Wahikuli-Honokōwai Coastal

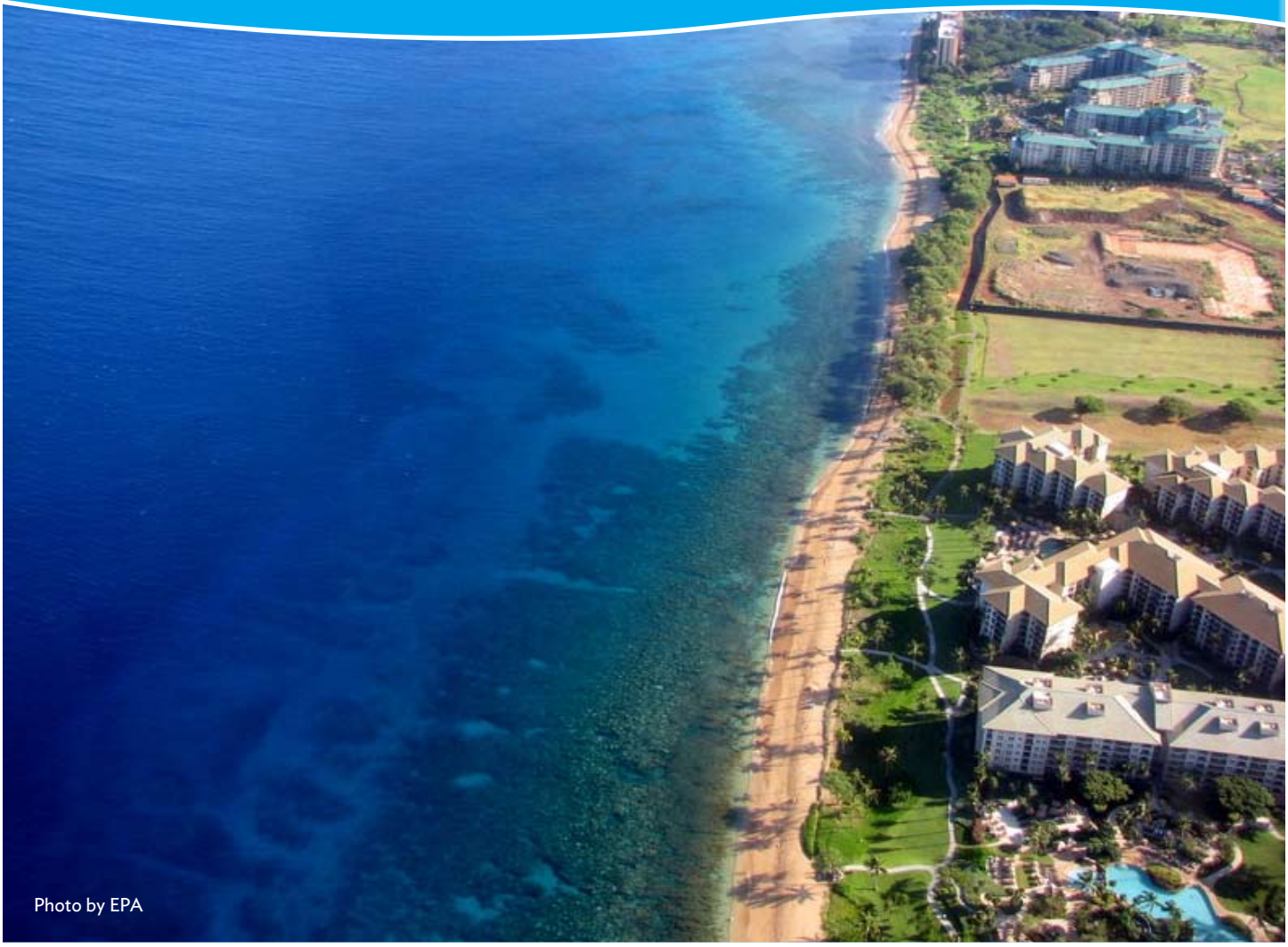

Photo by EPA

Conservation Action Plan

Vision: To revive and restore the coral reefs of Kāʻanapali to vibrancy and abundance.

Department of Land and Natural Resources State of Hawaii

DAR Hawaii Division of Aquatic Resources

The Nature Conservancy Protecting nature. Preserving life.

NOAA CORAL REEF

CORAL REEF ALLIANCE

WEST MAUI Ridge 2 Reef INITIATIVE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

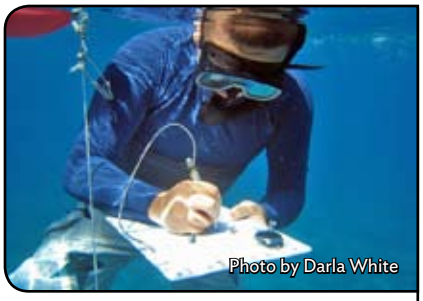
Photo by Darla White


Photo by Liz Foote


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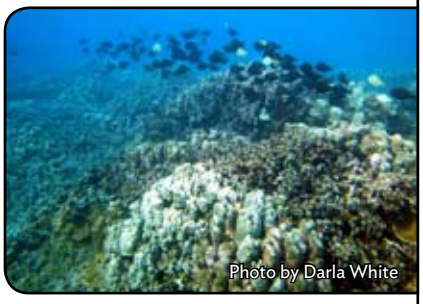
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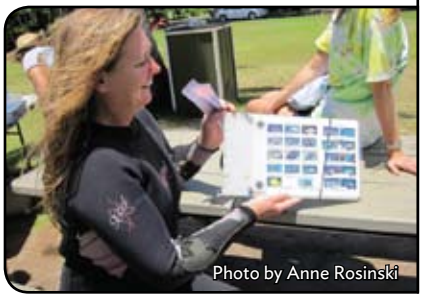


Photo by Anne Rosinski

Table of Contents

Planning Process

The Hawaii Department of Land and Natural Resources (DLNR), Division of Aquatic Resources (DAR) is the lead agency on this Conservation Action Plan. DAR's mission is to manage, conserve and restore the state's unique aquatic resources and ecosystems for present and future generations. The planning process was coached by The Nature Conservancy (TNC) and supported by the National Oceanic Atmospheric Administration's (NOAA) Coral Reef Conservation Program.

This plan was developed by a multidisciplinary project team who convened at four workshops from 2011-2013 as part of a peer planning and learning process with two other marine sites, Molokini Shoal Marine Life Conservation District (MLCD) and Kahoʻolawe Island Reserve Commission, to increase effective management of Hawaiʻi's marine protected areas.

The project team used Conservation Action Planning (CAP), a powerful process to guide conservation teams to develop focused strategies and measures of success. Utilizing the CAP process provided practitioners with a common approach and language for conservation planning and the opportunity for candid exchange and peer review. It provides an objective, consistent and transparent accounting of conservation actions and the intended and actual outcomes of conservation projects. It will enable project staff to responsively adapt their actions to improve strategy effectiveness and achieve a greater conservation impact.

Wahikuli-Honokōwai Coastal CAP Team Members

The project team is coordinated by NOAA/DAR Coral Reef Management Fellow Anne Rosinski and current (2013-2014) members are: Tova Callender, West Maui Watershed and Coastal Management Coordinator; Liz Foote, Coral Reef Alliance (CORAL); Lance Gilliland, Honua Kai Resort; Hudson Slay, Environmental Protection Agency (EPA); Linda Nakagawa, DAR; and Eric Conklin, TNC. Past members include: Luna Kekoa, NOAA/DAR, Dwayne Minton, TNC, and Jay Carpio, fisherman (Figure 1).

Figure 1: Photos of the CAP team in 2010 and 2013

Site Description

The geographic area of the Wahikuli-Honokōwai Coastal CAP (WHCCAP) is approximately 2.2 square miles of nearshore reef and waters, along 5 miles of the Kāʻanapali coast on the island of Maui, Hawaiʻi (Figure 2). This area extends from the northern edge of the Honokōwai watershed to the southern edge of the Wahikuli watershed, roughly including the ahupuaʻa of Honokōwai, Makaiwa, Hanakaoʻo, and Wahikuli, and aligning with the boundaries of the Wahikuli-Honokōwai Watershed Management Plan (WMP). The area includes the Kahekili Herbivore Fisheries Management Area (KHFMA), and nearshore waters out to the seaward edge of the KHFMA.

The shoreline is primarily sand beach and rocky points. In north Kāʻanapali some of the native coastal strand

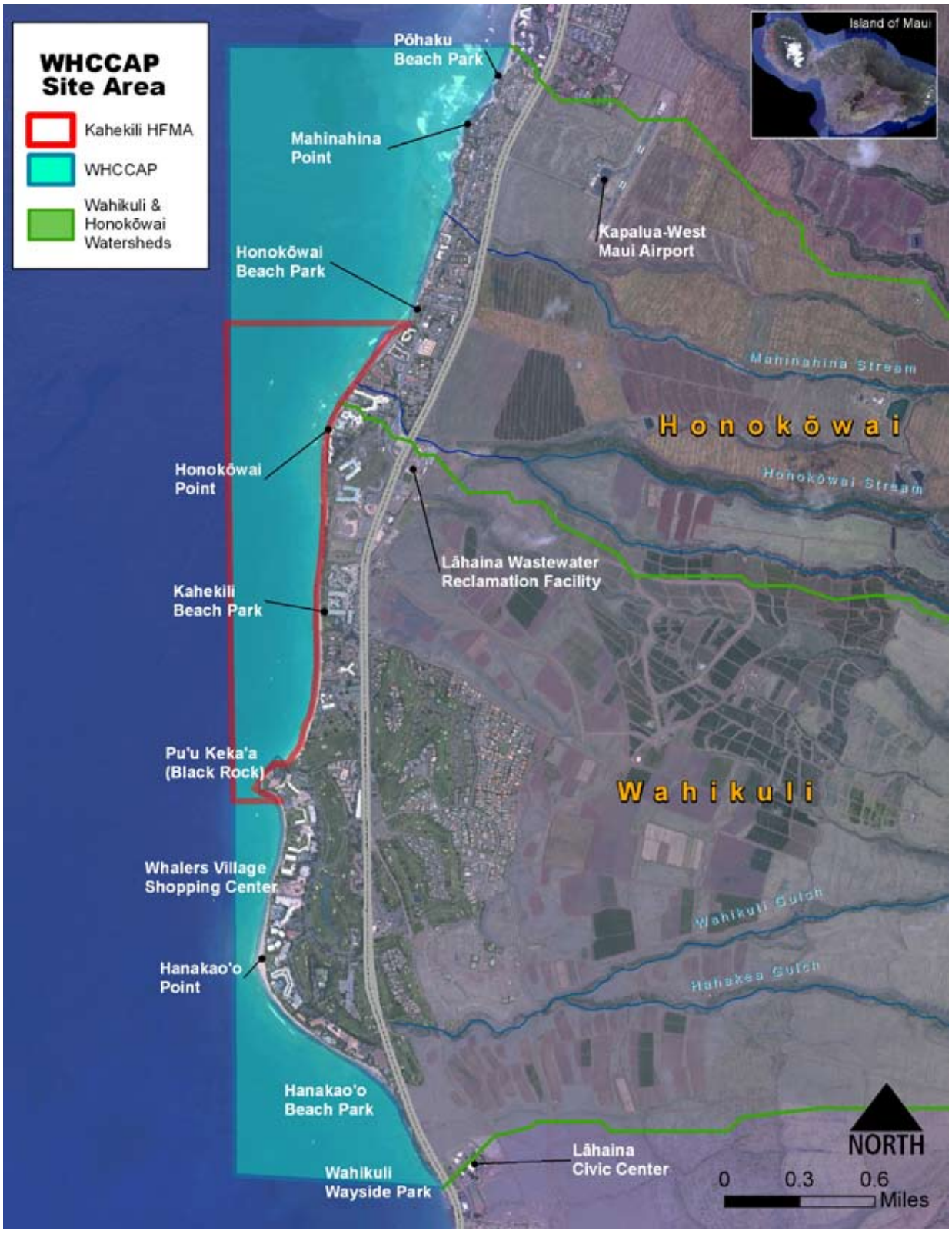


Image: 2011 Digital Globe, WV02. Map: NOAA Pacific Services Center, DAR.

Figure 2. Map of the geographic scope of this plan.

vegetation and wetlands have been restored. Most of the area is developed with hotels. Beach parks are located at either end of the area.

The coral reef ecosystem of Wahikuli and Honokōwai is home to a variety of fish species, and variety of fish including weke and kumu (goatfish), awa (milkfish), roi (introduced peacock grouper), uhu (parrotfish), nenue (chubs), palani and kala (surgeonfish), honu (Hawaiian green sea turtle) and the occasional `ilio-holo-i-kauaua (Hawaiian monk seal). The substrate includes coral cover ranging from 10% to 90% cover to about 65 feet in depth, uncolonized hard bottom and sand. In water greater than 65 feet, the seafloor is dominated by sand and a green calcified native algae *Halimeda kanaloana* (Swarzenski, 2012).

This area has been the subject of several focused management actions in the last five years. In 2009, after a thorough scoping and planning process, the State DLNR designated the KHFMA to control the overabundance of alien and native marine algae on the coral reefs by increasing the abundance of herbivorous (algae eating) fishes and sea urchins through fisheries management. These natural controls of marine algae are intended to help the marine ecosystem in the area return to a healthy balance (HAR 13-60.7-1). Under the KHFMA rules, it is illegal to take any of the herbivorous species seen in Figure 3, and fish feeding is prohibited.

In 2010, DAR and the Coral Reef Working Group (comprised of state and federal scientists and managers) identified Wahikuli and Honokōwai Watersheds on Maui and South Kohala Watershed

Figure 3. Herbivores protected within the Kahekili Herbivore Fisheries Management Area.

on Hawai'i Island as the two priority sites in the 2010 Hawai'i Coral Reef Strategy. In addition, the United States Coral Reef Task Force (USCRTF) selected Wahikuli and Honokōwai watersheds as one of three priority watershed areas in the U.S. for implementation of the Watershed Partnership Initiative. The Watershed Partnership Initiative provides a framework for USCRTF member agencies to increase collaboration and leverage resources to improve the condition of coral reef ecosystems.

It was out of these actions that the Wahikuli-Honokōwai Watershed Management Plan (WMP) was created in 2012, through sponsorship by the NOAA Coral Reef Conservation Program, as an initial evaluation of the Wahikuli and Honokōwai watersheds. The WMP is an element of the West Maui Ridge to Reef (R2R) Initiative and addresses impacts of land-based pollutants on coral reefs in this area. The plan adheres to the Environmental Protection Agency (EPA) Clean Water Act Section 319 guidelines for watershed plan development.

Kahekili Herbivore Fisheries Management Area (KHFMA)

- Est. 2009 by DAR
- 2.4 miles of coastline
- 0.7 square miles of ocean
- Goal: To control the overabundance of marine algae on the coral reefs by increasing herbivores

Wahikuli-Honokōwai Watershed Management Plan (WMP)

- Finalized in 2012 by state and federal partners
- Part of the West Maui R2R Initiative
- 2 Priority Watersheds
- Goal: To address impacts of land-based pollutants on coral reefs

Figure 4. A comparison of two designated areas within the CAP project area – the Kahekili Herbivore Fisheries Management Area and the Wahikuli-Honokōwai Watershed.

The coastal area addressed by this plan is also known as Keka'a (Sterling, 1998). The community of Keka'a once had abundant fishing grounds and cultivated lowland crops of taro and sweet potato (Handy, 1940). In more recent history over 10,000 acres of land in this area were cultivated for commercial production of sugar cane. Due to the declining demand for sugar cane from the Hawaiian Islands and the growing tourist industry in the late 1950s, the owner of the largest sugar plantation in Kā'anapali, American Factors, Ltd., developed a multi-million dollar resort around Pu'u Keka'a. Development in the area has grown since this time, and ownership has diversified. In 2013, there were at least 40 visitor accommodations in this coastal area. Kā'anapali Land Management Corporation, the largest landowner in Kā'anapali, converted 300 acres of once sugar cane to Kā'anapali Coffee Farms, a private agricultural community upslope from the KHFMA. In addition, the corporation is working with stakeholders to plan and develop a new community (housing, parks, schools, etc.) on 240 acres surrounding the old plantation camp of Pu'ukoli'i Village.

Why We Are Concerned

Concerns over sediment runoff and algal blooms in this area date back to the 1960s. These events led to a series of watershed management plans developed to "prevent floodwater and sediment damage in the flood plain and discoloration of the ocean along the coast." However, nuisance blooms of both red algae (*Acanthophora spicifera*) and green algae (*Cladophora sericea and Ulva fasciata*) continued to occur in the shallow reefs as well as the deep *Halimeda kanaloana* meadows at Kahekili Beach Park (Smith et al., 2005) through the 1990s and 2000s.

In general, algal blooms have several negative effects on ecosystems including low oxygen levels, higher potential for disease, and a loss of fish in impacted areas (Rosenberg, 1985; Alber & Vailela, 1994; Morand & Briand, 1996; Lapointe, 2005). On coral reefs, algal blooms can affect coral nutrition, growth, and overall survival by physically covering coral colonies and shading them from the sun (Kinsey & Davies, 1979; Walker and Ormond, 1982).

Despite several management plans as well as community and government initiatives that spanned the 1980s and 1990s, long-term monitoring at Kahekili Beach Park demonstrated a sharp decline in coral cover. Coral cover was reduced from around 55% in 1994 to

around 30% in the early 2000s (PIFSC, 2013). Data also showed that the beginning of this decline at Kahekili Beach Park coincided with a period of time beginning in 1999 when algal blooms were frequently observed (Figure 5). The elevated nutrient levels corresponding to the consistent algal blooms have a variety of sources including cesspool leakage, agricultural fertilizer runoff, and sewage effluent from injection wells (Dailer et al., 2010). The role of injection wells has come to the forefront in this area as almost all domestic and resort facilities within the area are connected by regional sewer lines to the Lāhaina Wastewater Reclamation Facility (WRF) near Honokōwai Point (Soicher, 1997).

Recent research has found that highly elevated levels of $\delta^{15}N$ (the stable isotope of nitrogen) in macroalgae in the area might be affected by aquifer drainage from the Lāhaina WRF (Dailer, 2010). A follow-up study by the U.S. Geological Survey (USGS) identified the submarine springs in the Kahekili nearshore coastal region as the main exit of the Lāhaina WRF injection plume into the coastal waters with pharmaceuticals, organic waste indicator compounds, and highly elevated $\delta^{15}N$ in water samples and benthic macroalgal tissue being the most conclusive tracers (Hunt and Rosa, 2009). The Lāhaina Groundwater Tracer Study conducted by the University of Hawai'i (UH) identified that 64% of the Lāhaina WRF treated wastewater injected at the facility's two primary disposal wells discharges from the nearshore submarine spring areas (Glenn et al., 2013).

The grazing activity of herbivorous fish is a natural mechanism to control algae growth on coral reefs. During an algae bloom in 2001, herbivores were found to be most abundant in areas where algae were most abundant (Smith et al., 2005). This suggests that the herbivores at Kahekili Beach Park were feeding on the algae, but grazing was not sufficient enough to control the algal blooms (Smith et al., 2005).

Land use in this region has also resulted in export of land-based pollutants that have impaired the water quality of nearshore ocean waters and adversely impacted the marine ecosystem (WMP 2012). Sources of this pollution include runoff from construction

Coral and Macroalgae Trends Kahhekili Beach Park

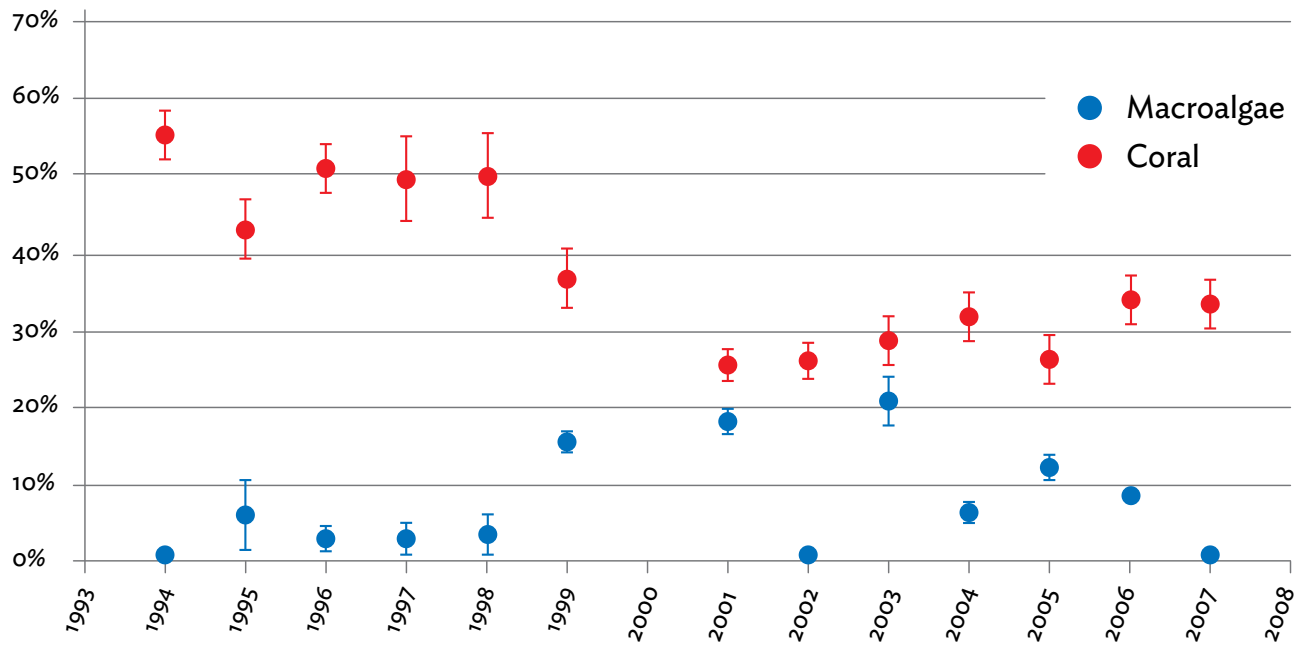


Figure 5. Coral and macroalgal percent cover trends 1993-2008 (PIFSC, 2013).

activities, suburban and resort development, current and historical agricultural activities as well as unused or fallow agricultural lands.

What We Are Protecting

Within the project scope, the CAP team identified five conservation targets (the features, ecosystems, species, and processes of the area that are the primary focus of management), and selected the coral reef ecosystem as a single priority conservation target. This selection was based on the current data available, the status of the target, and threats. Species and natural communities that would be conserved by preserving our conservation targets are listed as "nested targets." The four non-focal targets will indirectly benefit from the strategies devised for the coral reef ecosystem. These indirect targets are described in Appendix A.

Coral Reef Ecosystem

The coral reef can be defined as a functioning ecological unit that is made of living and non-living parts in waters from 1-20 meters in depth. For the purposes of this CAP, we have delineated the "coral-reef ecosystem" as all aggregated reefs (high relief area without sand channels), aggregated patch reefs (clustered reef separated by sand channels), and pavement (flat, low-relief solid carbonate rock with coverage of algae, coral, or other sessile invertebrates). These benthic habitat categories are used by the NOAA Biogeography Branch and the USGS. The focal area includes 1,000 acres of coral reef ecosystem (70% of the CAP area), as well as areas of sand patches, algal flats, and uncolonized hard bottom (Figure 6). The main coral species is *Porites spp.* (CRAMP, 2010).

The most abundant fish on the shallow reefs within the Kahekili HFMA are māʻiʻiʻi (lavender tang) and uhu (palenose parrotfish) (CRAMP, 2010). Kahekili HFMA ranked second highest among 60 Hawaiian reefs in terms of fish species richness, or the number of fish species found at the site (CRAMP, 2010).

Preliminary data show positive effects of the 2009 Kahekili HFMA herbivore fish protections to control the overabundance of algae. Surgeonfish biomass doubled from 2009 to 2012 (PIFSC, 2013). There has also been a consistent increase in both parrotfish biomass and the number of larger fish (>30cm) being seen more regularly on the reefs in the Kahekili HFMA (PIFSC, 2013).

However, additional improvement in the number of herbivores within the Kahekili HFMA is needed to control the overabundance of algae. The increase in parrotfish biomass was not evenly distributed, with little to no increase in reef areas directly adjacent to the Kahekili Beach Park where shore fishing is the most accessible (PIFSC, 2013). A survey of fishing activity in the Kahekili HFMA revealed that herbivores still comprise 18% of the recreational catch by weight and three out of the top five most frequently caught fish (Friedlander et al., 2012).

Status of the Coral Reef Ecosystem

The status of each conservation target was assessed according to key ecological attributes that are essential to the viability of the ecosystem. We assessed viability by assigning values along a four-part scale from poor, to fair, good or very good. Each target is assigned a current ranking as well as a desired future ranking. This CAP focuses on how to move the target from its present state to a preferred future state. Appendix B provides the details for the target viability rankings and an explanation of viability ranking criteria.

Priority Conservation Target	Nested Targets	Current Status	Desired Status
Coral Reef Ecosystem	Reef herbivores: chubs, parrot fish, surgeon fish, sea urchins	Fair	Good

Table 1. The priority conservation target of the WHCCAP is the coral reef ecosystem. The overall goal of the plan is to change the status of this target from fair to good.

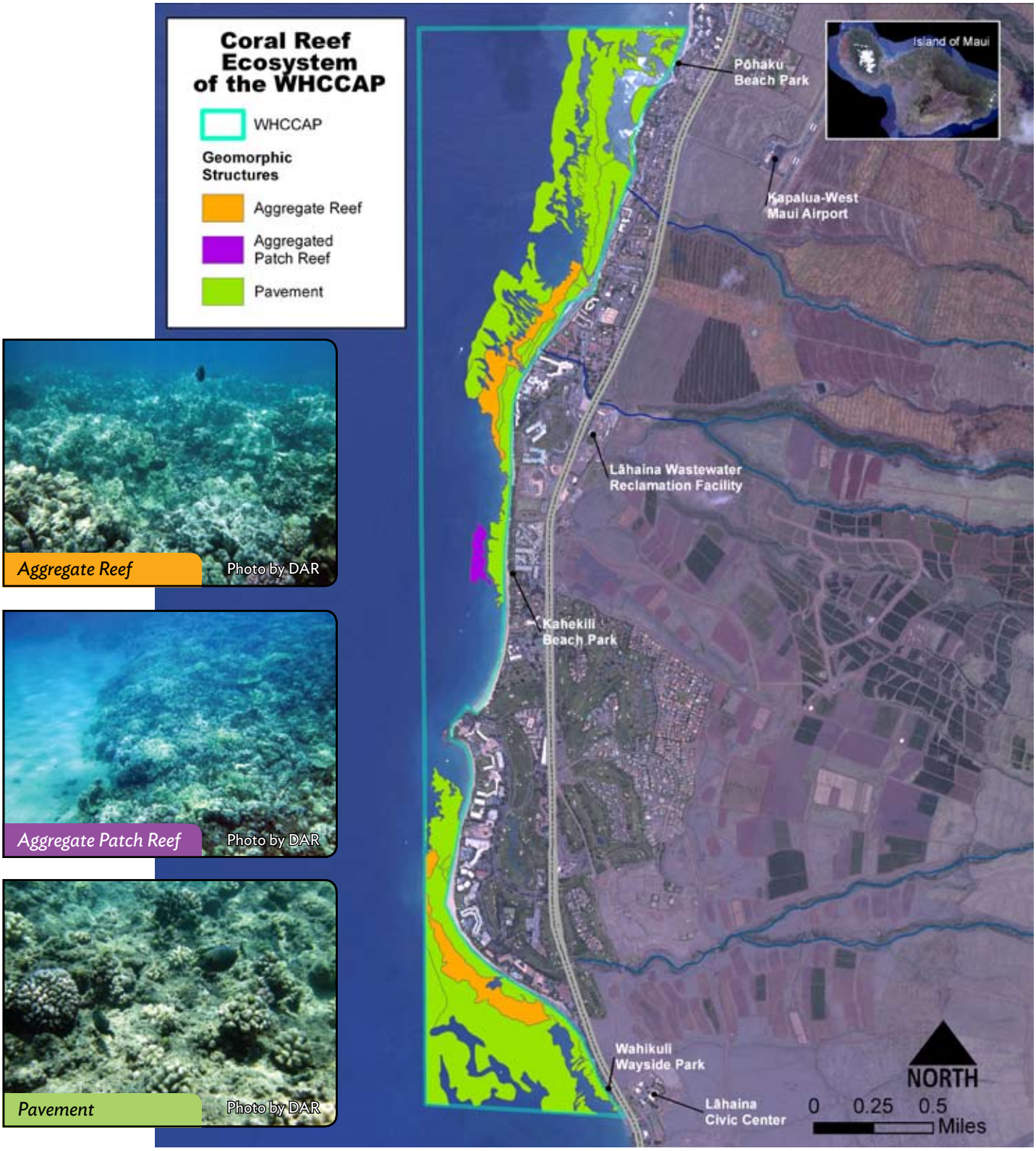
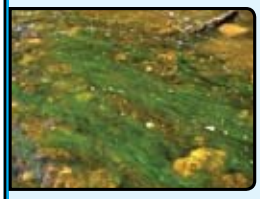


Image: 2011 Digital Globe, WV02. Benthic Habitat Data: NOAA National Ocean Service. Map: NOAA Pacific Services Center, DAR.

Figure 6. Map of the coral reef ecosystem within the WHCCAP including the three geomorphic structure types: a) aggregate reef, b) aggregated patch reef, and c) pavement.

Threats to the Coral Reef Ecosystem

Individually, each threat is serious, and in addition, multiple threats can act together to severely alter coral reef health, including ecosystem phase shift and collapse. Fifteen direct threats were evaluated by the CAP team and ranked using several criteria (see Appendix C for a description of the threats and ranking process). The highest ranked threats are listed below. The CAP team used these threats to identify priorities for the development of conservation strategies. These high-ranked threats have direct impacts on the coral reef ecosystem.



Nutrients and Other Contaminants
- Wastewater injection wells
- Urban district pollutants
- Legacy groundwater pollutants

Land-based Pollutants and Sediment
- Runoff from agriculture district and fallow fields
- Urban district pollutants
- Stream diversions

Resource Extraction
- Take of regulated herbivores in the Kahekili HFMA
- Unsustainable harvest outside of the Kahekili HFMA

Figure 7. Summary of the highest ranked threats.

Objectives and Strategies

This section summarizes the objectives and strategic actions to reach the overall goal of restoring the coral reef ecosystem in the focal area. To do this, actions focus on increasing the health of the conservation targets, decreasing the impacts of the identified threats, and capitalizing on opportunities to restore natural systems. These strategies rely on the efforts of the community, and partners involved in the West Maui R2R Initiative, NOAA, DAR, EPA, Department of Health (DOH), Commission on Water Resource Management, US Department of Agriculture Natural Resources Conservation Service, National Fish and Wildlife Foundation (NFWF), US Army Corps of Engineers, as well as the state's community-based Makai Watch program. See Appendix D for a description of current Makai Watch activities. The objectives and strategies of this plan support those of the Wahikuli-Honokōwai WMP, which outlines several strategies pertaining to the reduction of non-point source pollution in the Wahikuli and Honokōwai watersheds (WMP, 2012).

Objective 1	Within the Kahekili HFMA, reduce non-compliant herbivore fishing from 18% of catch by weight (as observed in the creel survey) to 9% in one year, then an additional 50% every year thereafter, and maintain compliance as herbivore biomass increases.
Objective 2	Promote sustainable fishing practices within the entirety of the WHCCAP.
Objective 3	By 2023, support the reduction of injection well disposal of sewage onto the nearshore coral reefs in the WHCCAP by at least 20% of 2013 conditions.
Objective 4	Support Wahikuli-Honokōwai WMP initiatives to reduce land-based pollution, nutrients, and sediment loads onto the nearshore coral reefs to figures comparable to state water quality standards.

Table 2. Summary of objectives to restore the coral reef ecosystem.

Objective 1. Within the Kahekili HFMA, reduce non-compliant herbivore fishing from 18% of catch by weight (as observed in the creel survey) to 9% in one year, then an additional 50% every year thereafter, and maintain compliance as herbivore biomass increases.

Strategic actions

1.1 **Build upon current education, outreach and awareness activities of the Kahekili HFMA:**
   a) Continue to install more effective signs at key access points, main entrances and restrooms.
   b) Continue to spread the word about the Kahekili HFMA on- and off-site through educational outreach to the local community.
   c) Involve youth and K-12 students through outreach, on-site educational opportunities, and curriculum development.

1.2 **Increase enforcement and deter non-compliant herbivore fishing by:**
   a) Division of Conservation and Resource Enforcement (DOCARE) officer presence on site.
   b) DAR and Makai Watch presence 3-4 days per week.

1.3 **Engage hotel stakeholders by enlisting hotel security to be more informed and engaged in deterring violations as well as collecting enforcement data.**

Objective 2: Promote sustainable fishing practices within the entirety of the WHCCAP.

Strategic Actions

2.1 **Promote adherence to State of Hawai'i catch sizes and bag limits.**

2.2 **Synthesize all available sources of locally relevant guidance on ethical and pono fishing practices.**

2.3 **Develop and promote a unified set of best fishing practices.**

2.4 **Support fishing rules and regulations that are based on target species' ecology and life history.**

Objective 3: By 2023, support the reduction of injection well disposal of sewage onto the nearshore coral reefs in the WHCCAP by at least 20% of 2013 conditions.

Strategic actions

3.1 **Synthesize all information on the impact of injection wells on the coral reef ecosystem and possible corrective actions.**
   a) Maintain up-to-date list of research studies and new information on impact of injection wells.

3.2 **Continue implementation of outreach program to gain public, government (local and federal), and business support for expanding our R1 reuse and infrastructure opportunities.**
   a) Develop an outreach plan to target the following audiences: legislature and agency heads, local and federal agency staff, and local businesses.
   b) Continue outreach efforts with the general public.
   c) Develop monetary/non-monetary business incentives to promote voluntary cooperation that is tied in with public outreach (e.g. reef friendly certification, water re-use).
   d) Focus on relationships with decision-makers and promoting appropriate outreach materials to increase political will for RI reuse initiatives.

3.3 **Support selection of the best corrective action for reducing wastewater input into the coral reef ecosystem by 2015 and develop a plan to implement it.**
   a) Work strategically with the Funding and Agency Support Team (FAST) of the R2R Initiative and the WMP Working Group.
   b) Work with other appropriate agencies in a position to decide what corrective actions to implement.

Objective 4. Support Wahikuli-Honokōwai WMP initiatives to reduce land-based pollution, nutrients, and sediment loads onto the nearshore coral reefs to figures comparable to state water quality standards.

Strategic actions

4.1 **Support implementation of the following strategies described in the WMP:**
   a) Reduce amount of sediment generated from agricultural access roads where hydrologic connectivity is apparent.
   b) Reduce the amount of sediment and associated pollutants generated from agricultural fields where hydrologic connectivity is apparent.
   c) Encourage production and reuse of R-1 water.
   d) Dam Analysis and Solution Design Development (Honokōwai Structure #8).
   e) Fertilizer management plan(s) for agricultural and urban areas.
   f) Generation of a Burn Area Emergency

Response Plan for wildfire.

g) Construction of constructed wetland and bioretention cells (rain gardens) in urban areas.

4.2 Assess the most efficient way to integrate CAP implementation into current and future WMP and R2R efforts.

a) Define the relationship between the CAP team, R2R FAST, and R2R Working Group and analyze how CAP implementation can compliment ongoing watershed activities.

b) Engage community volunteer groups in monitoring activities where possible.

c) Encourage and facilitate individual actions to reduce land-based pollution through support and implementation of a social marketing campaign.

Measuring Our Success

For this project, this monitoring plan answers two basic interrelated questions:

Resource Status

How are key targets, threats, and other factors at the project site changing over time?

Strategy Effectiveness

Are the conservation actions we are taking achieving their desired results?

To answer these questions, the CAP team and its partners are collecting data on a number of indicators that gauge either the status of a target, change in a threat, or progress towards an objective. These indicators inform us of our progress towards accomplishing our objectives, and ultimately all of the goals of the project. See the details on tables 3 and 4 on the next page.

Accomplishments

During the development of the CAP, these strategic actions were previously included and have since been accomplished:

1. **Collect data characterizing fishing within the Kahekili HFMA**
   a. Creel fisher survey completed
2. **Assign a specific DLNR position to coordinate and conduct DLNR actions in the watershed**
   a. NOAA Coral Fellow is working in DAR and coordinating the CAP efforts
   b. West Maui Watershed and Coastal Management Coordinator hired
3. **Review all corrective actions in the WMP**
4. **Create a one-stop shop for all information on the watershed (e.g. website)**
   a. www.westmauir2r.com
5. **Integrate research findings from most up-to-date injection well research (tracer study, dead zones, herbivory, biomarker and toxicity studies). This must be a full analysis of all options for wastewater treatment and disposal (including strategies currently being considered as well as innovative technologies and decreasing general water use in the region) complete with pollutant loading analysis and cost information**
   a. Described in the WMP, West Maui Recycled Water Verification Study
   b. Literature review by NOAA Coral Fellow for CAP team
6. **Create and promote a community-based non profit organization that can disseminate information and mobilize community**
   a. Makai Watch program is active
   b. R2R Initiative Hui is active
   c. West Maui Kumuwai social marketing campaign encouraging individual action for ocean health www.westmauikumuwai.org
7. **Develop an "executive board" comprised of significant county, state, and federal decision makers, important business people, and a representative of the community to serve as a guiding/sounding**
   a. R2R FAST, R2R Working Groups active
8. **Increase compliant fishing**
   a. New interpretive signage developed for the Kahekili HFMA; first sponsored sign installed at Kahekili Beach Park; second sign purchased and slated for installation at Honokōwai Park in March 2014
9. **Research and specialized monitoring projects are also being pursued, including:**
   a. Coral reef health monitoring using genetic markers (UH)
   b. Toolkit for assessment and mitigation of agricultural activities to benefit coral reefs (NFWF, UH)
   c. Benthic habitat mapping, historical sediment loading, groundwater discharge (USGS)
   d. Water quality and reef ecology (Scripps Institute of Oceanography, University of California San Diego)
   e. Sediment and chlorophyll tracking maps (NOAA)
   f. Knowledge, Attitudes, and Perceptions Survey (NOAA)
   g. West Maui Resorts and Condominiums Water Use Survey (CORAL)

Table 3: How is Resource Status Changing Over Time?

Coral reef ecosystem status indicators	Current monitoring	Frequency
Percent coral cover	Coral Reef Assessment Monitoring Program (CRAMP) surveys by DAR	Annual
Abundance of reef herbivore and apex predators	CRAMP surveys by DAR. Herbivore monitoring led by DAR and Kāʻanapali Makai Watch	CRAMP surveys performed annually, Makai Watch performed continuously
Natural levels of sediment (see DOH standards[1])	Turbidity measurements by DOH, video monitoring led by watershed coordinator, sediment trap monitoring (proposed by NOAA, DAR, USGS in 2014)	Continuously, reviewed quarterly
Acceptable nutrient thresholds (see 'open coastal waters' DOH water quality standards 'dry criteria' for TN, nitrate, nitrite, ammonia, TP chlorophyll a)[1]	Shoreline and seep water quality monitoring by DOH - Clean Water Branch	Variable/ dependent upon station (minimum ~10 samples/ station/year)

Table 4: Are Our Actions Having the Desired Effect?

Objective	What we want to see (2013 - 2016)	How we will measure
1. Herbivore extraction in Kahekili HFMA	Effective signs, on- and off-site education programs, K-12 engagement, consistent DOCARE and Makai Watch presence	Re-assessment of fishing characteristics through creel survey (% catch by weight) in 2015
2. Sustainable fishing practices	Adherence to state regulations, fishermen following best practices	Hawaiʻi pono fishing practices developed and promoted, West Maui moon calendar produced and promoted, % adherence to state regulations as measured through the 2015 creel survey
3. Nutrients and toxins	Clear understanding of all alternative wastewater treatment options, public support of reuse opportunities, corrective wastewater disposal plan developed, at least 1-2 actions taken	Outreach conducted to key audiences, measurable increase in R1 reuse, measurable decrease in volume of wastewater injected
4. Land-based pollution and sediment	Efficient communication between CAP and R2R teams, land-based pollutant loads at state water quality standards	Communication plan developed for CAP and R2R teams, measurable decrease in land-based pollutant loads

[1]Full text of DOH water quality standards available at: http://gen.doh.hawaii.gov/sites/har/AdmRules1/11-54.pdf (see 11-54-6 pg. 54-43), standards used here include Total Nitrogen (TN) (110ug/L), Nitrate and Nitrite (3.50ug/L), Ammonia (2.00ug/L), Total Phosphorus (TP) (16.00 ug/L), Chlorophyll a (.15 ug/L), and turbidity (.20 Nephelometric Turbidity Units (NTU)).

Appendix A: Indirect Conservation Targets

Coastal Shoreline Habitat:

The coastal shoreline habitat can be defined as the sand beach, sand dunes, wetlands, and rocky shoreline and cliffs that form the boundary between land and sea. This area is a vitally important native coastal strand vegetation and sea bird, shore bird, and water bird habitat including the Hawaiian petrel, which is an endangered, endemic species. The natural coastal structures and habitats provide a variety of ecosystem functions and services including coastal protection, erosion control, water purification, habitat for endemic plant and animal species, and tourism. Dune vegetation plays a key role in stabilizing soil, and is an important factor in mediating the negative impacts of global climate change, including rising sea levels, severe storms, and drought. These fragile systems are subject to both natural and human-caused threats such as storm blowouts, development, and invasive species. Nested Target: Native wetland and shore birds.

Nesting Green Sea Turtles and Resting Monk Seals

The threatened green sea turtle (*Chelonia mydas* or honu) frequents the Wahikuli-Honokōwai area and have been documented nesting on the beach. The endangered Hawaiian monk seal *(Monachus schauinslandi* or ʻIlio-holo-i-ka-uaua) also may come ashore at times in order to rest on the beach. These species can be disturbed or deterred from coming up on the beach by people or dogs, and sea turtle eggs (buried in clutches in the sand) can be dug up or eaten by dogs, cats, rats, and mongoose. Nesting and resting habitat is lost through shoreline erosion as well.

Halimeda Meadows

In the waters of the Wahikuli-Honokōwai area greater than 65 feet, the sea floor is dominated by green calcified *Halimeda spp*. algae. *Halimeda spp*. helps to secure sand, therefore creating habitat structure in the deep ocean for species including the endangered hawksbill turtle (*Eretmochelys imbricata* or honu ʻea) that forages in the meadows (Spalding 2004). *Halimeda spp*. meadows also support a diverse and unique invertebrate community that increases in abundance and diversity with depth (Fukunaga, 2008). This alga helps to shape the benthic community where it is found as well as coastal habitats; *Halimeda* contributed to around 30% of the biogenic (or from living organisms) sand in Kailua Bay, Oʻahu (Fukunaga, 2008; Harney et al., 2000). Nested target: Hawksbill turtle and deep ocean ecosystem.

Estuary (Muliwai)

Where the Honokōwai stream meets the ocean, it creates an estuary (muliwai) where fresh and salt water merge and serves as habitat for several species of reef fish in their juvenile stage. The stream delivers organic matter, algae, insects, and shrimp that are food sources for juvenile and adult fish in the estuarine and near stream environments. The Hawaiian endemic stream animals must reach the sea to survive as well. These fish, shrimp and mollusks evolved from marine forms and still require that their larvae spend several months at sea as larvae before returning to the stream. This stream is also the primary source of sediment to the reef during large flow events. Nested targets: Native wetland and shore birds.

Appendix B. Target Viability Rankings Criteria

Key Ecological Attributes, Indicators, and current ranking for Coral Reef Ecosystem

Item	Status	Poor	Fair	Good	Very Good
Benthic composition (% cover)					
▲ Percent coral cover	Fair	< 30% cover	> 30% cover	> 50% cover	> 70% cover
Fish species diversity					
▲ Fish species diversity	Fair	Low to no herbivores	Few herbivores	Presence of red fish, kumu, uhu; some apex predators	Many apex predators; presence of 7-11 crabs
Nutrients					
▲ Nutrient levels	Fair	Does not meet appropriate state water quality standard and there is a declining trend in water quality	Does not meet appropriate state water quality standards (no trend data)	Meets appropriate state water quality standards (no trend data)	Meets appropriate state water quality standards and conditions are either stable or improving
Sediment					
▲ Amount of sedimen-tation on substrate/ coral	Fair	Does not meet EPA turbidity standards and there is a declining trend	Does not meet EPA turbidity standards (no trend)	Does not meet EPA turbidity standards (no trend)	Does meet EPA turbidity standards and there is an improving trend

Legend Table ▲ Indicator Key Ecological Indicator

Appendix C. Threats and Ranking Process

Threats/Targets	Definition	Threat to Coral reef ecosystem
Injection wells	Used for disposal of wastewater, which is treated and then injected into the ground between impermeable layers of rocks	High
Invasive algae	Non-native and native algae species that impede coral settlement, specifically red algae (*Acanthophora spicifera* and *Hypnea musciformis*) and green algae (*Ulva spp.*) and native turf algae species	High
Overfishing	Harvest that exceeds the natural replenishment rate	High
Urban district pollutants	Nutrients, sediments, toxins, and chemicals delivered to coastal area from existing development	Medium
Fallow fields	Abandoned and eroding agricultural fields that have the potential to contribute to sedimentation and nitrification in coastal and marine areas	Medium
Construction runoff	Nutrients, sediments, toxins, and chemicals delivered to coastal areas and waters from construction sites	Medium
Legacy groundwater pollutants	Any organic or inorganic substance that impacts the quality of the water, leftover in the groundwater from previous practices	Medium
Illegal fishing	Extraction of fish (take) not in abidance with the State of Hawai'i fishing regulations	Medium
Agricultural runoff	Nutrients, sediments, toxins, and chemicals delivered to coastal areas and waters from agricultural practices	Low
Fish feeding	Illegal fish feeding that could disturb the fish community in the Kahekili HFMA	Low
Invasive fish	Non-native fish species including grouper (roi or *Cephalopholis argus*), blacktail snapper (to'au or *Lutjanus fulvus*) and blueline snapper (ta'ape or *Lutjanus kasmira*), which pose a threat to native fish and coral species primarily through competition	Low

Threat Ranking: The known impact of each threat was evaluated for each target. The ranking was based on the stresses leading to the degradation of the target and on the source of the stress. The stress is rated in terms of the severity (the level of damage the resource could reasonably expect within 10 years under the current circumstance), and the scope (very widespread to very localized that would be expected within 10 years under the current circumstance). The source of the stress was rated in terms of contribution (is the source acting alone to cause the stress or is it a low contributor to the particular stress?), and irreversibility (the degree to which the effects of a source of stress can be restored). Each of the criteria (severity, scope, contribution, and irreversibility) was ranked on a four point scale (low, medium, high, and very high) for each target.

Appendix D. Kā‘anapali Makai Watch

A Makai Watch program for Kāa‘napali was established in 2009 and is co-coordinated by the CORAL and DAR. Efforts focus on citizen science utilizing the Coral Reef Monitoring Data Portal, outreach and education in support of the Kahekili HFMA, and observation and incident reporting. The primary biological monitoring protocol is the Herbivore Enhancement Area (HEA) herbivore fish surveys coordinated by DAR. Other types of surveys periodically conducted include beachgoer surveys to assess visitors' and residents' awareness about the Kahekili HFMA, Reef Environmental Education Foundation fish surveys, Eyes of the Reef Reporting Network surveys, and recreational use surveys.

The biological monitoring, outreach and education, and observation and compliance efforts led by DAR and the Kā‘anapali Makai Watch Program are described below.

Herbivore Enhancement Area (HEA) Surveys

These surveys are currently scheduled several days per month for group participation, and can be done anytime one enters the water. Training is offered on a regular basis (both in classroom and in the field), and materials such as slates and datasheets are available to be checked out from DAR.

Herbivore Grazing Surveys

These surveys are conducted to assess the contributions of individual species of grazers to overall levels of herbivory within the Kahekili HMFA and track how these levels change over time in response to the implementation of the Kahekili HMFA. In these surveys, individual fish of the various species of surgeonfish, parrotfish, and rudderfish are observed, with the grazing rate (number of bites during a one minute observation period) by species, size class, behavior, and habitat recorded.

Behavior Survey

This survey protocols compliment the herbivore grazing pressure data. The herbivore behavior survey provides an estimate of how fish allocate their time between grazing and other behaviors throughout the day. Volunteers record the first behavior observed for each individual fish of a given species in a specific habitat.

Grazing School Survey

This survey was developed specifically to better characterize the composition and sizes of fishes in larger schools (> 50 individuals).

Makai Watch volunteers, supporters and partners at the 2012 Kahekili HFMA birthday bash.

Awareness and Outreach Activities

Kā‘anapali Makai Watch hosts periodic outreach stations as part of on-site events at Kahekili (such as Earth Day, beach cleanups, and the Annual 'Birthday Bash' celebration to mark the anniversary of the Kahekili HFMA's establishment), and also in partnership with the Westin Kā‘anapali Ocean Resort and the Hawaiian Islands Humpback Whale National

Marine Sanctuary. The group also uses a "roving volunteer" approach where individuals who have attended workshops and trainings on the Kahekili HFMA and Makai Watch can share their knowledge in an informal capacity, wherever they may be. Volunteers approach site users and inform them about the Kahekili HFMA and share key information verbally and are also able to pass out information such as DLNR regulation booklets. Volunteers also assist in the dissemination of information through the maintenance of literature display boxes attached to the DLNR signs within the Kahekili HFMA ('Adopt a Box' program) that contain important information for site users. Kā'anapali Makai Watch also uses social media tools such as Facebook, Twitter, and blogging to conduct outreach and education.

Observation and Incident Reporting: Online Reporting Pilot Program

As a way to address the illegal fishing objectives, the Kā'anapali Makai Watch program has initiated a pilot online reporting system to strengthen the relationship between the community and DOCARE. For those who have attended training workshops or other forms of volunteer orientation, DOCARE's Community Incident Report Form is available online: http://www.123contactform.com/contact-form-makaiwatch-205427.html

Acronyms

Agencies/Institutions
DAR - Division of Aquatic Resources
DLNR - Department of Land and Natural Resources
DOCARE - Division of Conservation and Resource Enforcement
DOH - Department of Health
EPA - Environmental Protection Agency
HEA - Herbivore Enhancement Area
FAST - Funding and Agency Support Team
NFWF - National Fish and Wildlife Foundation
NOAA - National Oceanic and Atmospheric Administration
USCRTF - United States Coral Reef Task Force
R2R - Ridge to Reef Initiative
UH - University of Hawai'i at Mānoa
USGS - United States Geological Survey

Organizations
CORAL - Coral Reef Alliance
TNC - The Nature Conservancy

Other
CAP - Conservation Action Plan
CRAMP - Coral Reef Assessment Monitoring Program
HFMA - Herbivore Fisheries Management Area
MLCD - Marine Life Conservation District
WHCCAP - Wahikuli-Honokōwai Coastal Conservation Action Plan
WMP - Wahikuli-Honokōwai Watershed Management Plan
WRF - Lāhaina Wastewater Reclamation Facility

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Wahikuli-Honokōwai Coast

Conservation Action Plan