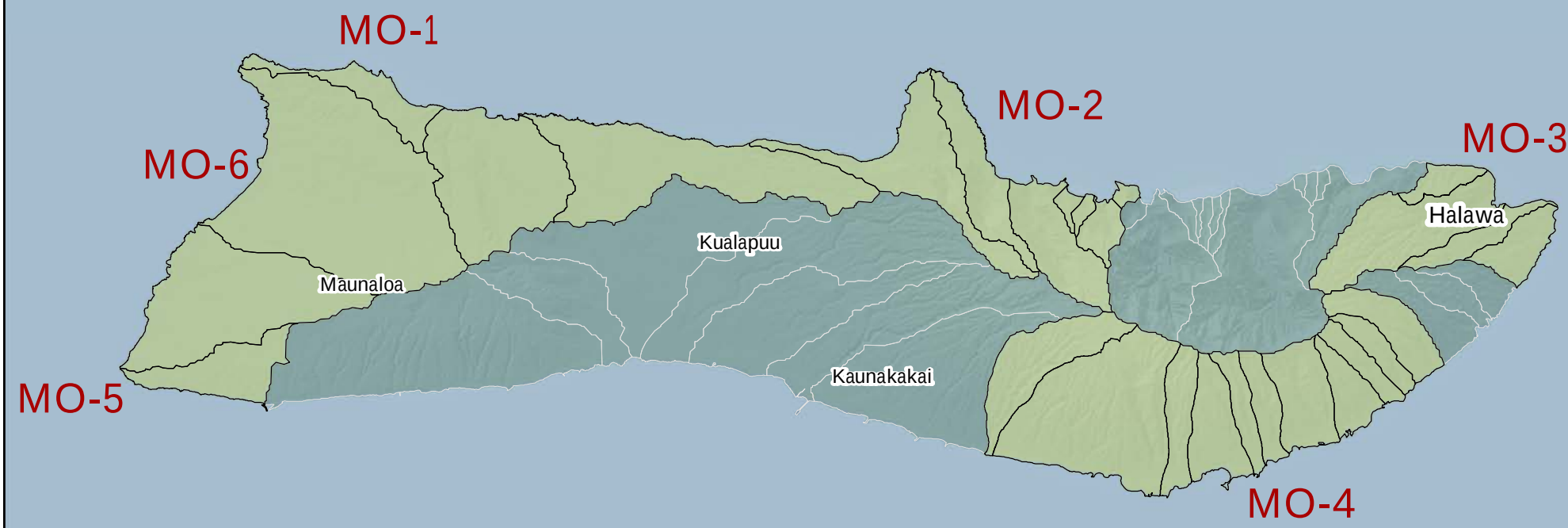
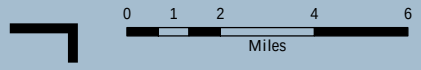
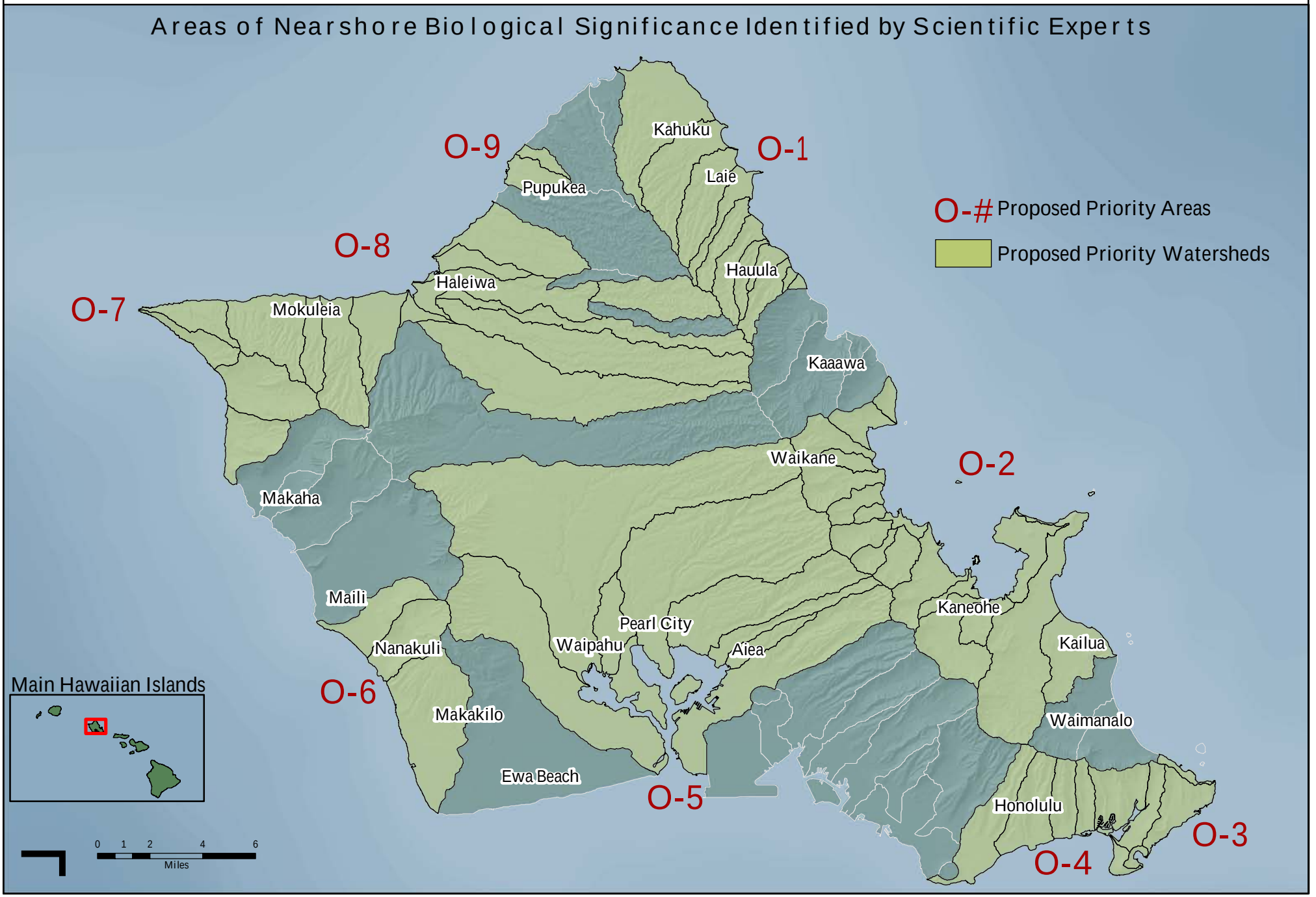




MO-# Proposed Priority Areas

Proposed Priority Watersheds

Hawaii's Coral Reef Strategy Site Prioritization Map



Appendix E: CRWG Ranking Results and Site Profiles

Two sites—Ka'anapali-Kahekili and Pelekane Bay-Puako-Anaeho'omalu 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

Hawai'i Coral Reef Strategy Region Profile (M-7)

Area Boundaries: Ka'anapali-Kahekili (suggested start Kahana watershed, Honokōwai to Wahikuli)

Other Resources for information:

Biological Value:

- Very good coral reef system
- Hawksbill turtle foraging
- Preferred rocky intertidal
- Preferred halimeda meadow
- Representative near-shore substrate: sand, aggregate reef, patch reef, pavement, pavement with sand channels
- Representative zone: Bank shelf, channel, fore reef, reef crest, reef flat
- Hawaiian monk seal haul-out area

Scope and Degree of Threats:

- Heavily fished area
- Coastal erosion
- Solid coastal development—associated impacts such as runoff plus highly modified shoreline
- Loss of wetland at Lahaina
- Listed as impaired water
- Proximity to underground injection well (including Lahaina Wastewater Reclamation Facility, 6,700,000 GPD (surfaces at Ka'anapali)
- Cesspools
- High recreation use; hotel and visitor impacts
- Invasive algae; algae blooms (cladophora and acanthophora)
- Predicted sea level rise rank 3
- Highly zoned for ocean recreation
- Recreation diving
- Land use changes from pineapple to residential and hotels

Existing Plans/Management Activities/Monitoring/Research:

- Proposed Kahekili Herbivore Enhancement area
- Injection well permit to reduce nitrogen loads
- Hawaiian Island Humpback Whale National Marine Sanctuary
- Part of West Maui Watershed Partnership
- West Maui Watershed reconnaissance study ongoing by the ACOE
- Has old West Maui Watershed management plan
    - SWCD is working on updating old watershed management plan
- Ocean Recreation Zone (DOBOR)
- EPA has historic water quality data (1990s)
- Coral monitoring data by CRAMP/DLNR-DAR (15+ years)
- Recent NPDES permit revised to reduce nutrients
- Day use moorings proposed
- UH research- Celia Smith (algae)
- Plans for coastal hiking trail

- § CZM is supporting BMPs in the area
- § Potential beach nourishment site
- § Education of the community on herbivore impacts on coral reefs

Partnerships/Community Support/LAS Connections:

- § Some outreach by HIHWNMS
- § Invasive fishing tournaments by local fishermen and County of Maui
- § Potential for integrated work (LAS–AIS, RIR, LBP, FLASH)
- § Economic support from tourism
- § ACOE currently has authority to partner (NRCS, County of Maui, DOH, West Maui Watershed Partnership, Maui Land and Pineapple, Napili Beach Foundation
- § Community monitoring
- § Access for local residents in this area should also be improved

Potential partnerships with those currently working in the area

- § DLNR–DAR
- § UH–Celia Smith
- § HIHWNMS
- § County of Maui
- § Local fishermen
- § SWCD
- § ACOE
- § EPA
- § DOBOR
- § Maui Reef Fund
- § Malama Kai Foundation
- § CZM
- § Maui Land and Pineapple
- § Napili Beach Foundation
- § DOH
- § Local community monitors
- § Maui Community College
- § Maui Ocean Center
- § Local hotels
- § REEF
- § Project S.E.A-Link
- § West Maui Watershed Partnership

Other:

- § Extend this area out to the boundary with M8. Add watershed #163 as pink because: 163 is DOH/EPA priority watershed; discrete bays in this area, e.g., Honokeana are small manageable units for LBSP
- § Propose merging M7 out to M8 (not just to the boundary)
- § Challenge with conflicting interest groups
- § Important area economically
- § 50% coral decline well documented, but still have 30% coral cover

Hawai'i Coral Reef Strategy Region Profile (H-1)

Area Boundaries: Pelekane Bay (suggested start: Mahukona) to Airport (suggested end: Ka'uhpulehu Bay)

Other Resources: Bill Walsh, Ivor Williams, Cindy Punihaole (Kohala Center), Chad Wiggins (TNC), Carolyn Stewart (Malama Kai Foundation)

Biological Value:

- Excellent reef development in this region; Area characterized by reef flats, patch reefs and sandy bays
- Narrow but relatively healthy reef extends along entire coast line
- The region is bookended by two of the 7 high priority areas for coral reef habitat (Puako, Makalawena-Keāhole)
- Priority manta ray cleaning and feeding station
- Priority estuary (Kiholo)
- Bays (Kiholo, Puako) - possible recruit area
- Seagrass beds
- Intertidal rocky
- Deepwater corals
- Keāhole Point: different reef structure than to the north (no freshwater)
- Spinner dolphin resting area (not selected exclusion zone)
- Puako is a recruitment area - especially for uhu, surgeonfish, butterflyfish, and wrasse species.

Scope and Degree of Threats:

- Cesspool and fishing threat (No AIS now)
- Puako sewage disposal concerns
- Multiple private owners along coastline in Puako and Mauka in Waikōloa town; mostly several large developments (north of Kawaihae) /resorts (south of Kawaihae) directly mauka of region
- Water quality and sedimentation concerns as a result of watershed degradation and cesspools
- Injection wells/sewage wells at resorts probably not being monitored for rate of input
- Too much development already and other future development entitlements in place for much impact UNLESS county and community development planning become actively involved
- Illegal fishing concerns; resulting in conflicts between Pacific transplant community (fishing group), long-time residents and newer property owners
- Increasing recreational use – both shore based and vessel based
- Threats (e.g. fishing) are within our capacity to mitigate
- Roi densities among highest recorded in state (and nascent programs to try to control roi)
- State leases for offshore fish cages in place (may be far enough out to not be concern for us)
- Kawaihae and Pelekane Bay need attention
- Suggest encompassing Ka'upulehu to Mahai'ula for most effect

Existing plans/Management activities/Monitoring/Research:

- FRA and FMA within region
- Pelekane Bay Watershed Management Project
- Wai'ula'ula Watershed Management Plan (in development)
- Kohala Watershed Partnership Management Plan
- DOH Priority Watershed
- DAR Coral monitoring program in place
- QUEST monitoring site (Puako)
- Very good existing data including long-term (multi-decade) fish surveys
- Pelekane Bay Watershed Restoration project- ACOE
- Kiholo Bay priority area for DAR next 2 years

- Puako: TNC monitors coral and fish; Community monitors fish, recreational catch, and human use; WQ tidepool monitoring
- Wai'ula'ula watershed projects: stream gauges,
- Kohala Watershed projects: Invasive species removal, fencing, native plantings, seed propogation.
- MPA possibility: WHFC working on developing network of MPAs along West Hawai'i
- Day use moorings awaiting permits (Puako)
- UH Sea Grant College Program's ReefWatcher Monitoring Project

Partnerships/Community Support/LAS connections:

- Community awareness and support especially at Pelekane (Kawaihae), Puako and Ka'upulehu
- Poster child for intervention at Pelekane
- TNC working in area
- National Park (Pu'u Kohola)
- State Harbor (Kawaihae)
- Various watershed groups: Wai'ula'ula, Kohala Mountain Watershed Partnership, Pu'u Wa'awa'a
- Existing institutional support
- Mauna Lani Turtle monitoring and release
- Resorts interested in conservation – three beach operated watersports outfits: Ocean Sports, Hualalai Watersports, Mauna Lani Sea Adventures), plus dive operators from Kona.
- Kekaha Kai State Park- "recreational renaissance"; Rangers?

Potential partnerships with those currently working in the area

- The Nature Conservancy
- DAR
- Wai'ula'ula Watershed Advisory Group
- Pelekane Watershed
- Mauna Kea Soil and Water District
- NRCS
- ACOE
- National Park Service
- Local schools: HPA, Parker, WHEA
- UH, including MOP
- Three Mountain Alliance
- Local hotels: Mauna Lani
- West Hawai'i Fisheries Council
- WHFC Local Resource Council- Kawaihae
- State Parks
- Kanu o ka 'Āina Charter School (Kawaihae)
- Kamehameha Schools
- Queen Emma Foundation
- DHHL
- UH Sea Grant College Program West Hawai'i
- DOFAW
- US Forest Service
- DOBOR- Harbors
- Kohala Watershed Partnership
- Malama Kai Foundation
- USGS
- DOH

Other:

- Some support for fishing restrictions and/or no-take areas in Puako; protective designation in Ka'hupulehu area
- This site should be redefined to Lapakahi or Mahukona at north end (possibly shortened to Ka'upulehu at south end)
- Puako is very important area; functional reefs are worth protecting from future problems.
- Recent recipient for Pelekane Bay restoration funds (2.7M) from NOAA (check dams, fencing, planting, invasive removal
- Need to engage Hawai'i County.