

**MARINE CORPS BASE HAWAII
CORAL REEF ECOSYSTEM MANAGEMENT STUDY**

Final Report

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Use of Hawaiian language in the document:

Hawaiian and English ('Olelo Pelekane) are both official languages of the State of Hawai'i. Markings that help to pronounce Hawaiian words have been noted in many texts in recent years. Extensive debate exists among teachers and native speakers of Hawaiian whether the diacritical markings should be part of the actual written language or merely learned as similar marks are used in the English dictionary for pronunciation of English words.

As a compromise, this document includes the Hawaiian 'okina mark (‘) that places a stress, a glottal stop, in front of the vowel it proceeds, but has not used the kahako or macron marks (for example: ā) to indicate a vowel to be stressed. However, if a reference title uses a Hawaiian word without diacritical marks, the original title has been retained without the 'okina marking.

EXECUTIVE SUMMARY

This Coral Reef Ecosystem Management Study (CREMS) was funded by and for Marine Corps Base Hawaii (MCBH) in response to heightened national concern about the health of coral reef ecosystems (CREs). A majority of U.S. CREs are found in Hawai'i and MCBH is the only US Marine Corps installation in the nation with coral reefs within its management jurisdiction. More specifically, this CREMS was prepared in response to: (1) MCBH program goals in the 2001 MCBH Integrated Natural Resources Management Plan/Environmental Assessment (INRMP/EA) (Drigot *et al.* 2001); (2) a 1999 Environmental Compliance Evaluation that special consideration be devoted to near shore/fringing reef areas within MCBH jurisdiction; (3) compliance requirements in natural resource protection laws, regulations, and directives pertinent to coral reef ecosystems; and (4) a 1998 Executive Order (EO) 13089 Coral Reef Protection that mandates all Federal agencies whose actions affect US coral reef ecosystems take steps to protect and enhance such coral reef ecosystems and ensure their actions are consistent with this goal.

This CREMS summarizes information available and addresses critical information gaps regarding coral reef ecosystems. This CREMS is organized around eleven (11) related management concerns as further detailed in the Scope of Work (Appendix A). It presents recommendations on how MCBH can improve progress toward reaching Goal 7.4 in the MCBH INRMP/EA (Drigot *et. al.*, 2001) to use "an ecosystem-based watershed approach to manage and enhance shoreline and nearshore marine resources within MCBH control and/or use." This CREMS offers information and recommendations to supplement the Coastal and Marine Resources Management component of the INRMP/EA, which already commits MCBH to address six management objectives and twenty-two management actions toward achieving this goal. One of the twenty-two management actions is completed by production of this CREMS: "Complete HI20009 CREMS." The next step is for MCBH managers to complete the INRMP-stated management action to "Evaluate and implement appropriate recommendations from the HI2009 Coral Reef Ecosystem Management Study." A Summary Table of Recommended Management Actions and Implementation Measures is presented at the end of this Executive Summary. The full table of Recommended Management Actions and Implementation Measures is presented and further discussed in Section 12. It cross-references published INRMP objectives and provides a more detailed means by which MCBH managers can evaluate and decide on implementation strategies.

The geographic scope of MCBH's responsibility for CREs is primarily at Mokapu Peninsula, Marine Corps Base Hawaii-Kaneohe Bay (MCBH-KB) within the offshore restricted access 500-yard buffer zone around the peninsula. It also encompasses vital U.S. Marine Corps transit corridors and "ship to shore" training maneuver areas within Kane'ohe Bay, between MCBH-KB and Marine Corps Training Area-Bellows (MCTAB), and along approximately one mile of coastline within Waimanalo Bay. The marine environments adjacent to MCBH-KB and MCTAB are interconnected within a larger State-emphasized Ko'olaupoko Watershed Region receiving Category I clean up attention through the State's Implementation Plan for Polluted Runoff Control (Hawai'i Coastal Zone Management Program 2000) as further discussed in the MCBH INRMP/EA. This CREMS discusses ways in which MCBH activities do or could impact CREs in this larger regional context, in both positive and detrimental ways. Furthermore, it discusses external forces that impact upon CREs within MCBH jurisdiction, and explores ways in

which MCBH can better exercise their CRE stewardship responsibilities within this larger regionally-shared regulatory context.

This CREMS has been prepared with the understanding that amphibious training in Hawai'i is a critical component of the DoD's strategy of forward presence in the Pacific. MCBH's primary military mission includes provision of services and support to use of designated areas for ocean transit, launch, recovery, and operation of landing craft and assault amphibious vehicles and beach landings. Potential environmental impacts to CREs from amphibious training are associated with the physical effects of open ocean transit, transit over shallows, beaching, tracked and wheeled vehicle movement, and debarked personnel crossing the beach. Actions recommended herein address the need to review, revise, amend, or clarify current SOPs and management activities for amphibious operations in order to continue to carry out these vital mission functions while remaining in compliance with stewardship responsibilities toward CREs.

Diminishing health of CREs results from threats originating on both adjacent lands and in the surrounding marine environment. Coral reefs are among the most biologically diverse, complex, and economically valuable of all ecosystems. They support a wide variety of fascinating and economically valuable life forms (from a vast array of algae, sea grasses, and invertebrate animals to reef fishes, turtles, marine mammals, and sea birds). They also provide a wide range of valuable environmental services. The physical reef structure protects and stabilizes shorelines from seasonal storm waves. It provides unique habitat to an enormous diversity of plants and animals. Coral reefs provide recreational and aesthetic enjoyment. They support harvest of a wide variety of edible and ornamental species – some of which are important sources of pharmaceuticals and natural-product chemicals. The calcium carbonate skeletons of reef-building corals are literally the building blocks of reefs, and as such, keystone species of the coral reef ecosystem. When this foundation is damaged or destroyed by natural or human-caused factors – temperature change, diseases, pollution, over-fishing, introduction of alien species, and physical impacts – the entire reef ecosystem and benefits provided are at risk.

Recent developments have dramatically improved the potential for better understanding and management of coral reef ecosystems in Hawai'i. However, existing ecological and management data on CREs in MCBH jurisdiction are sparse. Furthermore, even though CREs in the Kane'ohe Bay portion of the Ko'olaupoko Watershed Region are perhaps the most intensely studied of CREs in the State of Hawai'i, the substantial amount of scientific data generated are not readily accessible to managers. MCBH lacks an up-to-date, comprehensive inventory of marine species and habitats within its jurisdiction. An assessment of their condition is also lacking for marine areas under MCBH jurisdiction, and along vessel transit routes used for training between MCBH-KB and MCTAB properties, particularly in associated nearshore/fringing reef areas. This report consolidates existing ecological and management information on the CREs within or adjacent to MCBH jurisdiction, including a species list. The nearshore areas surrounding MCBH-KB within the 500-yard buffer zone consist of four different biophysical zones of coral reef communities: Kane'ohe Bay Zone, Reef Flat Zone, Open Ocean Zone, and Kailua Bay Zone. Zones differ primarily in exposure to wave energy and currents. A number of offshore islets also occur within the MCBH 500-yard buffer zone and represent unique biophysical zones. Endangered marine mammals, including the humpback whale (*Megaptera novaeangliae*), Hawaiian monk seal (*Monachus schauinslandi*), threatened green sea turtles (*Chelonia mydas*), and endangered hawksbill turtles (*Eretmochelys imbricata*) occur in waters around Mokapu. In addition, extensive rookeries of over a

dozen different species of protected seabirds occur in offshore islets along coastal areas of the Ko'olaupoko Watershed Region, including areas within MCBH jurisdiction. Protected Pacific bottle-nose dolphins (*Tursiops gilli*) are less frequent but significant visitors to MCBH-KB's offshore buffer zone area.

A variety of readily available methods exist to assess and monitor CREs in Hawai'i. They vary depending on the spatial scale and temporal extent of inquiry. Techniques range in scope from analysis of aerial photographs and hyper-spectral images to complex video-based assessment and monitoring programs. Techniques are described herein and evaluated according to the spatial scale over which they are most effective and useful to MCBH for CRE inventory, assessment, and monitoring. At the national level, the Coral Reef Mapping Implementation Plan provides a comprehensive framework to map all US coral reef habitats by 2007 using a suite of satellite, aircraft, and underwater data-collection platforms. Some of these mapping activities were pilot-tested in or near marine waters within MCBH jurisdiction in the Ko'olaupoko Watershed Region. Once available, some of the map products can be incorporated into the MCBH EGIS and can be used by MCBH Environmental as decision support tools for coral reef ecosystem research, conservation, and management.

Spill risk and other forms of pollution represent potential threats to CREs under MCBH jurisdiction. Coastal and estuarine environments, including shallow coral reef ecosystems, are far more sensitive to the impacts of oil spills than the open ocean. Thus, spill risk is a significant threat due to the large volumes of oil and other hazardous substances handled by Navy/Marine Corps operations at MCBH and the transit of some of these materials to the Base through the sensitive barrier reef and patch reefs of Kane'ohe Bay. Recommended actions include improvement of spill response preparedness, improvement of information base for "at risk" areas, and clarification of responsibilities.

Threats to CREs via surface water pollution in stormwater runoff from MCBH activities are minimal, and probably represent an insignificant contribution compared to that contributed by other sources in the Ko'olaupoko Watershed Region generally. For example, previous studies conclude that non-point pollution from Ka'elepulu Stream and Kawai Nui Channel accounts for the great majority of pollution in Kailua Bay. Efforts to identify non-point source pollution from the Ko'olaupoko Watershed Region have revealed pollution sources such as sediment from soil erosion; fertilizers, pesticides, and herbicides; chemical and metallic residues from vehicles; seepage from cesspools; polluted runoff from impervious areas; domestic animal and wildlife wastes; leaking sewer lines and sewage pumping station failures; oil, paint, grease, and leaks from car batteries; polyacyclic aromatic hydrocarbons; and other factors. On a smaller scale, land and water-based activities on Mokapu Peninsula pose a non-point source pollution threat for adjacent CRE's from these same kinds of sources. Recommended actions include innovative solutions to minimize freshwater run-off, such as those already incorporated into projects listed in the Watershed Component (Section 7.3) of the MCBH INRMP/EA. These include, but are not limited to actions such as reducing paved areas and increasing the area of penetrable surfaces; utilizing settling ponds; and by providing leadership on non-point source pollution prevention in the Ko'olaupoko Watershed Region. Additional recommendations focus on improving communication among stakeholders internal and external to MCBH's command structure, and through continuous improvement in adoption of EPA's Best Management Practice (BMP) guidelines for non-point source pollution in all pertinent MCBH activities.

Marine debris from illegal ocean dumping represents a significant threat to CREs in the region. The Hawaiian Islands trap oceanic debris as the prevailing marine current patterns carry water containing debris around the islands. For CREs in Hawai'i, fishing nets and plastics are the most destructive type of marine debris. As it drifts into nearshore areas, marine debris can become caught and entangled on coral reefs, severely damaging or potentially destroying the reef. Marine debris can also harm or kill reef inhabitants, such as fish, seals, turtles, marine mammals and birds, through ingestion, strangulation or entanglement. Marine debris also can facilitate introduction of invasive species. Recommended actions include a range of marine debris removal and prevention steps, such as continuing to partner with DLNR/DAR on net removal efforts, and continuing to participate in coordinated shoreline cleanup campaigns.

Marine recreational activities are another potential source of CRE resource use and/or abuse. The shallow depth, sheltered environment, and low wave activity make coral reefs at MCBH ideal for marine recreational activities such as swimming, SCUBA diving, and snorkeling. MCBH waters offer diverse boating opportunities (e.g., paddling, sailing, jetskiing, waterskiing). The MCCA Marina provides a number of recreational boating services to Base patrons. Marine recreational activity can result in physical damage by vessel groundings, anchoring, and by human trampling. In addition to physical damage, vessel groundings can result in oil spills and a variety of other impacts. Other recreationally-based effects may include thrill craft impacts, noise impacts, and prop- and jet-shearing effects on algal and seagrass habitats. Finally, shoreline pole fishing and nearshore spear fishing are also popular activities at MCBH, but can contribute to overfishing if not adequately managed. Recommended actions focus on assessment and monitoring, regulations, enforcement, data management, and education.

Accidental and intentional species introductions can negatively impact CREs. Alien species can feed on or displace native species and disrupt native trophic structure. Changes in species composition of communities can then lead to alterations in nutrient cycling and energy flow, which in turn lead to large, cascading, unpredictable effects throughout marine communities. Disease and global climate change are broad scale environmental threats to CREs under MCBH jurisdiction. While MCBH cannot readily prevent disease and global warming, their impact can be mitigated by reducing other types of CRE stressors over which management measures can be exercised.

This CREMS makes a total of 94 recommended management actions across the broad categories of Assessing the MCBH Coral Reef Ecosystem (Section 5), Mapping the MCBH Coral Reef Ecosystem (Section 6), Amphibious Training and Transit (Section 7), Pollution (Section 8), Marine Recreational Activities (Section 9), Public Access (Section 10), and Broad-Scale Environmental Factors (Section 11). In addition, there are three recommendations that are general in nature: 1) formally assign coast and marine resource management responsibilities to appropriate MCBH personnel; 2) ensure assigned personnel have appropriate training in tropical marine ecology and marine resource management; and 3) transfer all record-keeping and incident reports to electronic format that can be stored to a secure shared-access network.

CREMS recommendations are summarized, cross-referenced to appropriate sections of the CREMS and the MCBH INRMP/EA (Drigot *et al.* 2001), and assigned priority levels (Levels I-III) in Table 12-1 in

Section 12. Recommendations from Table 12-1 are further distilled into broad management categories in Table ES-1 of this Executive Summary. Priority Level I and Level II Recommended Actions in Table ES-1 relate primarily to staffing, mapping, monitoring and assessment (particularly related to invasive species and recreational fisheries), amphibious training, and NRDAR Responsibilities. Priority Level I and Level II Recommended Actions should be accomplished within the short-term (e.g., 1 to 2 years) in order to achieve or maintain compliance with applicable laws, regulations or military directives to protect coral reef ecosystems. Priority Level III Recommended Actions are best management practices that should be continued or accomplished within the long-term (e.g., 3 to 5 year time frame). Note that Priority Levels I-III do not refer directly to the three alternatives described in the MCBH INRMP/EA.¹ Because the CREMS is the first comprehensive management study to be undertaken for the coral reef ecosystem at MCBH, the vast majority of recommended actions are new (i.e., most all would be categorized as optimal stewardship under the defined alternatives in the MCBH INRMP/EA).

Implementation Priority Codes are as follows:

PRIORITY LEVEL	
Level I: Minimum Compliance	Action <i>urgent</i> due to non-compliance with applicable law, regulation or military directive and/or due to the immediacy of the ecological threat and the potential costs or irreparable nature of the consequences.
Level II: Anticipatory Compliance	Action <i>important</i> . Although ecological threat is not immediate or irreparable, action should be implemented to avoid possible non-compliance.
Level III: Optimal Stewardship	Action <i>helpful</i> to achieve management goals. Best management practice should be implemented or continued (Operational Stewardship).
ACTION TIME	
Short-term (1-2 yr)	Priority Level I and Level II Recommended Actions should be accomplished within the short-term in order to achieve or maintain compliance with applicable laws, regulations or military directives to protect coral reef ecosystems.
Long-term (3-5 yr)	Priority Level III Recommended Actions should be continued or accomplished within the long-term as best management practices for coral reef ecosystem management.

¹ Defined alternatives in the INRMP include Alternative 1: Operational Stewardship (No Action/ Continuing Action); Alternative 2: Compliance-focused Stewardship (Reduced Action); Alternative 3: Optimal Stewardship (Increased Action).

Table ES-1. Summary Table of Recommended Actions and Implementation Priorities

	Recommended Actions ²	Implementation Priority		
		Level I: Minimum Compliance	Level II: Anticipatory Compliance	Level III: Optimal Stewardship
I. General Coastal and Marine Management	3	2		1
II. Assessing the MCBH Coral Reef Ecosystem				
Assessment and Monitoring: Benthic Geomorphology	9		3	6
Assessment and Monitoring: Biotic Resources	2	1		1
Assessment and Monitoring: Human Uses	1		1	
III. Mapping the MCBH Coral Reef Ecosystem	3			3
IV. Amphibious Training and Transit				
Review, Revise, Amend, or Clarify SOPs	7		2	5
Review and Mitigate Potential Impacts	9		4	5
Improve Navigational Infrastructure	6		1	5
V. Pollution				
Point-Source Pollution: Oil Spill Risks	8		3	5
Point-Source Pollution: Outfalls	4			4
Non-Point-Source Pollution: Runoff	5		1	4
Non-Point-Source Pollution: Marine Debris	10			10
VI. Marine Recreational Activities				
Assessment and Monitoring	2		2	
Regulations, Enforcement, and Data Management	9		2	7
Education	4			4
Recreational Facilities	5			5
VII. Public Access	2			2
VIII. Broad-Scale Environmental Factors				
Marine Disease	2			2
Invasive Marine Species	5		3	2
Global Climate Change	1			1
TOTAL	97	3	22	72

² Total number of recommended actions. Recommended management actions and implementation measures are tabled and cross-referenced to appropriate sections of the CREMS and the MCBH INRMP/EA (Drigot *et al.* 2001) in Table 12-1 in Section 12.