Special Public Notice

U.S. Army Corps of Engineers®
Honolulu District

Public Notice No.	Date:
POH-2009-00314	**July 26, 2010**

Reply to:
U.S. Army Corps of Engineers
Honolulu District
Regulatory Branch, CEPOH-EC-R
Building 230
Fort Shafter, Hawaii 96858-5440

Respond by:
August 26, 2010

APPLICANT:

The Nature Conservancy of Hawaii
923 Nuuanu Avenue
Honolulu, Hawaii 96817

AGENT: Not applicable

LOCATION:

The location of the proposed in-lieu fee program encompasses the eight Main Hawaiian Islands and includes four service areas, as defined by expert delineated stratification units: Hawaii Island, Maui Nui Complex (Maui, Molokai, Lanai, Kahoolawe), Oahu Island, and Kauai-Niihau Islands.

ACTIVITY/WORK:

The review of a prospectus prepared by the applicant, which is associated with the establishment and management of an in-lieu fee program for compensatory mitigation of coral reef ecosystems for Department of the Army (DA) permits.

Evaluation Factors:

The decision whether to authorize the proposed in-lieu fee (ILF) program will be based on an evaluation of the probable impacts, including cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefits, which reasonably may be expected to accrue from the proposal, must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered, including the cumulative effects thereof; among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and, in general, the needs and welfare of the people. In addition, if the proposal would discharge dredged or fill material, the evaluation of the activity will include application of the EPA Guidelines (40 C.F.R. 230) as required by Section 404(b)(1) of the Clean Water Act.

The U.S. Army Corps of Engineers is soliciting comments from the public, Federal, State, and local agencies and officials, and other interested parties in order to consider and evaluate the impacts of this activity. Any comments received will be considered by the Corps to determine whether to issue, modify, condition or deny a permit for the work. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects, and the other public interest factors listed above. Comments are used in the preparation of an Environmental Assessment and/or an Environmental Impact Statement pursuant to the National Environmental Policy Act. Comments are also used to determine the need for a public hearing and to determine the overall public interest of the activity. In addition, all comments will be distributed to the members of the Interagency Review Team (IRT) and the sponsor within 15 days of the close of the public comment period. The Honolulu District Engineer (DE) and the IRT members will also have the opportunity to comment to the sponsor. After considering comments from the DE, IRT and the public, if The Nature Conservancy (TNC) chooses to proceed with the establishment of the ILF program, TNC will prepare a draft instrument and submit it to the DE.

Background:

On April 10, 2008 the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency (EPA) jointly published the Final Rule on Compensatory Mitigation for Losses of Aquatic Resources ("Mitigation Rule"), which went into effect June 9, 2008. The Mitigation Rule replaced most previous guidance concerning compensatory mitigation, including the previous ILF guidance of 2000. The new Mitigation Rule includes requirements that prospective ILF program providers meet substantially the same standards as mitigation banks and undergo the same IRT review and approval process as mitigation banks.

TNC is a nonprofit conservation organization that was founded in 1951 to preserve plants, animals and natural communities by protecting ecologically important lands and waters. Consistent with the requirements of the Mitigation Rule at 33 C.F.R. Part 332.8(d), TNC has submitted a prospectus to the Corps for the purpose of establishing and managing an ILF program. The Corps is seeking comments from the public, interested parties and the IRT on the prospectus. A copy of the full prospectus is attached to this special public notice.

Comment and Review Period:

Conventional mail or e-mail comments on this public notice will be accepted and made part of the record and will be considered in determining whether it would be in the public interest to authorize this proposal. In order to be accepted, e-mail comments must originate from the author's e-mail account and must include on the subject line of the e-mail message the permit applicant's name and reference number as shown below. All e-mail comments should be sent to: susan.a.meyer@usace.army.mil. Conventional mail comments should be sent to: U.S. Army Corps of Engineers, Honolulu District, Regulatory Branch, Building 230, Ft. Shafter, HI 96848. Both conventional mail and e-mail comments must include the permit applicant's name and reference number and the commenter's name, address, and phone number. All comments whether conventional mail or e-mail must reach this office, no later than the expiration date of this public notice to ensure consideration. Please include the following name and reference number: **POH-2009-00314**.

Please contact Ms. Susan A. Meyer at (808) 438-2137 or susan.a.meyer@usace.army.mil if further information is needed concerning this notice. This special public notice is issued by the Chief, Regulatory Branch.

Attachment
(*Final Prospectus to Establish an In-Lieu Fee Program for the Main Hawaiian Islands*, dated July 13, 2010)

Final Prospectus to Establish an In-Lieu Fee Program for the Main Hawaiian Islands

Submitted to:
U.S. Army Corps of Engineers, Honolulu District
Regulatory Branch

Submitted by:
The Nature Conservancy of Hawai'i

July 13, 2010

Acronyms

CRAMP	Coral Reef Assessment and Monitoring Program
CRCP	Coral Reef Conservation Program
CWA	Clean Water Act
CZM	Coastal Zone Management
DA	Department of the Army
DLNR-DAR	Department of Land and Natural Resources-Department of Aquatic Resources
DBET	Department of Business, Economic Development and Tourism
DLNR	Department of Land and Natural Resources
DOH	Department of Health
ESI	Environmental Sensitivity Index
FDIC	Federal Deposit Insurance Corporation
FMA	Fishery Management Area
FRA	Fishery Replenishment Area
GIS	Geographic Information System
HBMP	Hawaiʻi Biodiversity and Mapping Program
HIMAG	Hawaiʻi Island Marine Algae Group
ILF	In-lieu fee
IRT	Interagency Review Team
LAS	Local Action Strategy
MERP	Marine Ecoregional Planning
MHI	Main Hawaiian Islands
MLCD	Marine Life Conservation District
MMA	Marine Managed Area
MPA	Marine Protected Area
NAR	Natural Area Reserve
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWI	National Wetland Inventory
SFMA	Subsistence Fisheries Management Area
UIC	Underground Injection Control
TNC	The Nature Conservancy
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

Introduction

Hawaii's nearshore waters are home to more than 7,000 forms of marine life, a quarter of them found nowhere else on Earth. Hawaii's coral reefs are a global priority for conservation, supporting more unique marine species than any place of its size in the tropics, including some of the nation's most endangered marine species such as monk seals and sea turtles. 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 reef ecosystem creates habitat for many fish and invertebrate species with commercial value, supports tourism and recreational industries, and shelters coastlines from natural disturbances. Life in Hawai‘i depends upon a healthy and thriving marine environment.

Over the past several decades, the health of Hawaii's rich aquatic environment has been significantly altered due to anthropogenic and natural stresses. With the added threats from global climate change predicted to occur within the next 50 years, the need to protect our reefs and other aquatic resources has never been more urgent.

The U.S. Army Corps of Engineers (Corps), Honolulu District, anticipates dozens of permitting actions over the next few decades that will likely have unavoidable impacts on aquatic resources under the jurisdiction of the Corps and the U.S. Environmental Protection Agency (USEPA). In such instances, compensatory mitigation may be required to replace the loss of wetland, stream, coral reef and/or other aquatic resource functions and services. The Nature Conservancy's Hawai‘i Program (TNC) is proposing to establish an in-lieu fee (ILF) program, as contemplated under 33 CFR Part 332 and 40 CFR Part 230, to help make more effective and ecologically sound decisions regarding compensatory mitigation in Hawai‘i for the nearshore marine resources, particularly coral reefs and seagrass beds.

The Corps and USEPA joint regulations (commonly referred to as the "Mitigation Rule") state that compensatory mitigation decisions should be made from a watershed approach in which the type and location of compensatory mitigation follows from an analytically-based watershed assessment to assure that the proposed compensation is successful, ecologically sound and consistent with overall watershed goals. TNC will use its scientifically peer-reviewed and approved marine ecoregional assessment and planning framework for the main Hawaiian Islands (MHI) as the basis for prioritizing and selecting compensatory mitigation sites and activities (http://www.hawaiiecoregionplan.info/home.html). TNC's analysis includes a spatial database of the ecoregion's biodiversity and the factors that affect it, a decision-support framework to evaluate conservation and management alternatives, and a set of conservation areas with the present threats and opportunities identified for each.

This ecoregional assessment has been developed in close collaboration with State and Federal partners, and includes input from a broad range of the State's scientific experts. Results from the assessment are being used by the State of Hawaii's Department of Land and Natural Resources Division of Aquatic Resources (DLNR-DAR) and NOAA's Hawai‘i Coral Reef Conservation Program (CRCP) to assist with prioritization of funding and management efforts. Utilizing this same framework for the ILF Program not only ensures that appropriate sites will be selected for individual mitigation projects, but that the sum of these individual projects fits within and contributes to the whole of a comprehensive statewide aquatic conservation strategy that leverages the strengths and resources of multiple partners. Incorporation of these tenets and analytical data into the ILF Program is expected to result in long-term, self-sustaining benefits to coral reef resources.

As the Sponsor, TNC would be responsible for preparing all documentation associated with establishment of the ILF Program, including the Prospectus, Instrument, Mitigation Plans and other appropriate documents. This document serves as the Prospectus for the ILF Program ("Program") for the main Hawaiian Islands. This Prospectus provides an overview of the proposed ILF Program, outlining the objectives, feasibility, compensation planning framework of the Program, and the qualifications of TNC as the proposed sponsor of the Program. The prospectus serves as the basis for public and initial Interagency Review Team (IRT) comment. As required under the rules, a Prospectus must be approved by the District Engineer before production of an ILF Instrument.

I. Objectives

The primary objective of the ILF program is to provide a compensatory mitigation option for Department of Army (DA) authorized impacts, Civil Works project impacts, and/or resolution of non-compliance issues or unauthorized activities (i.e., enforcement) to ensure "no net loss" of acreage and/or function of marine aquatic resources (e.g., coral reefs, sea grass beds) applying an approach synonymous to a watershed approach. TNC proposes an ILF Program that will help protect, maintain, and restore sustainable, functional marine aquatic ecosystems through:

- Consolidating mitigation requirements of multiple projects into an organized, comprehensive marine management plan that achieves watershed and regional restoration priorities;
- Abating principle threats in each site and re-establishing healthy land-sea connections;
- Developing an integrated watershed approach to mitigation by leveraging terrestrial- and marine-based mitigation strategies;
- Working closely with the government, general public, private, and scientific communities to develop state-of-the-art implementation, assessment and monitoring methods and tools to ensure that lost aquatic resource functions are equitably replaced at the compensatory mitigation sites;
- Strategically locating ILF mitigation projects within close proximity of ongoing multi-agency regional conservation efforts to optimize ecological benefits;
- Magnifying the commitment of communities to manage publicly accessible mitigation sites (e.g., marine waters) by providing greater opportunities for engagement and making it more feasible for community members to voluntarily implement threat-abatement strategies and secure successful long-term commitment (i.e., legal recognition);
- Achieving a high level of accountability using appropriate monitoring methods to evaluate the effectiveness of project specific mitigation strategies and applying the information to determine the need, level and timing of adaptive management; and,
- Producing scientific evidence to demonstrate the individual contribution of mitigating particular stressors as it relates to restoration, particularly for coral reefs, and building a more

comprehensive, science-based assessment of the efficacy of various aquatic mitigation and restoration strategies.

The desired outcome of the program is ecological success on a watershed basis, and in some instances an ecoregional basis, to ensure no net loss of coral reef functions. The goal is to ensure that the compensatory mitigation sites are effectively managed as part of a larger network which restores, enhances, establishes and preserves viable marine habitats that provide sustainable ecological processes and support healthy populations of floral and faunal species encompassed by the ecoregion.

Because this would be the first ILF Program in the nation designed largely for coral reef ecosystem mitigation, TNC strives to bring an enhanced understanding of and model for coral reef mitigation to the scientific and natural resource management communities to further marine conservation state- and nationwide.

II. Establishment and operation of the Program

TNC proposes to establish itself as a qualified ILF sponsor for providing third party compensatory mitigation associated with Department of the Army authorized impacts, non-compliance of DA permit conditions, and/or resolution of unauthorized (enforcement) activities. The IRT, whose members include the Corps, U.S. Fish and Wildlife Service (USFWS), USEPA, National Oceanic Atmospheric Administration (NOAA), State of Hawaiʻi Department of Health Clean Water Branch (DOH), State of Hawaiʻi Coastal Zone Management (CZM) Program, and the State of Hawaiʻi Division of Aquatic Resources (DLNR-DAR), will advise the Corps on the establishment and management of the ILF program. The Corps' District Engineer may designate different representatives or agencies than those listed above or may invite the participation of additional members.

The ILF Instrument (Instrument) establishes the ILF program and will govern all aspects of the Program, including how mitigation projects within the service area(s) will be established, credited, monitored and managed. The Instrument describes the program elements such as service area determination, accounting procedures, legal responsibility, site protection, financial assurances, credit/debit accounting, and reporting requirements.

Each mitigation project will have a separate mitigation plan prepared, reviewed and signed by TNC, and approved by the IRT. Mitigation plans will include the following information: objectives, compensation planning framework, site selection rationale, site protection instrument, baseline information, credit determination, mitigation work plan, maintenance plan, monitoring requirements, including performance standards for determining mitigation success, long-term management plan, adaptive management plan, long-term funding mechanism, and other information as needed.

III. The proposed service area(s)

The project area encompasses the main eight Hawaiian Islands, which includes the islands of Hawaiʻi, Maui, Molokaʻi, Lanaʻi, Kahoʻolawe, Oʻahu, Kauaʻi and Niʻihau. Collectively, the narrow shelf around the MHI supports approximately 1,231 km^2 (<10fm) of coral reef area (Rohman et al. 2005), as well as estuaries, rocky and sandy intertidal, unconsolidated sediment, and marine plants.

The project area will be subdivided into four service areas based on expert delineated stratification units: Hawaiʻi Island, Maui Nui Complex (Maui, Molokaʻi, Lanaʻi, Kahoʻolawe), Oʻahu Island, and Kauaʻi-Niʻihau Islands. The stratified service areas are based on scientific findings to date on genetic connectivity of marine habitats and species (e.g., Bird et al. 2007). Impacts occurring in each service area would require compensatory mitigation occur in the same area.

IV. General need for the in-lieu fee program

In 2003, the USFWS investigated the effectiveness of compensatory mitigation from completed federally funded or permitted coastal construction projects in the U.S. Pacific where there were unavoidable impacts to coral reef ecosystems. Of the 38 projects that had information that could be used for the analysis (out of 5,000), the federal resource agencies recommended compensatory mitigation for only eleven sites, including four in Hawaiʻi (Bentivoglio 2003). Of the cases examined, only four of the 38 projects (11%) were effective in offsetting the losses to the coral reef ecosystem, compensating for the loss of only 0.7% of the total acreage of coral reef habitat lost.

At present, there is no comprehensive program designed to oversee compensatory mitigation for unavoidable losses to the coral reef system in the state. Of the existing permittee-responsible compensatory projects, mainly for wetlands, experts claim the mitigation efforts are conducted on an ad-hoc basis and have a low level of success.

In general, ILF programs are considered a preferred alternative to permittee-responsible mitigation in reducing risk and uncertainty through more advanced planning and the additional requirements necessitated by the Mitigation Rule for such programs. In-lieu fee programs may be the environmentally preferable option because they can provide consolidated compensatory mitigation projects that have greater ecological benefits than small, geographically separated, permittee-responsible mitigation.

Findings from TNC's ecoregional assessment confirm the need for a holistic approach to coral reef ecosystem restoration and protection. According to many of the state's top marine scientists, the primary sources of stress to aquatic ecosystems include coastal development and associated land-based pollution (e.g., sediment), alien species (e.g., algae, vegetation, fish), and overuse/harvest of the resources. Both empirical data and expert opinion demonstrate the need for the preservation of high quality areas at risk of biological decline, terrestrial-based threat-abatement mitigation strategies, and in-water restoration measures in order to achieve long-term recovery and sustainability of coral reefs and other freshwater and marine aquatic resources.

V. Technical feasibility

TNC is confident that many of the technical needs required to meet the objectives of the program are feasible. First, TNC has already completed the main element of the Program, the compensatory planning framework, in the form of our ecoregional assessment and planning framework for the marine waters of the MHI. Second, TNC and other organizations and agencies are currently active in on-site restoration, and are already testing adaptive management mitigation strategies, including short- and long-term monitoring components to measure individual project effectiveness and success. Third, communities, scientists, government, managers, and conservation groups are ripe with interest to restore large areas of coral reef habitat around the state, and would likely welcome the opportunity to participate in the large-scale efforts envisioned by the Program.

Given the extraordinary complexity of coral reef systems and the current inability to isolate a single stress/perturbation responsible for reef degradation, the primary challenge in meeting the program objectives lies in the deficiency of well-established and proven methods for coral reef restoration as well as the impracticability of controlling and eliminating all potential anthropogenic and natural stressors that may contribute to coral reef degradation. Coral reef science as a whole is only now beginning to empirically evaluate some of the many possible management actions available, and best management practices are a subject of continued debate. TNC mitigates this shortcoming with our organization-wide adopted Conservation by Design framework. To meet the needs of each mitigation project, TNC will incorporate the best available science along with an appropriate monitoring program that will evaluate the effectiveness of the implemented strategies and inform adaptive management. These plans will be vetted by the IRT and other relevant experts and provide the greatest chance of success for each project. They will also provide a meaningful contribution to the small-but-growing body of knowledge on effective reef restoration techniques.

VI. Proposed ownership arrangement and long-term management strategy

In contrast to terrestrial lands, waters cannot be purchased. TNC will work with DLNR-DAR to ensure that all compensatory mitigation sites are awarded with some level of recognized, formal protection that considers stewardship and community input. TNC will also pursue innovative options, particularly as part of watershed management, which will include the use of real estate and legal instruments (i.e., conservation easements, ownership of submerged waters, leasing of state and/or submerged lands) for long-term site protection. The type of ownership and long-term management strategy will vary by mitigation project site, though TNC will be responsible for ensuring long-term protection of each ILF project.

Ownership arrangement

The possible mitigation sites encompass public waters that are primarily under the jurisdiction of the State of Hawaiʻi. Some of the waters are marine managed areas (MMAs), including: 11 marine life conservation districts (MLDC), one natural area reserve (NAR), nine fishery replenishment areas (FRA), 19 fishery management areas (FMA), and one island reserve (Kahoʻolawe Island Reserve), as well as bottomfish restricted areas and the Hawaiian Islands Humpback Whale National Marine Sanctuary. A few other areas in the state have restricted uses under federal jurisdiction, including certain waters near Pearl Harbor and other military installations. Approximately 0.4% of nearshore waters of MHI are in complete no-take zones (i.e., no fishing of any kind is permitted).

In addition to state management, many communities across the islands have a strong interest in active resource management, and are willing to self-impose more stringent rules and regulations in order to restore and protect natural aquatic resources, especially nearshore marine resources. For instance, local communities within three geographic areas on the MHI have sought and gained subsistence fisheries management area (SFMA) designation from the State government (Moʻomomi on Molokaʻi, Miloliʻi on Hawaiʻi Island and Haʻena on Kauaʻi).

TNC's years of working with local communities on marine restoration and with partnerships and alliances on terrestrial restoration in Hawaiʻi show that strong community stewardship is an important factor in achieving ecological success. TNC intends to continue to work collaboratively with local organizations, agencies and communities to foster cooperation and community acceptance of compensatory mitigation activities for the long-term benefit of aquatic resources. TNC will ensure appropriate stewardship requirements are in place, even if long-term management responsibilities are transferred to a different stewardship entity, such as a public agency, non-governmental organization, or community group.

Long-term management strategy. TNC will continue to focus on strengthening community-based management state-wide. When applicable, particularly for terrestrial lands, TNC will use a variety of long-term site protection mechanisms, including: conservation easements, leases, direct acquisition, management agreements, and other appropriate legal instruments. TNC proposes to implement the mitigation projects directly as well as issue contracts with private firms, local governments, non-profit organizations, and other qualified entities to accomplish certain facets of the long-term management strategy. TNC will work with these partners to plan, implement, monitor, maintain, and provide long-term stewardship and ownership of the projects. TNC will monitor the complete project for an appropriate length of time, as detailed in the mitigation plan.

Long-term financing mechanisms will be considered for all compensatory mitigation projects. TNC will establish and oversee an account at a financial institution that is a member of the Federal Deposit Insurance Corporation (FDIC), which will hold the funds to ensure permanent site protection and ecological performance, even after the performance standards have been achieved (refer to section IX).

VII. Qualifications of the sponsor to successfully complete the types of mitigation projects proposed

TNC is an international private, non-profit conservation organization whose mission is to preserve plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. TNC has been working to protect Hawaii's native forests for more than 30 years, and, more recently, the nearshore waters of the MHI. In that time, the organization has had tremendous success on land and in the water, and remains on the frontlines of tropical marine and forest conservation management, research, and policy.

Recent examples of TNC Hawaii's leadership on a variety of technologies and strategies that have furthered conservation progress include:

<u>Adaptive Management</u>

- Completing the first state-wide, scientifically rigorous planning assessment that identifies the most biologically important places in the MHI for marine, coastal, and terrestrial systems. Results from the marine assessment are currently being used by the State, NOAA, and USFWS to plan coral reef conservation actions.
- Establishing accountability at each project site, through a Conservation Action Planning process where TNC sets and then methodically and rigorously measure's the success of conservation goals and objectives on an annual basis.
- Working with communities to protect and restore marine resources in six sites across the state, including: Maunalua and Kāneʻohe Bays on Oʻahu, Kaʻūpūlehu and Puakō on Hawaiʻi island, and Mūʻolea and ʻĀhihi-Kīnaʻu on Maui. With strong community involvement, the focus has been on developing strategic conservation management plans, conducting direct threat abatement (e.g. removal of invasive algae and/or fish), implementing targeted outreach programs to increase compliance with natural resource laws, and conducting scientific baseline monitoring to ensure management actions are having the desired positive biological effect on the marine resources.

<u>Restoration and Monitoring</u>

- Guiding and assisting communities in direct threat abatement, including invasive algae removal and native limu planting (Maunalua Bay and Kāneʻohe Bay), mitigation of run-off and sedimentation (Maunalua), management of unsustainable levels of recreational use (ʻĀhihi-Kīnaʻu, Puakō, Kaʻūpūlehu, and Mūʻolea), and other appropriate site-based activities.
- Working with the community to restore and enhance 60 acres of wetland habitat and taro loi at Heʻeia in Kāneʻohe Bay and inventory and monitor project success.
- Developing, in partnership with the University of Hawaiʻi and DLNR-DAR, new and innovative technology, (dubbed the "Super Sucker"), to effectively remove highly invasive alien algae from large areas of Hawaii's reefs. To date, the Super Sucker has cleared approximately 5 acres of alien algae from Kāneʻohe Bay.
- Overseeing $3.4 million from NOAA's Community-based Restoration Program under the American Recovery and Reinvestment Act of 2009 for the Maunalua Bay Reef Restoration project. As the grant recipient, TNC is working with the local community group Malama Maunalua to remove alien algae from 22 acres in the Bay.

- Establishing a marine monitoring team that collects long-term data on fish and benthic communities at TNC and partner community-based project sites. In the last year, the monitoring team has conducted several hundred transects over 17 survey trips at 10 sites, including Kahoʻolawe and Palmyra.
- Developing breakthrough technology for mapping and removing invasive weeds, including the development of high resolution aerial imagery to detect weeds in remote locations and precise application of herbicide to control individual weeds.
- Implementing new methods for controlling feral animals on TNC preserves using targeted professional hunting over 17,000 acres.
- Collecting groundbreaking data for wildlife studies and feral animal management by putting GPS collars on 41 animals and analyzing and monitoring their movement.
- Monitoring Pelekunu stream for native fauna and sedimentation loads before/after ungulate removal.

Land Protection

- Managing a statewide network of 11 nature preserves strategically positioned in key watersheds throughout the state and totaling almost 40,000 acres.
- Helping to purchase approximately 150,000 acres to create new National Wildlife Refuges and expand National Parks. Transactions include adding the 116,000-acre Kahuku Ranch to Hawaiʻi Volcanoes National Park, and helping to create the first national wildlife refuge for tropical forest birds at Hakalau on the island of Hawaiʻi.

Partnerships/Policy

- Developing the state's first social marketing campaign for ocean conservation which helped to limit the unsustainable use of lay gill nets statewide.
- Participating on multi-stakeholder committees on land and water, such as State Local Action Strategy (LAS) Steering Committees, the Offshore Islets Restoration Committee, the West Hawaiʻi Fisheries Council, the Hawaiʻi Islands Marine Algae Group, and the State Association of Watershed Partnerships to provide management and restoration recommendations.
- Working with public and private landowners to successfully develop eight watershed partnerships and alliances that are currently protecting nearly 1.5 million acres of forests and watersheds across the state.
- Spearheading the formation of the 18-agency Coordinating Group on Alien Pest Species.

VIII. Compensation Planning Framework

The compensation planning framework of the Program supports a statewide approach to compensatory mitigation, and is based on TNC's ecoregional assessment for the marine systems of the main Hawaiian Islands. The ecoregional assessment follows a standard process developed and used by TNC to analyze and identify biologically important areas that, if effectively managed, would 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, as generated through GIS analysis and expert focus group review and consensus.

The TNC ecoregional assessment process entails a standard set of steps, which are modified to reflect the particular place. The following is a brief itemization of the key steps:

1. Define geographic scope or ecoregional boundary.
2. Identify conservation targets at a variety of scales to represent the overall biodiversity of the ecoregion.
3. Assess viability of conservation targets by analyzing their size, condition and landscape context.
4. Establish conservation goals explicitly in terms of representation (specifies the number, area or percentage of viable conservation targets) and stratification (specifies distribution) sufficient to effectively conserve the ecoregion's biodiversity. Through representation and stratification, TNC tries to ensure all diversity is represented and risk is spread across the entire ecoregion (i.e. local catastrophes will not impact all examples of a target).
5. Assess critical threats to the conservation targets. Particular to the marine assessment, a suitability analysis was developed to help identify factors that are likely to have adverse effects on the marine conservation targets, and to steer the selection of conservation areas away from places likely to affect human use. A threat was defined as an anthropogenic source and/or action that may undermine the potential for biodiversity to persist sustainably.
6. Establish a selection of sites comprised of conservation areas that express the accumulated goals across the ecoregion, ensuring representation, stratification, and redundancy of viable conservation targets. Particular to the marine assessment, the site-selection algorithm program "Marxan" was utilized (Ball and Possingham 2000).
7. Select a subset of sites at which highest priority efforts will be focused.
8. Develop strategies to abate critical stress factors and maintain or improve viability of conservation targets through conservation actions.
9. Ensure a system for long term monitoring of conservation targets and management progress.

The steps are grouped into three phases:

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 Nui Complex (Maui-Moloka'i-Lana'i), (4) and 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., ecosystems, species or processes) used to define geographic areas. A representative set of the ecoregion's conservation targets were selected and spatially mapped using GIS. Ecosystems (e.g., nearshore coral reef and hardbottom, seagrass beds) were the first targets of focus (coarse filter targets - Table 1). It is presumed that the conservation of representative habitats will also conserve a representation of the diversity and needs of species found in these ecosystems.

Table 1. Selected coarse-filter targets

Habitats
Intertidal habitat (rocky, sandy)
Wetlands (estuaries)
Nearshore coral reef and hardbottom
Unconsolidated sediment (sand)
Marine plants (seagrass, halimeda)
Deep water habitat (hard and soft bottom)

Species that cannot be conserved through a focus at the ecosystem level or warrant special attention due to restricted distribution were identified as conservation targets. These include: green turtle nesting, hawksbill turtle nesting, humpback whale wintering, manta ray feeding and cleaning, monk seal pupping, and spinner dolphin resting areas.

For each target, a conservation goal was set (e.g., the amount and distribution of habitat) to protect viable target populations and communities representing the full range of diversity within the ecoregion. Appendix A illustrates the process, focusing on coral reef and hardbottom and marine plant habitat.

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 factors within any given planning unit. If there were multiple options for places to capture the same quality of targets, the ones with the lower degree of stress were considered more viable. Appendix B provides additional information on the data used in this suitability analysis.

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 geo-referenced 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 stress factors for each planning unit
- The stratification unit boundaries
- The planning unit boundaries

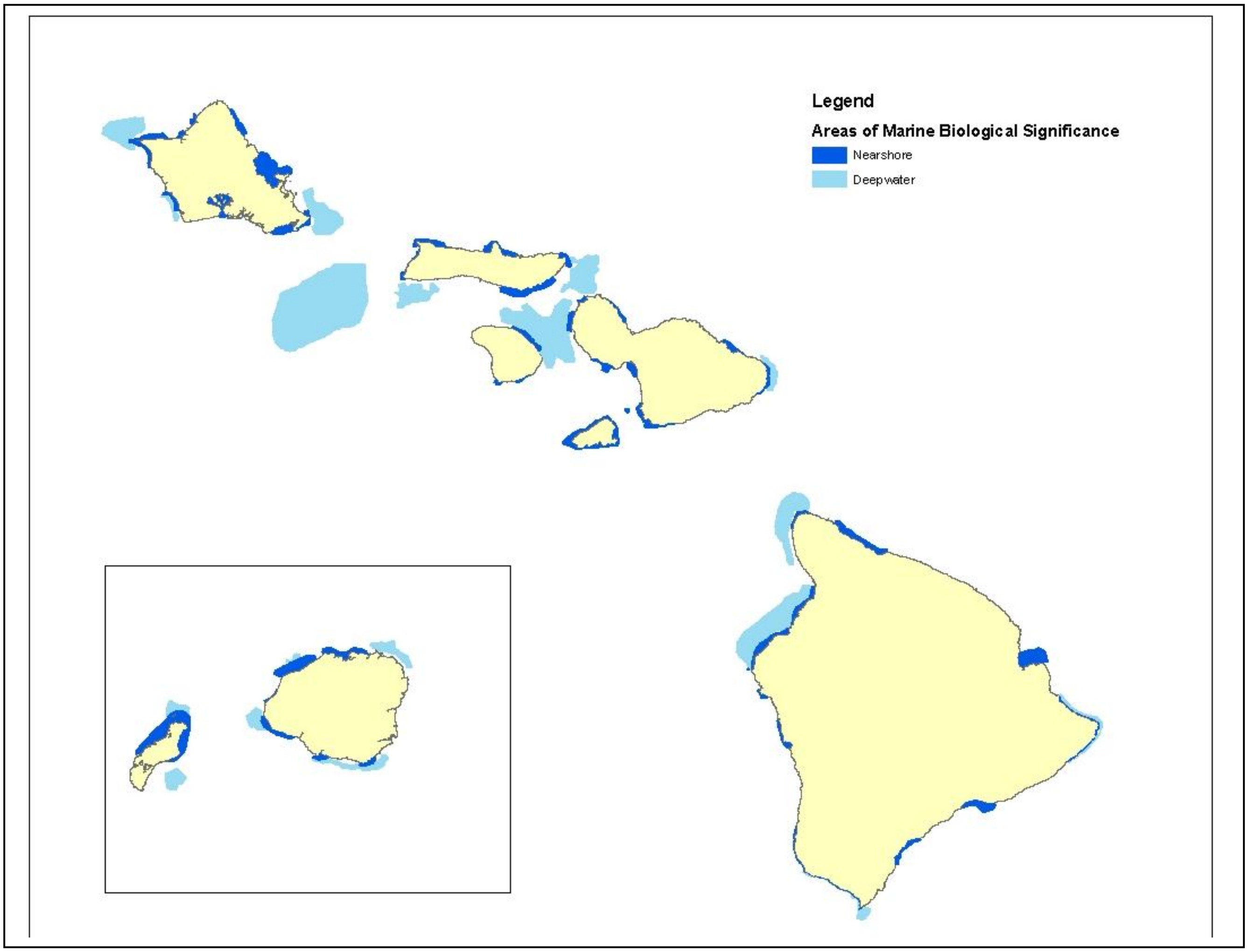
Dozens of scenarios were run using MARXAN to generate optimal and realistic sites that meet the stated conservation goals within the ecoregion. These biologically important sites were presented to scientific expert focus groups by stratification unit for their review, discussion, revision, and consensus. 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 end result was the identification of biologically important areas across the four stratification units [Fig. 1].

Expert input and partnerships were crucial to the development of the marine ecoregional assessment. More than 100 of the state's most prominent resource experts from organizations, academia, government, and the public were consulted over the three-year duration of the project.

The Compensation Planning Framework can be revised as necessary because TNC's decision-support framework was created such that it could be easily updated as new information became available or at a minimum every five years to abide by TNC's ecoregional planning guidelines. For use in the ecoregional assessment, the data on the ecoregion's biodiversity and the factors that affect it were formatted as geo-referenced shapefiles and stored in a GIS-database. To date, the database houses over 80 shapefiles on biodiversity and threats specific to the waters of the main Hawaiian Islands. New sources of information can be assessed, created, and integrated into the database. In addition, the decision-support framework that was created to evaluate conservation and management alternatives can be modified to reflect new decision making needs.

The results from the assessment are already being used to direct management and conservation efforts of TNC and partners. TNC's ILF Program will utilize this decision-support framework to provide the data and rationale for prioritizing restoration of each habitat-type within a service area.

Figure 1. Areas of biological significance, as identified in the ecoregional assessment

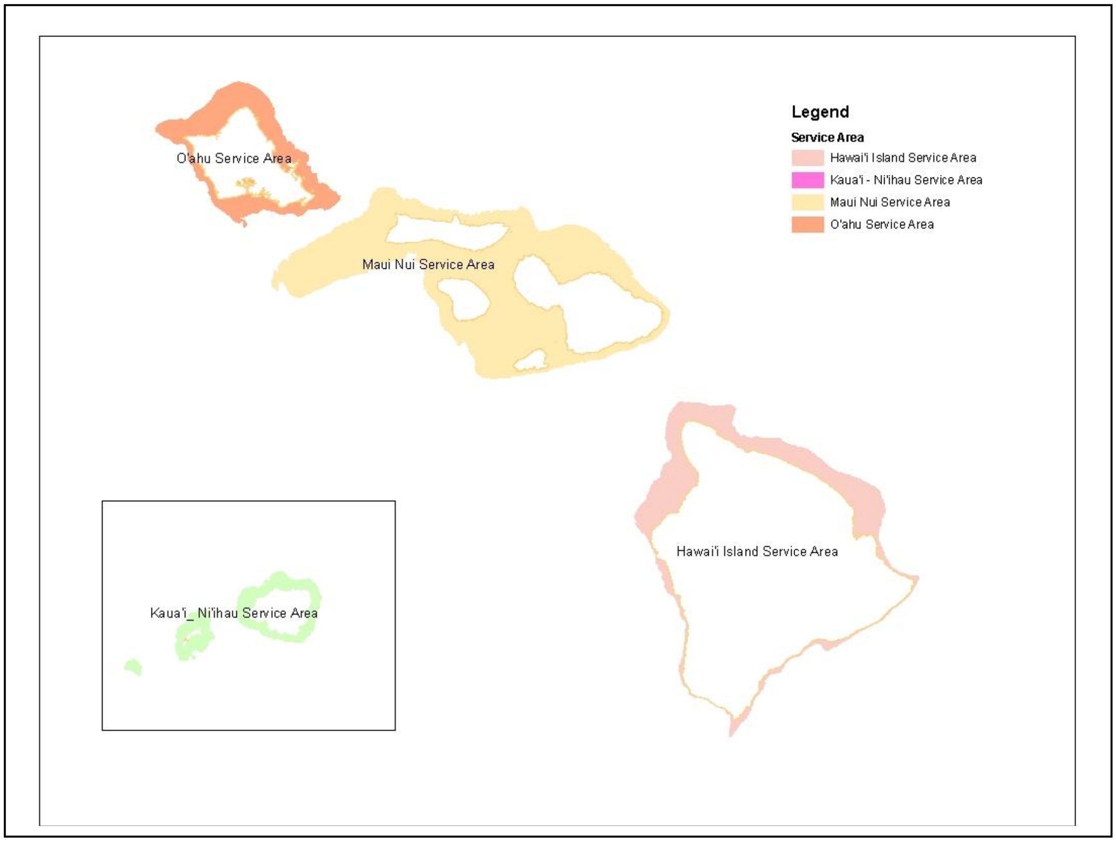


i. Geographic service area

As described previously, the project area encompasses the main eight Hawaiian Islands and will be subdivided into four service areas. The geographic service areas are [Fig. 2]:

- Hawai‘i Island Service Area
- Maui Nui Service Area
- O‘ahu Service Area
- Kaua‘i-Ni‘ihau Service Area

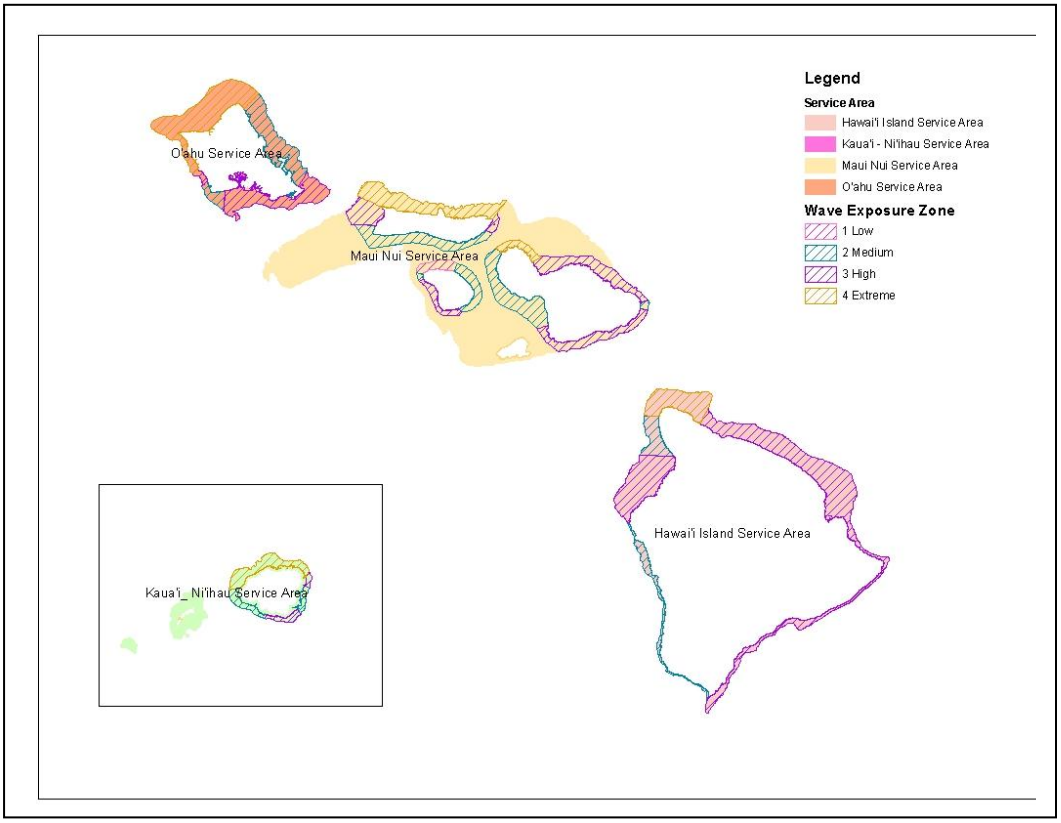
Figure 2. Proposed service areas



The Program will further use wave exposure zones to capture the variation in extent and type of shallow benthic communities at a regional scale to identify potential candidate mitigation sites [Fig. 3]. The zones are defined by the degree of prevailing winds and associated wind-driven waves and oceanic swells, equating somewhat to island side (e.g., leeward, south, windward, and north). In general, the wave exposure-associated benthic community can be described as: low wave energy/sheltered areas (*Porites compressa* and *Montipora. capitata*); medium wave energy areas (*Porites lobata*); shallow, high wave energy areas (*Pocillopora meandrina*); and, extreme wave energy areas (*Montipera flabellata* and crustose coralline algae). The greatest reef accretion occurs in areas sheltered from wave action, on the leeward side of islands, and on the seaward edge of fringing reefs and the fore reef slope. In addition to wave exposure, movement and accumulation of sediments, turbidity, light penetration, availability of substrate, temperature, and dissolved nutrients are factors that may be assessed at the project level. The wave exposure zones are based on Atlas of Natural Hazards in the Hawaiian Coastal Zone (Fletcher et al. 2002).

TNC will determine an appropriate spatial scale to replace lost functions and services within the same ecological systems (e.g., reef complex, seagrass bed, etc.). The terrestrial watershed boundaries will be used to effectively manage stressors across watershed units to achieve function gains in adjacent marine habitats.

Figure 3. Wave exposure zones



<u>Process to select candidate mitigation project sites</u>

For aquatic impacts authorized by DA permits, the marine priority areas identified in the ecoregional assessment serve as candidate mitigation project sites. TNC will select mitigation projects that: (1) are in the same service area (e.g., Oahu), (2) either support or have the potential to support the appropriate aquatic resource(s), and (3) are within the same wave exposure zone as the impact site. On-site mitigation might occur when the impacted site overlaps with a priority site identified as part of the ecoregional assessment. Off-site mitigation should occur when on-site mitigation is not practicable or when an off-site mitigation project would provide a greater environmental benefit than on-site.

Each candidate mitigation site will be evaluated for its potential to provide compensatory mitigation based on certain criteria, including:

- Likelihood of success of achieving the recovery of coral reef ecosystem function
- Ability to address multiple functions and services both among and within aquatic habitat types (e.g., seagrass, patch reef, fringing reef, etc.)
- Ability to affect or improve regional aquatic resource conservation initiatives, including existing restoration sites managed by TNC, local communities, organizations, or agencies (i.e., sites managed by Hawai‘i Coral Reef LAS, Offshore Islet Restoration Committee, or DLNR-DAR)

Possible candidate mitigation sites are identified and described in Appendix C.

ii. Description of the threats to aquatic resources in the service area(s) and how the in-lieu fee program will help alleviate impacts resulting from those threats.

Hawai‘i nearshore aquatic habitats have long been exposed to soil erosion and flooding because the land masses are geologically young. During the two past centuries, land use practices and the introduction of feral animals have greatly accelerated soil erosion. In more recent decades, an increase in coastal development and the proliferation of impervious surfaces has resulted in a loss of coastal wetlands and an increase of sedimentation and other sources of non-point pollution into the nearshore waters. In some areas, anthropogenic overuse (e.g., high fishing pressure, heavy recreation, ocean pollution) and non-native species (especially overgrowth of alien algae and invertebrates) affect nearshore areas. Natural stresses are also significant (e.g. hurricanes), and global warming poses a new and significant threat. The sources of stress vary by aquatic resource (Table 2).

The threats with respect to coral reefs and other aquatic resources vary within and among the stratified service areas. The types of expected stressors stem from several sources, including activities with substantial amounts of impacts (i.e., harbor expansion, shoreline armoring). The following is a brief review of principle sources of stress by stratified service area:

<u>Hawai‘i Island Service Area:</u> Major sources of stress to the aquatic resources include: sedimentation associated with land uses such as agriculture, development, feral ungulates, algal blooms, shoreline armoring, unregulated recreation, heavy fishing pressure, injection wells, cesspool and septic systems, marine debris, and pollutant loads associated with submarine groundwater discharge. Along the Hamakua coast, additional potential sources of stress include agricultural runoff, fishing pressure, and future harvest of eucalyptus.

<u>Maui Nui Service Area:</u> Major sources of stress to the aquatic resources include: increased overgrowth of reef by invasive seaweeds, particularly *Acathophora spicifera, Hypnea musciformis,* and *Ulva* spp., sedimentation, coastal development, heavy fishing pressure, recreational use/tourism (Maui), underground injection wells (Maui), pollutant loads associated with submarine groundwater discharge (West Maui) and overfishing. While not as populated as Maui, Moloka‘i does have excessive sediment-laden runoff impacting reefs on the south shore of the island. At Shipwreck Beach on Lana‘i, experts observe a high level of algae (50%) attributed to large amounts of sedimentation.

<u>O‘ahu Service Area:</u> Major sources of stress to the aquatic resources include: urban and residential development, high concentration of alien algae, aging sewage treatment facilities, channelization/flood control projects (e.g., loss of natural channel sinuosity and changes in channel hydraulics and hydrodynamics), widespread use of cesspools and septic systems (esp. along north and windward shores), heavy fishing pressure, urban runoff, sedimentation, harbor dredging and/or expansion, and possibly pollutant loads associated with submarine groundwater discharge.

<u>Kaua‘i Service Area:</u> Major sources of stress to the aquatic resources include: areas of medium to high impervious cover, concentrations of septic systems, cesspools, underground injection wells, harbor dredging and/or expansion, and large quantities of derelict marine debris.

Table 2. Generalized list of principle stressors within the state, by principle aquatic resource

Aquatic resource	Principle stressor
Coral reefs (includes crustose coralline algae, limu, turf algae)	▪ Invasive species ▪ Pollution: land-based, groundwater, and marine discharges ▪ Associated impacts from inappropriate maritime industrial uses (port construction, dredging, vessel groundings, and discharges) ▪ Heavily impacted by population growth and the associated degradation of watersheds ▪ High fishing pressure on the reefs, particularly in proximity to population centers ▪ Inappropriate human uses ▪ Marine debris ▪ Disease ▪ Anchor damage ▪ Effects of climate change (e.g., sea level rise and ocean warming) and acidification ▪ Heavy storms/hurricanes
Marine plants (Halimeda, seagrass)	▪ Nutrient and sedimentation loads ▪ Algal blooms (i.e., *Cladophora* sp and cyanobacteria) ▪ Invasive species (algae, invertebrates). ▪ Anchor scar damage (i.e., cruise ships) ▪ Disease ▪ Lack of scientific knowledge ▪ Trampling
Estuaries	▪ Direct loss due to development and navigation projects ▪ Secondary effects from land-use practices within watersheds, e.g., excessive sedimentation, altered natural hydrological regimes, altered water quality, and habitat modification ▪ Degradation by non-native invasive species, which has resulted in altered vegetation structure and sedimentation patterns ▪ Introduction of mammals, causing declines in populations of endemic birds ▪ Sensitivity to oil spills
Intertidal (Rocky)	▪ Trampling ▪ Overharvest of species ▪ Shoreline modification and armoring ▪ Point and nonpoint pollution (i.e., source of sediment and nutrient loads)

The Program will help offset the functions and services lost (i.e., by the types of stressors listed above) in a manner that would lead to a greater likelihood of success within the ecoregion. Based on the type and extent of unavoidable marine aquatic resource impacts that have been found to require compensatory mitigation, specific needs and opportunities within each service area would be identified, and compensatory mitigation would be directed at these opportunities and needs. Consideration of nearby land-based stressors would allow for more effective site-selection to reduce indirect effects of surrounding land uses on particular functions. A more detailed description of threat abatement and mitigation activities is provided in subsection VII.iv.

iii. An analysis of historic aquatic resource loss in the service area(s), supported by field documentation

There is limited scientific, peer-reviewed historical data on the status of aquatic resources of the MHI. The deterioration of the resources coincides with the increase in the human population and corresponding coastal and upland development and replacement of traditional fisheries management techniques with western recreational and commercial fisheries management practices.

While the coral reefs in the MHI are generally considered to be in fair to good condition, they are definitely degraded from historical conditions (Friedlander et al. 2004, Pandolfi et al. 2005), and vary in health among islands and regions. Long-term monitoring programs reveal a serious decline across much of the state's coral reef habitat (e.g., DLNR-DAR's Status of Maui's Coral Reefs 2006, Coral Reef Assessment Monitoring Program [CRAMP]), and scientists estimate that more than 75% of main Hawaiian Island reef fishes are in a critical or depleted condition.

The condition of the aquatic resources varies within the service area:

Hawai‘i Island Service Area: Hawai‘i Island supports many of the best examples of coral reef resources, and fewest sources of stress, in the MHI. Based on estimates by NOAA, Hawai‘i Island has the highest percentage of live coral of the MHI (approximately 57%).

Maui Nui Service Area**:** On Maui, nine reef areas are annually surveyed by DLNR-DAR in partnership with CRAMP: Honolua, Kahekili, Puamana, Olowalu, Maalaea, Molokini, Kanahena Bay, Kanahena Pt, and Papaula Pt. In 2006, coral cover ranged from 74% at Molokini to <10% at 4 sites: Honolua, (9%), Puamana (8%), Maalaea (8%), and Kanahena Pt (6%) (DLNR-DAR 2006). There is concern over the general decline in coral cover - 35% (1994) to 27% (2006), resulting in nearly ¼ of all living coral lost over that period (DLNR-DAR 2006). The observed decline has been most dramatic at Honolua (42% to 9%), Kahekili (55% to 33%), Olowalu, and Maalaea

Of the six islands surveyed by CRAMP, Moloka‘i and Kaho‘olawe had the highest proportion of reefs with coral cover exceeding 50%. The east side of the island of Lana‘i and south shore of Moloka‘i support some of the best coral cover in the ecoregion, but it has been subjected to severe sedimentation.

O‘ahu Service Area: Of the six islands surveyed by CRAMP, O‘ahu had the highest proportion of reefs with coral cover lower than 10%. In addition, the waters of O‘ahu have severely depleted reef fish populations. The island supports important estuarine habitat.

Kaua‘i Service Area: The upland watersheds on Kaua‘i deliver large quantities of sediment to the coastal area and restrict the development of fringing reefs, particularly in shallow waters and embayments in the north. Low coral cover is also attributed to storm exposure and runoff associated with the agriculture industry (particularly along the south shore). Kaua‘i reefs are best developed along the north and northeast coasts. Coral cover ranges from <5-26% on the northern shore to approximately 5-11% on the southern shore. Kaua‘i supports the best example of major perennial streams without diversion or stream channel modification in the ecoregion.

iv. Statement of aquatic resource goals and objectives for each service area

Table 3 generally describes the geographic extent of principle aquatic resources after applying some ecoregional assessment criteria filters. Several key datasets were utilized for statewide information on the distribution of aquatic conservation targets: (1) the NOAA Environmental Sensitivity Index (ESI), which was designed for ranking sensitivity of shoreline types to oil spills and is the best and most accurate coast-wide database for intertidal habitat; (2) the National Ocean Service, Center for Coastal Monitoring and Assessment Biogeography Team's GIS-based benthic habitat maps for the waters of the MHI, (3) Atlas of natural hazards in the Hawaiian coastal zone, and (4) Hawai'i Biodiversity Mapping Program (HBMP).

In *Status of Coral Reefs of the World*, Wilkinson et al. (2008) defined effectively "lost" as coral reefs not functioning because 1) there are few live coral and the remaining coral are either broken, diseased or covered in sediment; 2) fish populations are seriously over-fished with very few large predators and algal grazing fish; 3) there is clear evidence of pollution with poor quality, turbid water; and 4) reefs are being over-grown with macro-algae, sponges or other organisms favored by polluted waters. The combination of aforementioned conditions occurs in certain areas across the MHI, especially when compared to the nearshore marine ecosystem of the Northwestern Hawaiian Islands.

As stated above, the goal of the Program is to ensure no-net loss of marine aquatic resource functions, with an emphasis on the restoration of lost aquatic resource functions and services of coral reef ecosystems, particularly as it relates to the health of coastal and marine habitats and improved water quality. TNC's GIS spatial database, which was created as part of the ecoregional assessments and discussed in Section VIII, includes associated data layers on the sources of stress to aquatic resources for the MHI. TNC will be able to access these data layers to select mitigation project sites, and then describe the location, types, and extent of distribution of each aquatic resource in the ILF Program used to offset adverse impacts of an activity.

There are many types of activities that could be considered for compensatory mitigation. In general and given the aforementioned uncertainty in the efficacy and scientific acceptability of reef restoration techniques, the program will focus on: (1) the prevention of impending loss of biologically significant coral reef habitat (see Section VIII.vi) by alleviating stressors that interfere with natural reef processes, enabling the reef to repair itself, (2) land-based threat abatement, then (3) more direct in-situ techniques (in situations where above strategies alone are unlikely to produce the required results).

It will be difficult to project a single timeframe during which mitigation measures to recover degraded reefs may be effective. While coral growth measures for many species are known, recovery time will depend upon mitigation strategies employed, the intensity and duration of the stressors, existing physical characteristics and social uses, and unexpected natural hazards. Some biologic responses are easier to detect and/or quicker to occur than others. It is likely that some coral reef mitigation projects may require several decades of monitoring before any evaluation or performance criteria can be observed and/or deemed met.

Table 3. Principle nearshore aquatic resources and associated general approximation of extent by service area based on best available spatial data layer and expert input, applying an ecoregional assessment filter*

Conservation Target	**Components**	**Geographic extent in Service Area (Meters[1], Acres[2])**				**Source**
System		**Hawaii**	**Maui Nui**	**O'ahu**	**Kauai-Niihau**	
Coral Reef and Colonized Hardbottom						
Structure[2]	Aggregated reef	2,817	8,958	2,649	1,932	NOAA Benthic Habitat Maps
	Patch Reef	<3	294	598	0	NOAA Benthic Habitat Maps
	Pavement	395	29,208	46,414	31,637	NOAA Benthic Habitat Maps
	Pavement with Sand channels	116	2,083	10,734	5,263	NOAA Benthic Habitat Maps
	Rock/Boulder	21,464	19,183	4,426	26,364	NOAA Benthic Habitat Maps
	Rubble	40	131	514	121	NOAA Benthic Habitat Maps
	Scattered Coral/rock	27	561	319	114	NOAA Benthic Habitat Maps
	Spur and Groove	1,013	3,773	4,942	272	NOAA Benthic Habitat Maps
Zone[2]	Bank/Shelf	23,438	42,584	48,018	61,107	NOAA Benthic Habitat Maps
	Fore Reef	793	6,837	8,080	3,005	NOAA Benthic Habitat Maps
	Reef Crest	15	1,742	1,100	158	NOAA Benthic Habitat Maps
	Reef Flat	1,611	12,770	10,032	1,409	NOAA Benthic Habitat Maps
	Back Reef	0	0	2,076	0	NOAA Benthic Habitat Maps
	Channel	7	111	544	30	NOAA Benthic Habitat Maps
	Lagoon	0	0	405	0	NOAA Benthic Habitat Maps
	Reef Hole	0	42	2	<3	NOAA Benthic Habitat Maps
Unconsolidated sediment[2]	Sand	4,959	4,206	15,815	17,342	NOAA Benthic Habitat Maps
Marine Plants[2]	Halimeda Meadow	NA	5,693	208	NA	Expert
	Seagrass Beds	551	1,994	1,532	234	Expert
Wetland[2]	Estuary	2,617	4,023	10,228	1,441	Expert, DLNR-DAR Watershed Assessment, ESI, National Wetland Inventory (NWI), DHM Consultants
Rocky Intertidal	Sheltered Rocky Shore	7,520	1,232	5,159	649	NOAA Environmental Sensitivity Index (ESI)
	Exposed Rocky Cliff	367,038	283,314	27,560	64,416	NOAA ESI
	Exposed Wave-cut Platforms in Bedrock	181,319	132,612	65,747	67,582	NOAA ESI
	Exposed Scarps and Steep Slopes in Clay	0	1,271	0	0	NOAA ESI
Sandy Intertidal	Coarse Grained Sand Beaches	12,214	80,124	65,381	71,665	NOAA ESI
	Fine to Medium Grained Sand Beaches	104	13,216	49,854	26,342	NOAA ESI
	Gravel Beaches	241,836	240,985	19,337	65,062	NOAA ESI
	Mixed Sand and Gravel Beaches	44,295	50,747	25,673	35,817	NOAA ESI

*For example, the assessment only considered estuarine habitat that supported nursery/recruit habitat, ranked as an estuary by DLNR-DAR Watershed Assessment, and/or were expert nominated. The sites were assessed from a marine perspective as follows: (1) importance as juvenile nursery areas for fish that inhabit marine environments as adults; and (2) function to protect adjacent coral reefs (i.e., absorb nutrients, sediment, and other pollutants, slow pulses of freshwater and sediment during times of heavy rain, etc).

The following section introduces in limited detail some of the most commonly used mitigation techniques to address the most prevalent threats known to occur in the MHI that the Program may consider (based on available peer-reviewed literature):

Maximizing coral reef resilience (restoration and enhancement): The causes of coral reef decline around the MHI are complex and vary among location, but there are strong indications that human impacts, including degradation of watersheds and anthropogenic overuse, have been the primary cause of reef decline. The removal of anthropogenic stress allows natural regeneration processes to occur and often is the most effective approach in remediation (Hughes et al. 2003; Jokiel et al. 2005). While it might not be feasible to reduce all cumulative anthropogenic stresses to the coral reef ecosystem at a specific mitigation site, TNC believes the reduction of individual stressors will provide increased capacity for coral reef recovery.

Land-based pollution: It is now well accepted that many major coral reef ecosystem stressors originate from land-based sources, most notably, toxicants, sediments, and nutrients, where streams and wetlands are largely the conveyors or filters of the land-based pollution. Data from hardened streams draining urbanized watersheds on O‘ahu suggest high-nutrient concentrations with the potential to degrade coral reefs and seagrass beds (Laws and Roth 2004). Mitigation strategies will likely entail the manipulation of the physical, chemical and/or biological characteristics of the stream or wetland with the goal of restoring or enhancing its function to reduce sediment and nutrient loads and freshwater flows to the coral reef environment. For example, Wolinski et al. (2009) demonstrate how the observed coral degradation in Maunalua Bay (O‘ahu) is tied to urbanization of the watershed and the channelization of the associated streams. The long residence time of waters in coastal areas further facilitates degradation.

Several on-going projects around the MHI monitor watershed discharges into coastal waters to deduce the effect on coral community composition, structure, and function. Few reports in the scientific peer-reviewed literature demonstrate a clear relationship between specific terrestrial-based mitigation measures and coral reef recovery, here or worldwide. In Hawai‘i, three significant, successful restoration projects have been implemented: (1) at Kāne‘ohe Bay (O‘ahu), the removal of sewage outfalls in 1979 that led to the decrease in nutrient levels, turbidity, and phytoplankton abundance and a recovery of coral reef populations (Smith et al. 1981; Hunter and Evans 1995; Jokiel et al. 2006); (2) on Kaho‘olawe, the removal of 20,000 feral goats, termination of bombing, and reestablishment of vegetation that have helped to reduce erosion with a consequent dramatic positive impact on the reef (Jokiel et al. 2005)**;** and (3) at Kahe Point (O‘ahu), the installation of a new outfall pipe that stopped impacts from thermal effluent on an extensive area of reef (Jokiel et al. 2006). More recently, Richmond and Wolinski are on the forefront of research that integrates coral reef ecosystem integrity and restoration options (e.g., Richmond et al. 2007).

TNC will work with appropriate experts and agencies to establish the appropriate suite of tools to measure the terrestrial-based mitigation projects, such as suspended sediment traps, time-series instruments (currents, temperature, salinity), and reef mounted cameras, which will be outlined in each mitigation plan. The effects of land-based pollution on coral reefs are exacerbated when combined with other human effects (such as the introduction of invasive alien algae). TNC will employ integrated watershed management to help address impacts of development within watersheds, the channelization of streams for flood control projects, improper sewage treatment, and other land-use practices. The menu of remedies for land-based pollution includes: stormwater management, erosion control, pollutant minimization/control, and stream channel and riparian restoration.

Fisheries Management: Interaction among key species within an ecosystem is essential to maintain for ecosystem services to be delivered (McKleod et al. 2005), and just a small change can produce large ecosystem responses. Scientists correlate the difference in ecosystem health between the MHI and NWHI, as well as among the MHI, to the loss of key species. In the MHI, for example, there is an absence of large bodied predators at the apex of the food chain and many food fish. In addition, herbivores provide an essential ecosystem function on coral reefs by controlling algal growth. Yet, stocks of herbivores in the MHI are subject to heavy fishing pressure at the same time that alien macroalgal species are proliferating in many regions of the state, creating a risk that reefs could shift from being dominated by reef building corals and coralline algae to domination by non-native macroalgae.

The State is embarking on novel coral reef fisheries management at Kahikili (Maui). The goal of establishing the Kahikili Herbivore Fisheries Management Area is to control an overabundance of invasive marine algae on coral reefs by increasing the local abundance of herbivorous fishes and sea urchins, thus enabling these species to provide increased ecosystem services in the form of algal grazing. These natural controls on marine algae proliferation are intended to help restore the area's marine ecosystems to a healthy condition. Other areas that could benefit from this sort of action include places where a significant decline of herbivorous fishes with an overgrowth of macroalgae on coral reefs has been observed in recent decades.

Management of anthropogenic stressors: There is strong evidence that effectively managed waters can improve the condition of coral reef communities, allowing them to recover faster from any single disturbance. Possible mitigation may include strategies such as: enforcement of existing regulations, establishing new regulations where needed, education of the public and resource users, and establishment of ocean zoning, which may include marine reserve networks.

Direct reef restoration, enhancement, and establishment: While the body of scientific evidence suggests the preferred strategy is to restore, enhance and manage these aquatic ecosystems in a way that allows natural reef processes to restore reef function, there are marine habitats within Hawai'i that are sufficiently degraded such that more active management strategies are necessary to affect restoration on a reasonable time scale, and perhaps even to restore reefs that have passed a tipping point beyond which natural processes alone will be insufficient to reverse trends of decline. There have been reef restoration, enhancement, and establishment projects in Hawai'i, which help to demonstrate the viability of these mitigation options for some, but not all, areas.

Alien algae removal: The removal of harmful organisms is the key to restoring many of the high priority sites in Hawai'i. The continued invasion and degradation of new habitats by alien algae remains one of the most pressing threats to reefs in Hawai'i. Alien algae, such as *Gracillaria salicornia* and *Eucheuma denticulatum*, have spread and are outcompeting and smothering corals plus reducing sessile invertebrate and native algal diversity, leading to a community phase shift across large areas of reef (Smith et al. 2002; Smith et al. 2004; Conklin and Smith 2005). Experiments on control methods suggest that a combination of tactics is necessary. Preliminary research indicates that the suite of control methods –removing the bulk of the accumulated algal biomass by manual or mechanical means and using native sea urchins as biocontrol agents as short- to mid-terms solutions, while protecting herbivores and decreasing land-based nutrient sources as long-term solutions -- developed by the Hawaiʻi Islands Marine Alien Group can be an effective means of restoring affected reef habitats. Full-scale and full-time implementation of these methods needs to be achieved to be fully effective.

TNC is utilizing the mitigation strategy of alien algae removal, the first critical step in restoration at Kāneʻohe and Maunalua Bay, to 1) expose substratum, thereby providing the availability of suitable settlement space for coral planulae, and 2) prevent the further smothering and crumbling of corals, thereby enabling coral survival. Following algae removal, restoration options will entail outplanting seagrass and/or native algae, biocontrol measures, and community-established herbivore protection areas. TNC is actively monitoring the effect on the coral reef system, particularly natural recruitment and recovery.

Coral reef seeding: The method of seeding a reef with coral larvae and fragments may be appropriate when there are insufficient natural sources of larvae to establish colonies and where the substratum is suitable for initial coral settlement (Jokiel et al. 2006). The seeding technique can be used effectively as a tool to propagate and increase numbers of rare species and thereby meet management goals of protecting rare species and maintaining biodiversity (Jokiel and Naughton 2001).

Coral reef transplant: Transplanting corals or coral fragments may be a viable way to jumpstart coral recovery while watershed management actions like erosion control and stream restoration are being implemented. Transplantation of corals has been used to mitigate damage to coral reefs in Hawaiʻi and the U.S.-Affiliated Pacific Islands (Jokiel et al. 2006). Depending upon the case, the focus has been to: (1) remove corals from areas of future impact and transplant them into nearby receiving areas, (2) hold corals in reserve and then return them to their original habitats following the impacts, or (3) remove corals from areas of impending human impact to be used to restore previously impacted areas. Results warn that careful consideration must be given to the choice of receiving areas (i.e., limited disturbance, high quality habitat) (Jokiel et al. 2006).

The overall result of coral relocation is mixed, largely a function of time scale, providing a cautionary tale about how broadly applicable such methods can be. There has been a successful coral reef transplant in Kāneʻohe Bay, an area characterized as calm (Jokiel et al. 2005). A more recent attempt by the US Navy and DLNR-DAR to re-attach corals damaged by the USS Port Royal grounding has been more complicated due to the high wave environment.

The state of coral reef restoration science is in its infancy with little knowledge about how to restore ecosystem functions in a timely fashion and when, or even if, the desired outcome will be met. Only a handful of papers describe and summarize examples of mitigation and restoration projects that have been conducted in Hawaiʻi and U.S.-affiliated Pacific Islands. TNC intends to build upon and expand this collective knowledge by supporting adaptive research as a component of well designed mitigation projects. TNC will require the development of detailed and adaptive management plans.

v. A prioritization strategy for selecting and implementing activities

Over time, TNC anticipates having mitigation projects around the MHI that will provide appropriate compensatory mitigation for impacts to the waters of the U.S. and State that are within the mitigation project's service area. Selection of mitigation projects will focus on leveraging large-scale restoration projects that address land-sea priorities in the service areas, as outlined in a compensation planning framework.

Based on results from TNC and partners' existing management efforts and peer-reviewed scientific literature, TNC will likely engage in the full range of compensatory mitigation efforts depending upon the site-specific conditions of the mitigation site and the overall needs and characteristics of the watershed. Site-based strategic plans that incorporate a wide range of approaches designed to fit each situation will be written on a case-by-case basis. The general types of activities that will be considered for each compensatory mitigation site may include but are not limited to those stated in section VII.iv. and VII.vi.

To ensure the Program's mitigation objective of achieving no net loss of aquatic ecosystem functions and values, not just area, an assessment of ecosystem functions and values will be a critical accompaniment when determining compensatory mitigation requirements. The specific assessment appropriate for each site (such as Habitat Equivalency Assessment, Hydrogeomorphic Functional Assessment or Index of Biological Integrity) will be determined in the mitigation plan.

vi. If preservation is identified as an objective and addressed in the prioritization strategy, then an explanation as to how the criteria for use of preservation are satisfied

Given the threats and declining trajectory in the health of coral reef ecosystems worldwide and in Hawaiʻi, a precautionary strategy that includes preservation to ensure the viability of remaining relatively "healthy" coral reef systems is prudent in conjunction with mitigation options for restoration and enhancement of damaged reefs. In particular:

- Many of the reef resilience methods outlined above rely on sources of abundant larvae to facilitate reef recovery. Identifying key regional sources of larval supply and ensuring their continued productivity may be just as essential to effective mitigation projects as the actual on-site activities.
- Scientists express concern over the "shifting baseline" of ecosystem health – as the coral reef system becomes degraded, each generation uses a lower condition as the baseline to judge further loss.
- The Ecoregional Assessment identified several high priority biologically significant waters that are more removed from urban centers and experience less development-related pressures. However, no areas are completely devoid of human and natural induced

stressors and there is a reasonable expectation that many of these sites may decline over time as the cumulative impacts of various stressors take their toll. Federal agencies have begun to argue that preventing probable reef declines is a viable "restoration" activity, and one that preserves the healthiest reefs has the highest likelihood of success.

- According to most literature on climate change, scientist concur that healthier, intact reefs show greater capacity to recover from climate change events.
- Scientists believe that the loss of healthy coral reefs must be prevented to ensure the persistence of coral reef ecosystems.
- There is sufficient science to support the use of protected areas as a mitigation strategy, particularly as they provide benefits to the fisheries and to the ecosystems that maintain them.

Science-based evidence abounds that shows marine protected areas (MPAs), which includes marine reserves, can help improve the health of the coral reef. Selig and Bruno (2010) conducted an analysis of MPAs worldwide and concluded that they play a critical role in protecting coral reef ecosystems, and effectively prevent the loss of coral. The study assessed 5,170 individual surveys from inside and outside of MPAs that were conducted in 83 different countries from 1969-2006 to determine how spatial protection may affect temporal change in coral. Specific to areas within the Indo-Pacific, the researchers found that decline in reef health continued within the first five years of MPA establishment, followed by high increase in coral growth (2% per yr).

Through research on trophic cascades, Mumby et al. 2006 demonstrate how marine reserves can facilitate the recovery of coral from disturbance as well as enhance resilience. Results show how increased fish grazing, primarily driven by reduced fishing, was strongly negatively correlated with macroalgal cover and resulted in a two-fold increase in the density of coral recruits within a Bahamian reef system.

For these reasons, TNC will propose a Program that includes preservation of aquatic resources, especially those facing impending loss, in conjunction with other restoration strategies to satisfy compensatory mitigation requirements of individual projects. All compensatory mitigation will have a component for long-term protection, which would preserve created, restored, or enhanced aquatic resources. If, at any time, preservation is identified as a prioritization strategy, TNC will demonstrate the need to abate imminent threats and outline specific steps to ensure "no net loss."

vii. Description of public and private stakeholder involvement in the plan development

There was extensive involvement of public and private stakeholders in the development of TNC's ecoregional assessment and planning framework. Using this well-tested assessment and framework, more than 100 experts were consulted from agencies, organizations, communities, and academia for the marine assessment alone. In addition, the advisory group with members from NOAA and DLNR-DAR helped validate and provide oversight on the process.

TNC has been and will be in ongoing communication with the Corps, members of the IRT, leading scientists in the state, and other organizations and entities that have or are proposing ILF Programs in other states or jurisdictions (e.g., Guam, Maine, North Carolina, and Virginia) to discuss approaches to compensatory mitigation. TNC anticipates the rapport to continue to ensure a scientifically sound instrument along with subsequent mitigation plans.

viii. A description of the long-term protection and management strategies conducted by the sponsor

All sites would have long-term protection and management strategies, though the degree will vary by site. At sites where TNC is currently engaged in conservation efforts, on-the-ground restoration work must demonstrate that requisite conservation benefits are achieved. TNC's ultimate goal is to ensure that the project area is "effectively conserved," defined as (1) the condition of the resources are viable in the long term, (2) threats are abated, and (3) secure management and enforcement is in place. The following are required at every project site where we currently work, and this will remain true at potential mitigation sites as part of the Program:

- Management plan that is created using the Open Standards for the Practice of Conservation, which is a broadly endorsed assessment framework used to identify key resources, primary sources of stress to the resources (i.e., root causes of coral degradation), and priority restoration and management strategies.
- Appropriate execution of priority restoration and management strategies, as identified in the management plan.
- Biological monitoring conducted by TNC staff or other trained and qualified contractors or stakeholders to collect baseline inventory of resources and measures of resource health over time in collaboration with other ongoing monitoring efforts, including CRAMP, DLNR-DAR, and NOAA.

Shapefiles of the location of the compensatory mitigation sites will be made available to the Hawai'i Statewide GIS program that is managed by the Office of Planning within the Department of Business, Economic Development, and Tourism and identified on the Corps' internet site.

ix. A strategy for periodic evaluation and reporting on the progress of the in-lieu fee program goals and objectives;

TNC would provide annual reports on the Program. General information will include:

- Project summaries of each project (description of mitigation activities, partnership opportunities, long-term protection measures, conservation and ecological benefits, and current status of each project).
- Tables that include summaries of the status, proposed mitigation activity type and associated acreage, and proposed credit for each aquatic project pursued by TNC to serve as mitigation for impacts in the MHI.
- Tables that provide the amount of impacted acres in the service area, the total mitigation liability in credits, and a measure of the aquatic resource that is proposed to

be replaced through restoration and creation activities in comparison to the amount impacted.

- Status of progress toward mitigation performance standards.
- Detailed financial statements.

An initial evaluation of the Program will be conducted after five years to update and revise the Program as necessary. The collective status of all compensatory mitigation projects would be reviewed to evaluate projects and determine causal factors in success and/or failure. This type of review will assist in revision of future compensatory mitigation plans, particularly in light of any new scientific understanding of aquatic resource restoration science. The contribution by partners and contractors will also be evaluated at this time. Subsequent regular evaluations will occur.

The suite of potential compensatory mitigation sites would be revisited, mainly to evaluate the need to add new sites to the list of potential restoration sites. Some potential mitigation sites may be removed from the list to account for compensatory mitigation sites that have been successfully restored or have been permanently impacted. The timing of this process aligns with TNC's required 5-year review and update of the Ecoregional Assessment.

Lastly, the financial status of the program would be evaluated. The main focus of this evaluation would be the adequacy of the funding mechanism for future long-term management activities, especially after considering recent changes in costs related to compensatory mitigation, interest rates, and the current state of the economy.

IX. Description of the in-lieu fee program account

TNC will establish a specific ILF Program account. TNC will hold the Program account in a federally-insured interest-bearing institution to earn interest while maximizing the safety and preservation of the principal fees. TNC will account for the funds in accordance with generally accepted accounting principles. TNC will provide an annual accounting statement to the Corps and the IRT.

Funds collected from permittees, including interest on these funds, would be used for the selection, design, acquisition, implementation, management, and monitoring of ILF projects, with a percentage allowed for administrative costs as approved by the District Engineer.

A more detailed description of the program account will be included in the instrument.

X. Any other information deemed necessary by the District Engineer

References

Ball, I. and H. Possingham, 2000. MARXAN (V1.8.2): Marine Reserve Design Using Spatially Explicit Annealing, a Manual.

Bentivoglio, A. 2003. Compensatory Mitigation for Coral Reef Impacts in the Pacific Islands. US Fish and Wildlife Service. 39 pp.

Bird C., B. Holland, B. Bowen, and R. Toonen. 2007. Contrasting phylogeography in three endemic Hawaiian limpets (*Cellana* spp.) with similar life histories. Molecular ecology 16: 3173-3186.

Boland R. and M. Donohue, 2003. Marine debris accumulation in the nearshore marine habitat of the endangered Hawaiian monk seal, Monachus schauinslandi, 1999-2001. Marine Pollution Bulletin: 46, 1385-1394.

Brainard, R., D. Gulko, C. Hunter, A. Friedlander, R. Kelty and J. Maragos. 2002. Status of Coral Reefs in the Hawaiian Archipelago. In *Status of Coral Reefs of the World.* 14 pp.

Chiappone M, A White, SW Swanson, SL Miller. 2002. Occurrence and biological impacts of fishing gear and other marine debris in the Florida Keys. Marine Pollution Bulletin: 44, 597-604.

Coles S., F Kandel, P. Reath, and K. Longenecker. 2006. Rapid Assessment of Nonindigenous Marine Species on Coral Reefs in the Main Hawaiian Islands. Pacific Science: 483–507

Coral Reef Assessment and Mapping Program (CRAMP). http://cramp.wcc.hawaii.edu/.

Conklin, E.J. and J.E. Smith. 2005. Abundance and spread of the invasive red algae, *Kappaphycus* spp., in Kāne‘ohe Bay, Hawai’i and an experimental assessment of management options. Biological Invasions 7: 1029-1039.

Department of Land and Natural Resources-Department of Aquatic Resources (DLNR-DAR). 2006. Status of Maui Reef. Department of Aquatic Resources and Hawai‘i Coral Reef Program.

Department of Defense and Environmental Protection Agency (DOD and USEPA). 2008. Compensatory mitigation for losses of aquatic resources; final rule. Federal Register 73(70): 19594-19705.

Donohue M., R. Boland, C. Srame, and G. Antonelis. 2001. Derelict fishing gear in the Northwestern Hawaiian Islands: Diving surveys and debris removal in 1999 confirm threat to coral reef ecosystem. Marine Pollution Bulletin: 42(12), 1301-1312.

Fletcher C., E. Grossman, B. Richmond, and A. Gibbs. 2002. Atlas of natural hazards in the Hawaiian coastal zone. University of Hawaii, State of Hawai‘i Office of Planning, and National Oceanic and Atmospheric Administration.

Friedlander A., G. Aeby, R. Brainard, E Brown, A. Clark, S. Coles, E. Demartini, S. Dollar, S. Godwin, C. Hunter, P. Jokiel, J. Kenyon, R. Kosaki, J. Maragos, P. Vroom, W. Walsh, I. Williams and W. Wiltse. 2004. Chapter 15. Status of Coral Reefs in The Hawaiian Archipelago. In Wilkinson C (ed.) Status of coral reefs of the world: 2004. Mitchell, C, C Ogura, DW Meadows, A Kane, L Strommer, S Fretz, D Leonard, and A McClung.

Gulko D. 1998. Hawaiian Coral Reef Ecology. HI: Mutual Publishing. 245 p.

Hughes T.P., A.H. Baird, D.R. Bellwood, M. Card, S.R. Connolly, C. Folke, R. Grosberg, O. Hoegh-Guldberg, J.B.C. Jackson, J. Kleypas, J.M. Lough, P. Marshal, M. Nyström, S.R. Palumbi, J.M. Pandolfi, B. Rosen, and J. Roughgarden. 2003. Climate change, human impacts, and the resilience of coral reefs. Science 301: 929-933

Hunter C.L., C.W. Evans. 1995. Coral reefs in Kāne‘ohe Bay, Hawai‘i: two centuries of western influence and two decades of data. Bulletin of Marine Science 57: 501-515

Jokiel P. and J. Naughton. 2001. Coral reef mitigation and restoration techniques employed in the Pacific Island: II. Guidelines. Oceans, Conference Proceedings 1: 313-316.
Jokiel, P. L., S. P. Kolinski, J. Naughton and J. E. Maragos 2006. Review of coral reef restoration and mitigation in Hawai‘i and the U. S.- Affiliated Pacific Islands. Pp. 271-290 In: W. F. Precht (ed.), Coral Reef Restoration Handbook – The Rehabilitation of an Ecosystem Under Siege. CRC Press, Boca Raton, FL
Jokiel P., K. Rodgers, F. Farrell. 2005. Coral relocation project in Kāne‘ohe Bay, O‘ahu, Hawaii. Report on Phase 1. Coral Reef Assessment and Monitoring Program.
Laws, E. and L. Roth. 2004. Impact of stream hardening on water quality and metabolic characteristics of Waimanalo and Kāne‘ohe Bay streams, O’ahu, Hawaiian Islands. Pacific Science 58, 261–280.
McLeod, K., J. Lubchenko, S. Palumbi, and A. Rosenberg. 2005. Scientific consensus statement on marine ecosystem-based management. compassionline.org/?q=EBM
Mumby P., A. Harborne, J. Williams, C. Kappel, D. Brumbaugh, F. Micheli, K. Holmes, C. Dahlgren, C. Paris, and P. Blackwell. 2007. Trophic cascade facilitates coral recruitment in a marine reserve. *PNAS* 104(20): 8362-8367. pnas.org_cgi_doi_10.1073_pnas.0702602104
Naughton J. and P. Jokiel. 2001. Coral reef mitigation and restoration techniques in the Pacific Islands: I. Overview. Oceans, Conference Proceedings 1: 306-312.
Pandolfi J., J. Jackson, N. Baron, R. Bradbury, H. Guzman, T. Hughes, C. Kappel, F. Micheli, J. C. Ogden, H. Possingham, and E. Sala. 2005. Are coral reefs on the slippery slope to slime? Science 307: 1725-1726.
Richmond R., T. Rongo, Y. Golbuu, S. Victor, N. Idechong, G. Davis, W. Kostka, L. Neth, M. Hamnett, and E. Wolanski. 2007. Watersheds and coral reefs: conservation science, policy, and implementation. BioScience 57(7): 598-607.
Rohman S., J. Hayes, R. Newhall, M. Monaco, and R. Grigg. 2005. The area of potential shallow-water tropical and subtropical coral ecosystems in the United States. Coral Reefs 24(3): 0722-4028.
Selig, E. and J. Bruno. 2010. A global analysis of the effectiveness of Marine Protected Areas (MPAs) in preventing coral loss. PLo SOME 5(2) DOI: 10.1371/journal.pone.0009278.
Smith J., C. Hunter, and C. Smith. 2002. Distribution and reproductive characteristics of nonindigenous and invasive marine algae in the Hawaiian Islands. Pacific Science 56: 299-315
Smith J., C. Hunter, E. Conklin, R. Most, T. Sauvage, C. Squair, C. Smith. 2004. The ecology of the invasive red alga *Gracilaria salicornia* (C. Agardh) E.Y. Dawson on O’ahu, Hawai‘i. Pacific Science 58: 325-343
Smith S.V., W.J. Kimmerer, E.A. Laws, R.E. Brock, and T.W. Walsh. 1981. Kāne‘ohe Bay sewage diversion experiment: perspectives on ecosystem responses to nutritional perturbation. Pacific Science 35: 279-395
U.S. Department of Navy. 2005. Marine resources assessment for the Hawaiian Islands operating area. Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Prepared by Geo-Marine, Inc. Plano, Texas.
Wilkinson C. (ed). 2008. Status of the coral reefs. Global Coral Reef Monitoring Network and Reef and Rainforest Research Center, Townsville, Australia. 296 pp.

Wolinski E., J. Martinez, and R. Richmond. 2009. Quantifying the impact of watershed urbanization on a coral reef: Maunalua Bay, Hawaii. Estuarine, Coastal and Shelf Science 84:259–268.

Websites

http://cramp.wcc.hawaii.edu/
http://www.hawaiiecoregionplan.info/home.html
http://hawp.org/partnerships.asp
http://www.nmfs.noaa.gov/habitat/habitatconservation/publications/habitatconections/habitatconnections.htm (Accessed 1/07/10)

Definition of Terms

Conservation By Design: TNC's guiding framework – a systematic approach that determines where to work, what to conserve, what strategies to use and how effective we have been. The framework marries a collaborative, science-based approach with key analytical methods that we use to assess and plan our actions.

Compensatory mitigation: the restoration, establishment, enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

Conservation target: an element of biological diversity identified for protective action

Ecoregion: a large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions.

Ecoregional Assessment: TNC's process for setting priorities for conservation in ecoregions, same as "ecoregional plan."

Ecoregional portfolio: the suite of conservation areas that will collectively conserve the biodiversity of an ecoregion

Impending loss: Impending loss is the trajectory decline in coral reef health when existing stressors that interfere with natural reef processes are not alleviated. Effective marine management may help to slow, post-pone, or curtail the pace and/or severity of loss in coral reef function by reducing threats and thereby enabling the reef to repair itself. The timeframe for impending loss varies by location, and is particularly dependent upon the existing condition of coral reefs.

In-kind: a resource of a similar structural and functional type to the impacted resource.

Marine protected area: Official definition of a marine protected area in MPA Executive Order 13158: "...any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." (http://mpa.gov/**)**

Marine reserves: A type of marine protected area which usually refer specifically to no-take areas, where removing or destroying natural or cultural resources is prohibited. While all marine reserves are MPAs, not all MPAs are marine reserves. (http://mpa.gov/)

On-site: an area located on the same parcel of land as the impact site, or on a parcel of land contiguous to the impact site.

Service area: a geographic area within which impacts can be mitigated at for an in-lieu fee program

Sponsor: any public or private entity responsible for establishing, and in most circumstances, operating an in-lieu fee program.

Viability: status or "health" of a species population; ability of a conservation target to withstand or recover from natural or anthropogenic disturbances and persist for long time periods. In the ecoregional assessment, three factors are examined when characterizing viability: size, condition, and land/seascape context.

Watershed: a drainage area that empties into a major body of water. An ahupua'a often mirrors a watershed or several subwatersheds.

Watershed approach: An analytical process for making compensatory mitigation decisions that support the sustainability or improvement of aquatic resources in watershed.

Appendix A
Example of Data Utilized to Locate Areas of Biological Significance

This appendix describes the data layers and process used to identify areas of biological significance for coral reef and hardbottom and marine plants (seagrass and halimeda) in the waters surrounding the main Hawaiian Islands.

Coral reef and hardbottom. The National Ocean Service, Center for Coastal Monitoring and Assessment Biogeography Team developed digital (GIS-based) benthic habitat maps for the waters of the main Hawaiian Islands. Associated information included: zones (describes the insular-shelf location), habitat structure, and percent cover type for coral, crustose coralline algae, macroalgae, and unconsolidated sediment. This is the only habitat classification scheme that covers the majority of the waters, and was used as the base layer to identify the extent of the habitat ecoregion-wide. The data layers on zones and structures were used to define the extent of coral reef and hardbottom around the ecoregion.

Additional sources of information were used to more fully characterize the condition of the reef resources: (1) percent coral cover based on NOAA benthic maps and monitoring data from CRAMP, NOAA Coral Reef Ecosystem Division (CRED), and TNC; (2) expert nominated sites for areas; and, (3) coral reef associated fish biomass (see below). Expert nominated sites captured areas that harbor special characteristics, such as unique species or structural complexity (e.g., barrier reef at Kāneʻohe Bay, fringing reef along south shore of Molokaʻi, or high relief area at south end of Lanaʻi).

Data on coral reef-associated fish biomass were used to further identify significant coral reef areas. The suite of areas observed to support high fish biomass was captured using monitoring data from CRED – Rapid Ecological Assessments and towboard surveys, CRAMP, and expert input. In addition to key locations, capturing high quality examples of coarse filter targets important to nearshore fish survival (e.g., coral reef, sandy, and estuarine habitat) and designing conservation areas that encompass diverse, interconnected substrates (i.e., estuary adjacent to reef) was a good way to plan for associated fish.

Experts peer reviewed and modified the selected solution to ensure validity and representation.

Data layers utilized to characterize extent of coral reef and hardbottom

Conservation target		**Data Layer**	**Source**
Coral reef and hardbottom	Coverage (extent) by zone and structure	Shallow water benthic maps	National Ocean Service, Center for Coastal Monitoring and Assessment, Biogeography Branch (CCMA-BB)
	Percent cover	Shallow water benthic maps Benthic survey	CCMA-BB Monitoring programs (TNC, PIFSC-CRED, DAR CRAMP)
	Priority areas		Expert
Crustose coralline algae	Coverage (extent)	Shallow water benthic maps	CCMA-BB, Expert
	Percent cover		CCMA-BB
	Priority areas		Expert
Fish biomass	Abundance	Large fish survey	PIFSC-CRED
	Priority areas		Expert

To ensure that all nearshore coral reef habitats were adequately represented, specific goals were set for each: biologic structure, zone, percent cover for coral and crustose coralline algae, coral reef associated fish biomass, and expert nominated sites. It should be noted that some valuable information, such as rugosity and source-sink dynamics, was not available and will be integrated when ready.

For the habitat coarse filters, the following approach was used. Depending upon habitat and species abundance, conservation goals were ramped up.

Habitat Abundance		**Conservation Goal**	
		Nearshore	**Deepwater**
Very common	>20%	30%	10%
Common	5-20%	40%	20%
Uncommon	<5%	50%	30%

Site selection was also determined by the suitability analysis, which steered Marxan toward areas subjected to lower intensity of threats, when possible to do so and still meet conservation goal.

Marine Plants. Marine plants are commonly found on inner shallow reef flats or on deeper reef slopes below the zone of heavy wave actions. Marine plants include: limu, calcareous algae, turf algae, seagrass, and halimeda. For the purpose of this assessment, limu, calcarious algae, and turf algae were integrated within the coral reef and hardbottom ecosystem, as they are recognized as being part of a healthy reef system. Specific goals were identified for seagrass and Halimeda ecosystems.

The data on seagrass beds (*Halophila hawaiiana, H. decipiens*) and halimeda (*Halimeda kanaloana*, formerly *H. incrassata*) were derived from a literature review and expert interviews. Since seagrass beds and halimeda meadows are not overly abundant within the Hawaiian Islands, the patchy, restricted pattern of distribution could be manually digitized into GIS shapefiles.

A numeric goal specific for seagrass beds and halimeda meadows was set per stratification unit, with selection preference toward areas of higher viability.

Data layers utilized to characterize extent of marine plants

Conservation target	**Type**	**Data Layer**	**Source**
Marine plants	Macroalgae extent	Shallow water benthic maps	National Ocean Service, Center for Coastal Monitoring and Assessment, Biogeography Branch (CCMA-BB), Expert
	Percent cover	Shallow water benthic maps	CCMA-BB
	Priority areas		Expert
Seagrass (*Halophila hawaiiana, H. decipiens*)	Coverage		Expert
	Priority areas		Expert
Halimeda	Coverage		Expert
	Priority areas		Expert

Appendix B
Data Utilized in Suitability Analysis

This appendix describes the data utilized in the suitability analysis, i.e., the factors likely to affect the viability of a conservation target. Table 4 is a summary of this data.

The stress factors used included:

Factors: Biologic

Alien Species. Introductions and invasions of nonindigenous or alien species have escalated over the past decades in Hawai‘i. The negative effects of alien species are well documented, especially their ability to outcompete and displace native species and alter/destroy habitat (i.e., smothering of corals). There has been little work on ecological effects of introductions, particularly invertebrates, and an evaluation of factors that may influence the establishment or proliferation of introduced species on coral reefs (pers. comm. Godwyn, Coles et al. 2006). Interestingly, no introduced algae or invertebrates have been detected at select locations around Kaho‘olawe and Ni‘ihau. In contrast, Kāne‘ohe Bay and Pearl Harbor have a great number of introduced species. Coles et al. (2006) found the degree of isolation (especially from harbors), oligotrophic open-ocean reef environment, and native species richness on ocean-exposed coral reefs may inhibit the distribution and proliferation of most non-indigenous species in Hawai‘i

- Invertebrates. Over 400 established invasive alien invertebrates in Hawai‘i, threatening harbors and embayments. An invasive octocoral, *Carijoa riisei*, has been observed to overgrow deep-water black corals, which may have a major ecological implication to the ecoregion's deep reef communities. In 2001, deep water surveys of the Maui Black Coral Bed discovered *C. riisei* overgrowing and killing up to 70% of the black coral trees at 70-110 m depth. An introduced sponge, *Mycale armata* (orange keyhole sponge) may be impacting the shallow-water reef corals in southern Kāne‘ohe Bay (Coles et al. 2006). An introduced aggressive mantis shrimp has displaced native mantis shrimp species from coral rubble habitats (Coles et al. 2006). Other species include: conical hoof shell (*Hipponiz australis*), Christmas tree hydroid (*Pennaria disticha)*, and feather duster worm (*Sabellastarte spectabilis)*. Geospatial Dataset: Bishop data on non-native invertebrates.
- Algae. At least 20 species of macroalgae have been intentionally or passively introduced to Hawai‘i since the mid 1950s. Five species have successfully established and dispersed around the Hawaiian Islands: *Acanthophora spicifera, Gracilaria salicornia, Hypnea musciformis, Kappaphyscus spp., avrainvillea amadelpha,* and are now ecologically dominant in some areas, where they appear to be outcompeting native benthic species. Alien algae can overgrow and kill live coral and cause irreversible damage to these unique ecosystems, and out-compete native marine plant species. It is estimated that Hawaii's economy loses millions of dollars each year because of alien algae due to impacted commercial and recreational fisheries associated with habitat loss, decreased property values, decline in tourism, and city and county removal programs. Geospatial Dataset: Alien algae distribution from HIMAG.

Table 4. Stress Factors

Factors	Spatial Data*	Coverage**
Intertidal		
Shoreline hardening	NOAA Environmental Sensitivity Index Pers. Comm., Fletcher	Statewide
Sea level rise	Atlas of Natural Hazard	Statewide
Erosion	Atlas of Natural Hazard	Statewide
Invasive Species		
Mangrove	NOAA Environmental Sensitivity Index	Statewide
Invasive algae	Hawaiʻi Marine Alien Invasive Species Group Pers. Comm., Conklin	Select locations
Invasive Invertebrates	Bishop Museum Pers. Comm., Coles	Select locations
Ocean Pollution		
Commercial harbor	Department of Planning Pers. Comm., Coles	Statewide
Boating facility	Department of Planning	Statewide
Marine debris	NOAA Marine Debris Program	Statewide
Dumping area	Department of Planning	Statewide
NPDES	Environmental Protection Agency	Statewide
Impervious cover	NOAA Coastal Analysis Program DAR stream layer (Department of Planning) Pers. Comm., Richmond Pers. Comm., Carter Ogston et al. 2004	Statewide
Impaired water	Environmental Protection Agency Department of Health Pers. Comm., Slay	Select locations
Underground injection wells	Department of Health	Statewide
Septic systems	Department of Health	Oahu, Maui, Kauai
Cesspools	Department of Health	Hawaii, Maui, Kauai
Recreation/Fishing		
Ocean recreation zone	Department of Boating and Recreation	Statewide
Ocean recreation	Recreation Local Action Strategy NOAA Environmental Sensitivity Index	Select locations Statewide
Commercial fishing– Inshore species group	Department of Aquatic Resources	Statewide
Commercial fishing– All (incl. pelagic)	Department of Aquatic Resources	Statewide
Recreation fishing	NOAA Hawaiʻi Marine Resource Fishing Survey	Select locations
Artificial Structure		
Wrecks	Department of Planning	Statewide
FADS	Department of Planning	Statewide
Artificial reefs	Department of Planning	Statewide

*A contact at the respective agency/organization was consulted for peer-review on data interpretation and utilization.
**For many dataset described as statewide coverage excludes Kahoʻolawe, Niʻihau, and Lanaʻi.

- Mangrove. At least six species of mangroves have been introduced to Hawai‘i (Department of Navy 2005). *Rhizophora mangle,* intentionally introduced in the early 1900s for the purpose of stabilizing coastal mud flats, is now well established on mud flats and estuaries around most of the islands, and in some rocky coastal areas around Hawai‘i Island (Department of Navy 2005). *Bruguiera gymnorrhiza* and *Conocarpus erectus* have established self-maintaining populations (Department of Navy 2005). Geospatial Dataset: Environmental Sensitivity Index – mangroves.

Water Quality. Several elements were used to identify waters of low quality due to non-point and point source pollution. Sewage, nonpoint source run-off, and other forms of eutrophication can upset the delicate balance of coral reefs. High amounts of available nutrients, for example, lead to an increase in species such as fleshy algae and a subsequent decrease in diversity (Gulko 1998). The effect on coral reefs is exacerbated when combined with other human effects. Sources of concern include:

- Underground Injection Wells. The Hawai‘i Underground Injection Control (UIC) program is an environmental regulatory program whose purpose is to monitor and control injection well activity in order to prevent groundwater pollution (Program Statement 2002). UIC are used to dispose of wastewater from various activities, including sewage treatment, industrial processes, aquaculture, and surface runoff. Monitoring of and control over injection well activity are accomplished by the use of an underground injection control permit from the Department of Health. There is no monitoring of the marine waters in proximity to a well. Geospatial Dataset: Department of Health.
- Impaired Waters. Waters classified as category 5, defined as “available data and or information indicate that at least one designated use is not being supported or is threatened, and a TDML is needed.” Geospatial Data: DOH and EPA Integrated 303b List of Impaired Waters 2006.
- Cesspools. Geospatial Data: Department of Health
- Septic systems. Geospatial Data: Department of Health
- Impervious cover. Used NOAA’s impervious cover to predict level of degraded water quality due to runoff and reduced recharge due to surface cover, and assigned values to stream mouth by stream type. Geospatial Data: NOAA impervious cover
- Outfalls: Geospatial Data: Statewide GIS - Sewage outfalls.
- Gaps in data: Point source pollution is known to occur due to storm sewage overflow from manholes and sewage treatment plants, but this information varies temporally and is difficult to predict. Water quality experts expressed concern over bodies of water classified as “brown water” in the absence of rain; data not spatially documented.

Shoreline Armoring/Alteration. In Hawai‘i, coastal erosion and beach loss are problems. Much of the original sandy shoreline along many segments of coast has been replaced by shoreline hardening structures of various designs and construction methods (i.e., seawalls, revetments, groins of concrete, stone and wood) (Fletcher et al. 2002). Studies on O‘ahu have shown that nearly 25% of the sandy shoreline has been either significantly narrowed or lost since 1940s and nearly eight miles of beach on Maui has been lost to shoreline hardening (Fletcher et al. 2002). The loss of available sandy intertidal habitat and shoreline armoring/alteration causes a change in the marine ecosystem: reducing sand availability, changing sediment characteristics, and changing ambient water quality (Fletcher et al. 2002). In particular, a sea wall causes an increase in incoming reflected wave energy which accelerates the scouring of the sea floor until it hits beach rock/fossil reef. In areas of in-ground sewage disposal, armoring, and beach erosion, there is heightened potential for nutrient loading (pers. comm. Fletcher). Geospatial Data: NOAA Environmental Sensitivity Index – manmade.

Ocean Pollution.

- Dumping areas. Geospatial Data: Statewide GIS –dumping areas
- Marine debris "hotspots." There is evidence from NWHI, Florida, and elsewhere that debris is a contaminant that entangles and kills endangered Hawaiian monk seals, coral and other wildlife (Boland and Donohue 2003, Chiappone et al. 2002, and Donohue et al. 2001). Geospatial Data: NOAA marine debris
- Harbors/marinas/ports. Pumping, discharge, oil leaks, and alien species. For example, hull fouling is the attachment of organisms – macroalgae, mollusks, sea squirts, sponges, tubeworms, polychaetes, and barnacles - to the hulls of ships, barges, floating dry dock and other floating or submerged surfaces. According to Godwin, as many as 70% of the 287 introduced marine invertebrate species in Hawaiʻi may have been introduced via hull fouling. Geospatial Data: Statewide GIS – harbors/marinas/ports.

Natural Hazards. Coral reefs are subject to damage from hurricanes and storms, high wave action, unusually heavy rains, and extreme low tides. Healthy coral reefs can recover from a natural event such as a heavy storm or hurricane. But the addition of human-created stresses can diminish their ability to survive, and the coral reefs of MHI are at risk of accelerated degradation if existing human disturbances are continued or intensified.

- Erosion. Over time, coastal erosion increases the risk of flooding and diminishes the barriers. It is a common misconception that all shorelines in Hawaiʻi are eroding due to sea-level rise; simple sea-level rise will not elicit immediate shoreline erosion if there is an adequate supply of sand (Fletcher et al. 2002). For example, some portion of Kailua Beach on Oʻahu has been growing. Another cause of erosion is extreme storm event. Geospatial Data: Atlas of Natural Hazards in the Hawaiian Coastal Zone – erosion.
- Sea level rise. Result in global sea-level rise and vertical movements of the individual islands. Hawaiʻi County has the greatest rate of relative sea-level rise at 0.15 in/yr, related to loading of young volcanic rocks and sinking lithosphere in addition to sea-level rise. Maui has experienced a sea-level rise of about 0.10/yr while Oʻahu and Kauaʻi rate of about 0.06 in/yr (Fletcher et al. 2002). Geospatial Data: Atlas of Natural Hazards in the Hawaiian Coastal Zone – sea level rise.
- Coral bleaching. Thus far, Hawaii's coral reefs have mostly recovered from brief episodes of coral bleaching. But if the trend in rising water temperatures continues, any future damage could be permanent.
- Coral disease. Hawaiian reefs, until recently, have been largely spared from coral disease epidemics. The potential causes of coral tissue necrosis in Hawaiian reefs include elevated dissolved nutrient levels in the water column, mechanical abrasion of coral tissues, and pulses of excessive sedimentation (pers.comm. Aeby). The following areas have observed disease or coral tissue necrosis: Honolua Bay, Puakō, Kailua, Hana Bay, and Kāneʻohe Bay (pers.comm. Aeby)

Factors: Human Use

Fishing Area. The distinction between recreation, subsistence, and commercial fishing is difficult to distinguish as (1) traditional and subsistence fishing utilizes many of the same methods as recreational fishing, (2) commercial fishermen also fish recreationally on and between commercial fishing trips, and (3) recreational fishers trolling, handlining, and reef fishing often use similar techniques and gears as those of commercial fisher. In the absence of recreational fishing licenses and associated data collection, the extent of the fishery is poorly understood. The three types of fishing occur at many of the same types of locations (e.g., nearshore reefs, around network of FADs, near the island slopes and banks), with recreational fishing generally concentrated closer to shore and at coral reefs and on reef slopes.

- Recreational and subsistence fishing. Recreational fishing is an important component of Hawai‘i's way of life and livelihood strategies. For this reason, the ecoregional assessment attempted to minimize conflict with shoreline recreational fishers. Hawai‘i Marine Recreational Fishing Survey data were used to rank shoreline recreational fishing areas based on utilization patterns throughout the year. Geospatial Data: Hawai‘i Marine Recreational Fishing; Statewide GIS – FADs and wrecks.
- Commercial fishing. Coral reef ecosystems represent the most concentrated areas of fishery effort. A wide variety of gear types are used to harvest coral reef and deep water resources: fish traps, crab nets, surround nets, gill nets, hook-and-line, spearguns, mid-water handlines, beach seine nets, and cast nets. Fishing occurs year round, with seasonal restrictions for a variety of reef fish. Geospatial Data: DAR commercial fish catch data analyzed by species group landed per year for nearshore and all species.

Recreation Area

- State Designated Ocean Recreation Areas. The purpose of the rules is to further the public interest and welfare and to promote safety within the geographical limits of certain portions of Hawaii's ocean waters. In many instances, the purpose of the rules is also to reduce conflicts among ocean water users, especially in areas of high activity. Geospatial Data: State GIS Ocean Recreation Areas
- Recreation pressure (mainly scuba/snorkel areas). Geospatial Data: Created based on high use scuba/snorkel locations identified by the Recreational Local Action Strategy.

Artificial structures. Artificial structures are habitats (shipwrecks, artificial reefs, jetties, docks, FADs, buoys, and other man-made structures) that are physical alterations to the naturally occurring marine environment. Artificial structures provide a substrate upon which a marine community can develop. Spatial data was available for artificial reefs and FADs.

- Artificial reefs consist of one or more submerged structures of natural or man-made origin that are purposefully deployed on the seabed to influence the physical, biological, or socioeconomic processes related to marine resource (US Department of Navy 2005). Geospatial Data: DAR marine managed data layer - artificial reefs.
- FADs, or fishing aggregation devices, consist of a single or multiple floating devices suspended in the water column and connected to the seafloor by anchor or ballast. Geospatial Data: Statewide GIS – FADs.

Appendix C
Possible Candidate Mitigation Sites and Associated Data

The process to select candidate mitigation project sites was laid out in Section VIII, the compensation planning framework. Table 5 includes possible candidate mitigation project sites. For each service area, at least one candidate mitigation project site was identified where there is an anticipated permitted activity in that wave exposure zone.

Table 5. Possible candidate mitigation project sites (identifying one per wave exposure zone by service area where there are anticipated permitted actions)

Service Area	**Wave Exposure Zone**[1]			
	1	**2**	**3**	**4**
Hawai‘i Island	N/A	Papawai Bay	Puakō- Keahole	N/A
Maui Nui	N/A	Ka‘anapali-Honokowai	Kanaha	Moloka‘i North Shore
O‘ahu	N/A	Kāne‘ohe Bay	Maunalua Bay	N/A
Kaua‘i Ni‘ihau	N/A	Hanepepe	N/A	Ha‘ena-Hanalei

N/A (not applicable): No permitted action was identified in the wave exposure zone for that service area
[1] Wave exposure zone: 1 Low= No reasonable basis to expect high waves, 2 Medium= Seasonal high waves, 3 High= Seasonal high waves 6-8 ft w hazards, and 4 extreme= Seasonal high waves >12 ft, rapid onset

Tables 6 and 7 provide general qualitative and estimated quantitative information, respectively, on the candidate mitigation project sites. The information was derived from TNC’s compensation planning framework GIS database.

Table 6. Principle conservation targets, stress factors, and opportunities by site by service area

Service Area	Site Name	Principle Conservation Target	Principle Stress Factors	Principle Opportunity
Hawai'i	Puakō-Keahole	Area characterized by reef flats, patch reefs and sandy bays The region is bookended by two of the seven high priority areas for coral reef habitat (Puakō, Makalawena-Keahole) Priority manta ray cleaning and feeding station Priority estuary (Kiholo) Bays (Kiholo, Puakō) - possible recruit area Seagrass beds Intertidal rocky Deepwater corals Keahole Point: different reef structure than to the north (no freshwater) Spinner dolphin resting area (not a selected exclusion zone) Wave exposure: 3 Representative substrate: aggregated reef, pavement with sand channels, rock/boulder, rubble, scattered coral/rock, reef flat, sand Representative zone: bank/shelf, reef flat	Large stretch of coral reef area that supports largest concentration of resorts (> 80% of visitors to island) Accessibility to resource provided by hotels Nonpoint pollution: fertilizers from golf courses and landscaping High concentration of cesspools Proximity to Kawaihai Harbor High erosion rate predicted at several spots Increased access brought by proposed and potential housing/resort developments Proximity to underground injection wells: aquaculture Greatest impacted reefs north and south of Anaehoomalu Observed coral disease (1 of 4 areas) Alien algae Pockets of mangroves High recreation use	Kekaha Kai State Park Active fishpond/anchialine pool management Build upon existing management framework (MLCDs, FRAs, FMAs) TNC involvement at Puakō and Ka'ūpūlehu West Hawai'i Fisheries Council
Hawai'i	Papawai	Coral reef and associated fish High abundance of large fish "National Geographic" of reefs Spinner dolphin One of the seven areas selected for excellent coral cover and associated reef fish Steep dropoff Wave exposure: 2	Sandwiched between two degraded areas Development of mid-level road from airport through Kona and associated subdivision (increase impervious cover) High tourist traffic (especially large boat operators) Small concentration of cesspools to south Proximity to underground injection wells: Honokohau Boat Harbor (3,000 GPD) – small Commercial inshore fishing pressure ranked high	Old Kona Airport MLCD Economic value of healthy coral and fish (tourism and fishing) Good management Steep shoreline-limits access

Service Area	Site Name	Principle Conservation Target	Principle Stress Factors	Principle Opportunity
		Representative substrate: aggregated reef, rock/boulder Representative zone: bank/shelf, fore reef, sand		
Kaua'i-Ni'ihau	Hanapepe	Good nearshore coral Wave exposure: 2 and 3 Representative substrate: Pavement, rock/boulder, sand Representative zone: bank/shelf, channel	Minimal shoreline modification Boating facility Invasive fish, invertebrates NPDES sites Adjacent to underground injection well – industrial Concentration of cesspools present Category 5 impaired waters (monitored at Port Allen Boat Harbor) Discontinued dumping area	
Kaua'i-Ni'ihau	Ha'ena-Hanalei	Nearshore coral reef Very good fish biomass Estuarine Sandy intertidal Seagrass Coral cover >25%, mainly *montipora* Wave exposure: 4 Representative substrate: Aggregate reef, patch reef (little), pavement, pavement with sand channels, rock/boulder, rubble (little), scattered coral/rock, and spur and groove, sand Representative zone: bank/shelf, channel, fore reef, reef crest, reef flat, reef hole	Sedimentation Overfishing Mangroves High ocean recreation use Adjacent to high concentration of septic systems Adjacent to high concentration of cesspools Adjacent to underground injection wells (sewage from resort, Princeville Wastewater Pump Stations, and STP) Category 5 impaired waters	Community involvement Land based pollution LAS National Marine Sanctuary
Maui Nui	Ka'anapali-Honokowai	Very good coral reef system Hawksbill turtle foraging Preferred rocky intertidal Preferred halimeda meadow Wave exposure: 2 Representative nearshore substrate: sand, aggregate reef, patch reef, pavement, pavement with sand channels Representative zone: Bank shelf, channel, fore reef, reef crest, reef flat	Overfishing 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) High recreation use	Herbivore replenishment area Recreation zone (DOBOR) Multi-agency/organization involvement, including USACE and TNC

Service Area	Site Name	Principle Conservation Target	Principle Stress Factors	Principle Opportunity
			Invasive algae Predicted sea level rise rank 3 Highly zoned for ocean recreation Recreation diving	
Maui Nui	Kanaha-Maliko	Historically healthy coral reefs Monk seal habitat Representative nearshore substrate: sand (little), aggregate reef, pavement, rock/boulder, spur and groove Wave exposure: 3 Representative zone: Bank shelf, channel, fore reef, reef crest Preferred sandy intertidal, reef hole	Heavily impacted Adjacent to area of relatively low concentration septic systems NPDES site Kahului Harbor Invasive algae Adjacent to underground injection well: sewage and industrial Predicted sea level rise rank 3 Medium recreation fishing pressure from shore Relative intensity of inshore commercial fishing pressure: Medium (North Maui to Maliko)	
Maui Nui	Moloka'i-North Shore	Very good fish biomass, including large fish species Priority monk seal pupping Priority spinner dolphin resting Expert preferred rocky intertidal Offshore islets Wave exposure: 4 Representative nearshore substrate: sand (little), rock/boulder Representative zone: Bank shelf, reef flat	Marine debris (low)	NPS Adjacent to Bottomfish Recreation Management Area
O'ahu	Kāne'ohe Bay	Wide array of habitats for marine organisms within only a few km Most significant lagoon in ecoregion Coral reefs system (patch reef, pinnacle, and fringing) Sandy bottom Significant estuarine habitat Black-lipped pearl oyster (*Pinctada margaritifera*)	Heavily modified shoreline Agriculture Urbanization Streambed channels have increased freshwater runoff rates causing sediment and pollution NPDES	Ongoing cooperative restoration effort by State government, UH, NGOs, and local community groups Significant biological return for restoration effort *Pinctada margaritifera*

Service Area	Site Name	Principle Conservation Target	Principle Stress Factors	Principle Opportunity
		(historically abundant) *Lingula reevii*, an endemic brachiopod *Eucheuma spinosum* (tambalang), a red algae, and *Opheodesoma spectabilis*, a giant non-burrowing sea cucumber, are found almost exclusively in the Bay Pelagic organisms: large fish such as ulua and papio, aku, manta rays, hammerhead sharks, needlenose, green turtles, and occasionally Pacific bottlenose dolphins Pupping ground for scalloped hammerhead shark, *Sphyma zygaena* or mano kihikihi *Halophila* Rocky and sandy intertidal Historic green turtle nesting Hammerhead shark juvenile habitat Wave exposure: 2 Representative substrate: aggregate reef, patch reef, pavement, pavement with sand channels, rock/boulder (south into Kailua), rubble (very little), scattered coral/rock, spur and groove, sand Representative zone: back reef, bank shelf, channel, fore reef, lagoon, reef crest, reef flat	High concentration of invasive algae and invertebrates Extensive mangrove development Observed coral disease (1 of 4 areas) Presence of marine debris Discontinued dredged location Supports impaired water body Some watersheds of high impervious cover High level of recreation use for diving and snorkeling Highly zoned for recreation uses Wrecks High recreational fishing pressure Commercial fishing pressure on inshore fisheries: high	protected from harvest Lay gill net restricted zone
O‘ahu	Maunalua Bay	Most integrated algal beds and sand flats High productivity potential Coral reef system Estuarine system – expert preferred Spinner dolphin resting area Seagrass – expert preferred Wave exposure: 3 Representative substrate: aggregate reef, pavement, pavement with sand channels (little), rubble, spur and groove (little), sand Representative zone: bank shelf, channel, fore reef, reef crest, reef flat	Proximity to highly urbanized environment – heavy point and nonpoint pollution Dredged NPDES High concentration of invasive algae Predicted high rate of erosion (rank 3, 4) Commercial fishing pressure on inshore fisheries: Medium Supports impaired water body Watershed of high-medium impervious cover High level of recreation use for diving and snorkeling Highly zoned for recreation uses Maunalua Bay artificial reef Medium to high recreational shoreline fishing pressure	Ongoing cooperative restoration effort by State government, NGOs, and local community groups Significant biological return for restoration effort High Community engagement Paiko Lagoon restoration The vision of the sustainable use development plan for East O‘ahu is on the long-term protection of community resources and adapting to changing community needs.

Table 7. Estimated extent of biologic targets encompassed by the site by service area

Service Area	Site Name	Conservation Target	Area (meters, ha)
Hawaii	Puakō-Keahole	Aggregate reef	22803.80
Hawaii	Puakō-Keahole	Bank/Shelf	1181226.00
Hawaii	Puakō-Keahole	Coral cover 10-<50%	293500.69
Hawaii	Puakō-Keahole	Coral cover 50-<90%	20265.87
Hawaii	Puakō-Keahole	Coral cover 90-100%	4359.30
Hawaii	Puakō-Keahole	Deepwater precious or black coral - Priority	11576.80
Hawaii	Puakō-Keahole	Estuary - Priority	20404.20
Hawaii	Puakō-Keahole	Fore reef	2564.16
Hawaii	Puakō-Keahole	Green turtle foraging and basking	
Hawaii	Puakō-Keahole	Green turtle nesting	
Hawaii	Puakō-Keahole	Humpback whale wintering - Priority	5188556.25
Hawaii	Puakō-Keahole	Intertidal rocky: Sheltered rocky shore	30081.00
Hawaii	Puakō-Keahole	Intertidal sandy – Priority	103.44
Hawaii	Puakō-Keahole	Intertidal sandy: Fine to medium grained sand beach	208.92
Hawaii	Puakō-Keahole	Intertidal sandy: Gravel beach	3143868.00
Hawaii	Puakō-Keahole	Intertidal sandy: Mixed sand and gravel beach	398656.79
Hawaii	Puakō-Keahole	Manta ray feeding, cleaning, or aggregation	
Hawaii	Puakō-Keahole	Manta ray feeding, cleaning, or aggregation - Priority	
Hawaii	Puakō-Keahole	Pavement with sand channels	419.85
Hawaii	Puakō-Keahole	Reef flat	20624.92
Hawaii	Puakō-Keahole	Rock/Boulder	651439.50
Hawaii	Puakō-Keahole	Rocky intertidal: Exposed rocky cliff	4404456.00
Hawaii	Puakō-Keahole	Rocky intertidal: Exposed wave cut platforms in bedrock	3445061.00
Hawaii	Puakō-Keahole	Rubble	31.40
Hawaii	Puakō-Keahole	Sand	44148.72
Hawaii	Puakō-Keahole	Sandy intertidal: Coarse grained sand beach	122142.00
Hawaii	Puakō-Keahole	Scattered coral/rock	63.30
Hawaii	Puakō-Keahole	Seagrass	445.78
Hawaii	Puakō-Keahole	Spinner dolphin resting	
Hawaii	Puakō-Keahole	Spinner dolphin resting - Priority	
Hawaii	Papawai Bay	Aggregate reef	5700.95

Service Area	Site Name	Conservation Target	Area (meters, ha)
Hawaii	Papawai Bay	Bank/Shelf	224432.94
Hawaii	Papawai Bay	Coral cover 10-<50%	59898.10
Hawaii	Papawai Bay	Coral cover 50-<90%	5960.55
Hawaii	Papawai Bay	Coral cover 90-100%	1162.48
Hawaii	Papawai Bay	Deepwater precious or black coral represent	1747.02
Hawaii	Papawai Bay	Fore reef	641.04
Hawaii	Papawai Bay	Green turtle foraging and basking	
Hawaii	Papawai Bay	Intertidal sandy: Gravel beach	725508.00
Hawaii	Papawai Bay	Intertidal sandy: Mixed sand and gravel beach	132885.60
Hawaii	Papawai Bay	Mud	508.16
Hawaii	Papawai Bay	Reef flat	1330.64
Hawaii	Papawai Bay	Rock/Boulder	156345.48
Hawaii	Papawai Bay	Rocky intertidal: Exposed rocky cliff	1101114.00
Hawaii	Papawai Bay	Rocky intertidal: Exposed wave cut platforms in bedrock	1087914.00
Hawaii	Papawai Bay	Sand	2006.76
Hawaii	Papawai Bay	Sandy intertidal: Coarse grained sand beach	12214.20
Hawaii	Papawai Bay	Spinner dolphin resting	
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Coral cover 10-<50%	
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Fish Biomass 25-<50	
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Intertidal rocky: Sheltered rocky shore	648.68
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Intertidal sandy: Fine to medium grained sand beach	52684.40
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Intertidal sandy: Gravel beach	390372.61
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Intertidal sandy: Mixed sand and gravel beach	179086.00
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Rocky intertidal: Exposed rocky cliff	386494.80
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Rocky intertidal: Exposed wave cut platforms in bedrock	405490.78
Kauaʻi Niʻihau	Haʻena_Hanalei_Puu Poa	Sandy intertidal: Coarse grained sand beach	358326.48
Kauaʻi Niʻihau	Hanapepe	Coral cover 10-<50%	
Kauaʻi Niʻihau	Hanapepe	Fish Biomass 25-<50	
Kauaʻi Niʻihau	Hanapepe	Intertidal rocky: Sheltered rocky shore	1297.36
Kauaʻi Niʻihau	Hanapepe	Intertidal sandy: Gravel beach	390372.61
Kauaʻi Niʻihau	Hanapepe	Intertidal sandy: Mixed sand and gravel beach	143268.80
Kauaʻi Niʻihau	Hanapepe	Rocky intertidal: Exposed rocky cliff	450910.61
Kauaʻi Niʻihau	Hanapepe	Rocky intertidal: Exposed wave cut platforms in bedrock	473072.58
Kauaʻi Niʻihau	Hanapepe	Sandy intertidal: Coarse grained sand beach	143330.59

Service Area	Site Name	Conservation Target	Area (meters, ha)
Maui Nui	Kaʻanapali-Honokowai	Aggregate reef	14499.72
Maui Nui	Kaʻanapali-Honokowai	Bank/Shelf	1055057.60
Maui Nui	Kaʻanapali-Honokowai	Channel	1028.00
Maui Nui	Kaʻanapali-Honokowai	Coral cover 10-<50%	66298.14
Maui Nui	Kaʻanapali-Honokowai	Coral cover 50-<90%	2779.31
Maui Nui	Kaʻanapali-Honokowai	Fore reef	37228.36
Maui Nui	Kaʻanapali-Honokowai	Green turtle foraging and basking	
Maui Nui	Kaʻanapali-Honokowai	Halimeda	
Maui Nui	Kaʻanapali-Honokowai	Halimeda – Priority	
Maui Nui	Kaʻanapali-Honokowai	Humpback whale wintering	8535345.56
Maui Nui	Kaʻanapali-Honokowai	Humpback whale wintering - Priority	1045024.00
Maui Nui	Kaʻanapali-Honokowai	Intertidal rocky – Priority	10155.00
Maui Nui	Kaʻanapali-Honokowai	Intertidal sandy: Fine to medium grained sand beach	26431.00
Maui Nui	Kaʻanapali-Honokowai	Intertidal sandy: Gravel beach	240985.00
Maui Nui	Kaʻanapali-Honokowai	Intertidal sandy: Mixed sand and gravel beach	202987.20
Maui Nui	Kaʻanapali-Honokowai	Patch reef	119.48
Maui Nui	Kaʻanapali-Honokowai	Pavement	295495.00
Maui Nui	Kaʻanapali-Honokowai	Pavement with sand channels	1685.86
Maui Nui	Kaʻanapali-Honokowai	Reef crest	1578.08
Maui Nui	Kaʻanapali-Honokowai	Reef flat	67195.80
Maui Nui	Kaʻanapali-Honokowai	Rock/Boulder	15526.32
Maui Nui	Kaʻanapali-Honokowai	Rocky intertidal: Exposed rocky cliff	566628.00
Maui Nui	Kaʻanapali-Honokowai	Rocky intertidal: Exposed wave cut platforms in bedrock	397836.00
Maui Nui	Kaʻanapali-Honokowai	Sand	442621.40
Maui Nui	Kaʻanapali-Honokowai	Sandy intertidal: Coarse grained sand beach	160249.00
Maui Nui	Kanaha-Maliko	Aggregate reef	28999.44
Maui Nui	Kanaha-Maliko	Bank/Shelf	197823.30
Maui Nui	Kanaha-Maliko	Channel	514.00
Maui Nui	Kanaha-Maliko	Coral cover 10-<50%	66298.14
Maui Nui	Kanaha-Maliko	Coral cover 50-<90%	11117.24
Maui Nui	Kanaha-Maliko	Coralline algae cover 10-<50%	971.11
Maui Nui	Kanaha-Maliko	Fore reef	34364.64
Maui Nui	Kanaha-Maliko	Green turtle foraging and basking	
Maui Nui	Kanaha-Maliko	Intertidal sandy: Gravel beach	1445910.00

Service Area	Site Name	Conservation Target	Area (meters, ha)
Maui Nui	Kanaha-Maliko	Intertidal sandy: Mixed sand and gravel beach	152240.40
Maui Nui	Kanaha-Maliko	Monk seal present	
Maui Nui	Kanaha-Maliko	Monk seal pupping – Priority	
Maui Nui	Kanaha-Maliko	Pavement	153657.40
Maui Nui	Kanaha-Maliko	Reef crest	3156.16
Maui Nui	Kanaha-Maliko	Reef flat	107513.28
Maui Nui	Kanaha-Maliko	Reef hole	346.82
Maui Nui	Kanaha-Maliko	Rock/Boulder	85394.76
Maui Nui	Kanaha-Maliko	Rocky intertidal: Exposed rocky cliff	1699884.00
Maui Nui	Kanaha-Maliko	Rocky intertidal: Exposed wave cut platforms in bedrock	530448.00
Maui Nui	Kanaha-Maliko	Sand	187262.90
Maui Nui	Kanaha-Maliko	Sandy intertidal: Coarse grained sand beach	240373.50
Maui Nui	Kanaha-Maliko	Spur and Groove	4580.73
Maui Nui	Molokaʻi-North Shore	Bank/Shelf	824263.75
Maui Nui	Molokaʻi-North Shore	Coral cover 10-<50%	117863.36
Maui Nui	Molokaʻi-North Shore	Coralline algae cover 10-<50%	971.11
Maui Nui	Molokaʻi-North Shore	Deepwater coral present	1605.52
Maui Nui	Molokaʻi-North Shore	Fore reef	17182.32
Maui Nui	Molokaʻi-North Shore	Green turtle foraging and basking	
Maui Nui	Molokaʻi-North Shore	Intertidal rocky – Priority	43666.50
Maui Nui	Molokaʻi-North Shore	Intertidal rocky: Sheltered rocky shore	1231.99
Maui Nui	Molokaʻi-North Shore	Intertidal sandy: Gravel beach	1927880.00
Maui Nui	Molokaʻi-North Shore	Intertidal sandy: Mixed sand and gravel beach	253734.00
Maui Nui	Molokaʻi-North Shore	Monk seal pupping – Priority	
Maui Nui	Molokaʻi-North Shore	Reef flat	107513.28
Maui Nui	Molokaʻi-North Shore	Rock/Boulder	333815.88
Maui Nui	Molokaʻi-North Shore	Rocky intertidal: Exposed rocky cliff	1983198.00
Maui Nui	Molokaʻi-North Shore	Rocky intertidal: Exposed wave cut platforms in bedrock	1193508.00
Maui Nui	Molokaʻi-North Shore	Sand	102143.40
Maui Nui	Molokaʻi-North Shore	Sandy intertidal: Coarse grained sand beach	240373.50
Maui Nui	Molokaʻi-North Shore	Spinner dolphin resting - Priority	
Oʻahu	Kāneʻohe Bay	Aggregate reef	21432.00
Oʻahu	Kāneʻohe Bay	Back reef	23132.64
Oʻahu	Kāneʻohe Bay	Bank/Shelf	478798.20

Service Area	Site Name	Conservation Target	Area (meters, ha)
O'ahu	Kāne'ohe Bay	Channel	18065.84
O'ahu	Kāne'ohe Bay	Coral cover 10-<50%	173089.95
O'ahu	Kāne'ohe Bay	Coral cover 50-<90%	6396.30
O'ahu	Kāne'ohe Bay	Coral cover 90-100%	
O'ahu	Kāne'ohe Bay	Coralline algae cover 10-<50%	1981.95
O'ahu	Kāne'ohe Bay	Coralline algae cover 50-<90%	161.84
O'ahu	Kāne'ohe Bay	Deepwater precious or black coral represent	3438.88
O'ahu	Kāne'ohe Bay	Estuary - Priority	27681.03
O'ahu	Kāne'ohe Bay	Fish Biomass <25	
O'ahu	Kāne'ohe Bay	Fore reef	33467.10
O'ahu	Kāne'ohe Bay	Green turtle nesting	
O'ahu	Kāne'ohe Bay	Intertidal rocky – Priority	12307.32
O'ahu	Kāne'ohe Bay	Intertidal rocky: Sheltered rocky shore	10317.96
O'ahu	Kāne'ohe Bay	Intertidal sandy: Fine to medium grained sand beach	149561.10
O'ahu	Kāne'ohe Bay	Intertidal sandy: Gravel beach	77348.80
O'ahu	Kāne'ohe Bay	Intertidal sandy: Mixed sand and gravel beach	102690.00
O'ahu	Kāne'ohe Bay	Lagoon	40165.02
O'ahu	Kāne'ohe Bay	Manta ray feeding, cleaning, or aggregation - Priority	
O'ahu	Kāne'ohe Bay	Monk seal present	
O'ahu	Kāne'ohe Bay	Mud	64256.14
O'ahu	Kāne'ohe Bay	Patch reef	3388.84
O'ahu	Kāne'ohe Bay	Pavement	902041.44
O'ahu	Kāne'ohe Bay	Pavement with sand channels	39095.64
O'ahu	Kāne'ohe Bay	Reef crest	9399.30
O'ahu	Kāne'ohe Bay	Reef flat	204765.40
O'ahu	Kāne'ohe Bay	Rock/Boulder	12533.78
O'ahu	Kāne'ohe Bay	Rocky intertidal: Exposed rocky cliff	82680.30
O'ahu	Kāne'ohe Bay	Rocky intertidal: Exposed wave cut platforms in bedrock	525978.38
O'ahu	Kāne'ohe Bay	Rubble	624.18
O'ahu	Kāne'ohe Bay	Sand	198392.25
O'ahu	Kāne'ohe Bay	Sandy intertidal: Coarse grained sand beach	326906.50
O'ahu	Kāne'ohe Bay	Scattered coral/rock	258.44
O'ahu	Kāne'ohe Bay	Seagrass	9298.50
O'ahu	Kāne'ohe Bay	Spur and Groove	3999.88

Service Area	Site Name	Conservation Target	Area (meters, ha)
O‘ahu	Maunalua	Aggregate reef	16074.00
O‘ahu	Maunalua	Bank/Shelf	430918.38
O‘ahu	Maunalua	Channel	11117.44
O‘ahu	Maunalua	Coral cover <10%	
O‘ahu	Maunalua	Coral cover 10-<50%	31470.90
O‘ahu	Maunalua	Coralline algae cover 10-<50%	3567.51
O‘ahu	Maunalua	Coralline algae cover 50-<90%	161.84
O‘ahu	Maunalua	Deepwater coral present	2365.56
O‘ahu	Maunalua	Deepwater precious or black coral present	4298.60
O‘ahu	Maunalua	Estuary - Priority	21529.69
O‘ahu	Maunalua	Fore reef	40160.52
O‘ahu	Maunalua	Green turtle foraging and basking	
O‘ahu	Maunalua	Humpback whale wintering	2704327.01
O‘ahu	Maunalua	Mud	39542.24
O‘ahu	Maunalua	Pavement	394643.13
O‘ahu	Maunalua	Pavement with sand channels	13031.88
O‘ahu	Maunalua	Reef crest	5936.40
O‘ahu	Maunalua	Reef flat	132820.80
O‘ahu	Maunalua	Rock/Boulder	3581.08
O‘ahu	Maunalua	Rubble	1872.54
O‘ahu	Maunalua	Sand	147194.25
O‘ahu	Maunalua	Seagrass	2479.60
O‘ahu	Maunalua	Spinner dolphin resting - Priority	