# Pūpūkea Marine Life Conservation District Management Plan

Illustration by Koa Kakaio; photos by Mālama Pūpūkea-Waimea

**Last Updated April 12, 2024**

# PŪPŪKEA MLCD
# MANAGEMENT PLAN SIGNATURE PAGE

This plan was prepared by the Division of Aquatic Resources (DAR) staff in collaboration with Mālama Pūpūkea Waimea to provide a management framework for Pūpūkea Marine Life Conservation District.

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| _____ | Apr 12, 2024 |
| Brian Neilson- DAR Administrator | Date |

*This management was developed and revised by Mālama Pūpūkea Waimea and DLNR, Division of Aquatic Resources (DAR). It was edited and compiled by Debbie Gowensmith, Jenny Yagodich, Denise Antolini, and Bob Leinau from Mālama Pūpūkea Waimea, and Stacia Marcoux (DAR/ the Hawai'i Coral Reef Initiative) and Edward (Luna) Kekoa (DAR). Additional content was developed in collaboration with and provided by Dr. Mary Donovan and the Hawai'i Monitoring and Reporting Collaborative.*

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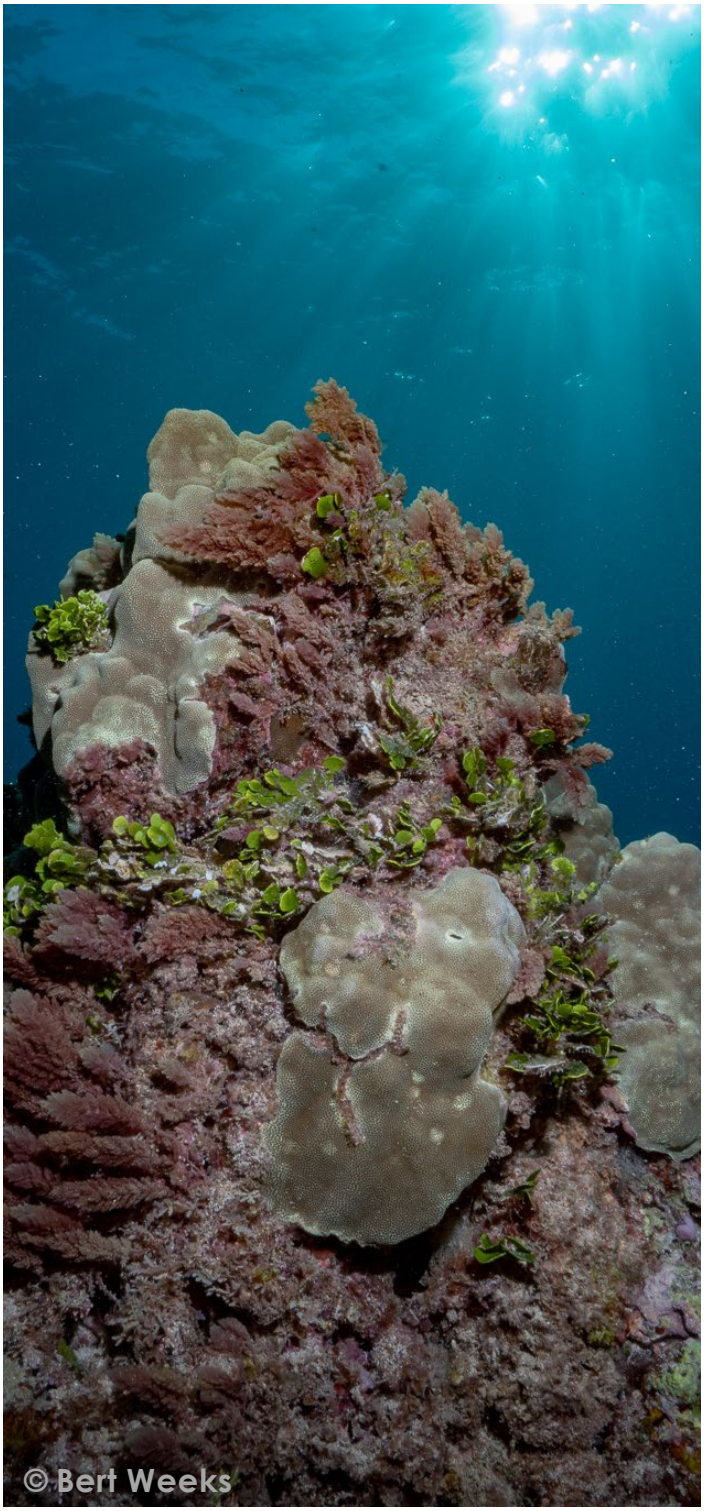
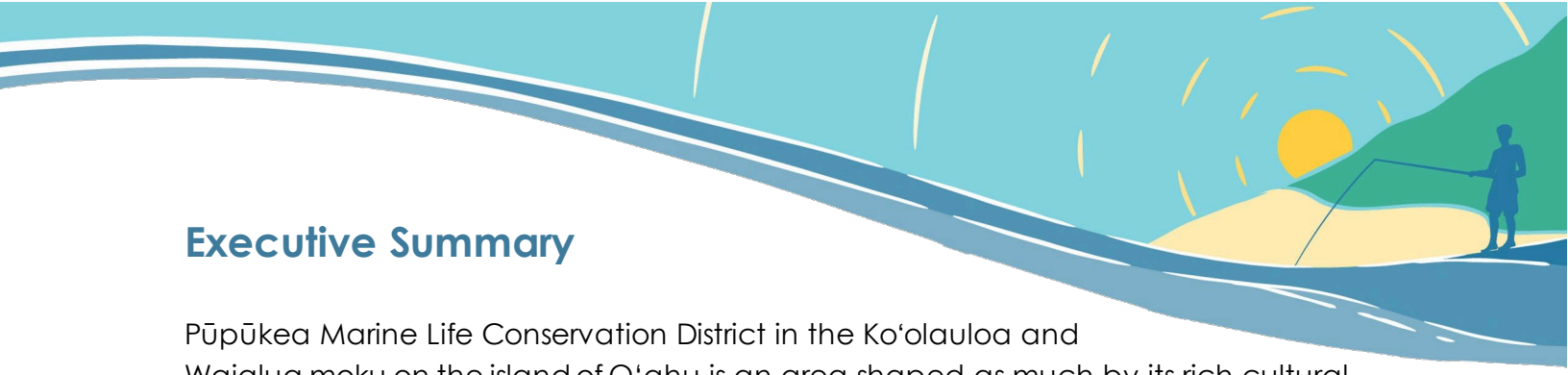




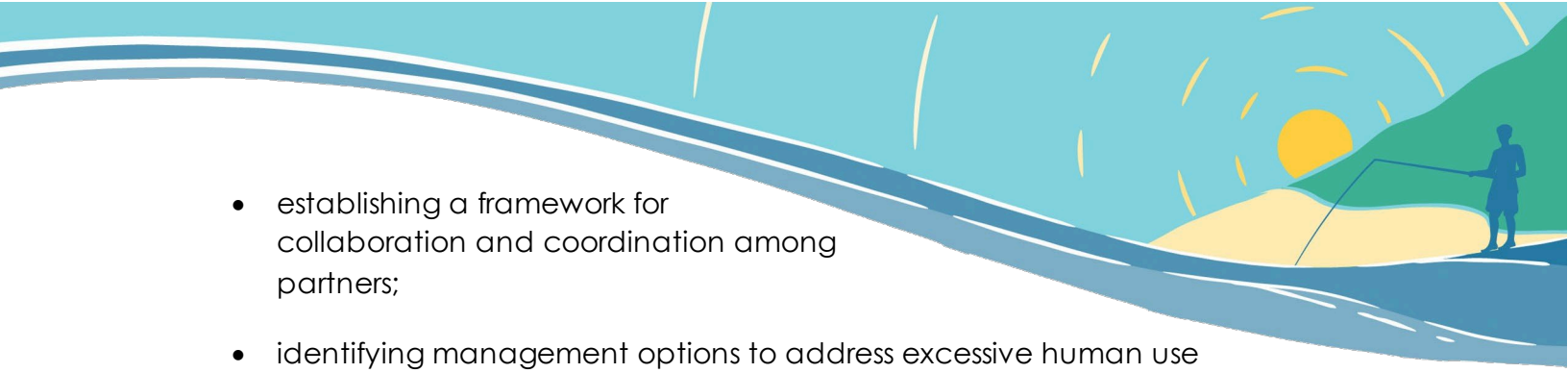
# Executive Summary

Pūpūkea Marine Life Conservation District in the Koʻolauloa and Waialua moku on the island of Oʻahu is an area shaped as much by its rich cultural and historical heritage as by its oceanography. Its distinct topography provides important habitat for abundant marine life. It was established in 1983 as a Marine Life Conservation District (MLCD), one of the highest level of protections for management in Hawai'i, in order to protect the unique diversity of marine organisms and important habitat that the area provides. The area within and surrounding the MLCD is co-managed by federal, state and city and county jurisdictions, as well as community organizations and dedicated community members.

Many studies and community members have identified threats to this special place including human impacts like excessive human use (including trampling on the coral), illegal harvesting and fishing, coastal erosion, leaching from sewage disposal systems and run-off from adjacent lands and developments. Based on these concerns, Mālama Pūpūkea Waimea, a local non-profit organization, brought together the Pūpūkea community to share observations, concerns and hopes for the future of the MLCD. From those discussions and on-going discussions with local scientists and the Division of Aquatic Resources, this management plan was drafted to address these concerns and promote the sustainability for the future of the MLCD.

Being an MLCD, Pūpūkea boasts relatively high levels of fish biomass, including higher than the Oʻahu average for the categories of total fish biomass, resource (food) fish biomass and herbivore biomass. Ecological indicators are spatially variable throughout the MLCD, reflective of the diverse habitat types and oceanographic conditions. Despite being exposed to high wave energy during the winter months, coral cover and the ratio of calcified to fleshy cover are comparable to the Oʻahu average and other MLCDs and reserves on Oʻahu. Since the MLCD was established 40 years ago, it would be expected that ecological indicators would have only negligible impacts from extraction (harvesting and fishing) and have comparable condition to the time prior to MLCD establishment. However, multiple threats are still affecting the ecological condition of the nearshore waters in this MLCD and could be addressed through additional management measures, beyond fishing regulations.

This management strategy is focused on inter-jurisdictional collaborations and coordination. Actions within each of the four pillars focus on bringing partners together to tackle large-scale threats to the MLCD with targeted actions and finding solutions to the many threats affecting the nearshore waters of Pūpūkea MLCD. Highlights of the management strategy includes:



- establishing a framework for collaboration and coordination among partners;
- identifying management options to address excessive human use by supporting a carrying capacity study;
- informing future management planning with the latest science;
- highlighting Hawaiian language and values in adaptive management and education about the MLCD;
- improving signage, outreach and education;
- conducting and analyzing ecological, socio-cultural and human use monitoring data;
- enhancing habitat through invasive species and marine debris removal;
- integrating nature-based solutions to reduce erosion and sedimentation;
- ensuring climate resilience through management actions, improving infrastructure and coordinating with other climate change related management plans.

Recognizing the need and commitment to preserve this special place, this management plan is the first step in a coordinated effort to adaptively manage Pūpūkea MLCD for present and future generations.

# Pūpūkea MLCD Management Strategy

Holomua Marine Initiative

## Place-Based Planning

**Goal:** Integrate, activate, and expand management coordination and programs with surrounding jurisdictions, partners, and management/ conservation areas.

Obj. 1: Convene partners at the MLCD annually for an action planning meeting to identify/ align goals, objectives, and commitments. Form working groups to convene at more frequent intervals to accomplish action items.

Obj. 2: Preserve, protect, and support the unique opportunities for sustainable MLCD use and enjoyment, including education, recreation, and access.

## Pono Practices

**Goal:** Promote interactions with the nearshore ecosystem are sustainable and not harmful or damaging by educating users on responsible behaviors that are guided by Hawaiian values and the best available science.

Obj. 1: Embrace, support, and enhance Hawaiian cultural values and practices (learn, teach, and do).

Obj. 2: Increase capacity for outreach and education to discourage poaching and encourage reporting of potentially illegal activity.

Obj. 3: Promote compliance from resource users and consistent, effective enforcement by DAR, DOBOR, DOCARE, prosecutors, and the Judiciary to support MLCD regulations.

## Monitoring

**Goal:** Promote management effectiveness by monitoring the health and abundance of biological and cultural resources in the MLCD, assessing ecological stressors, evaluating management effectiveness, identifying data gaps, and determining areas where the plan may need to be adapted.

Obj. 1: Conduct regular monitoring of biological management effectiveness indicators, including those that help to track climate change impacts.

Obj. 2: Conduct regular monitoring of human use and impacts

Obj. 3: Conduct regular kilo practices based on cultural knowledge.

Obj. 4: Integrate the results across all types of monitoring for decision-making and application to inform updates to the management plan. Focus on methodology where results are replicable so they can be compared with other areas, identify trends, and focus management priorities.

## Restoration

**Goal:** Develop a holistic approach to restoration by considering nearshore, coastal and land-based impacts to nearshore ecosystems that addresses current ecosystem threats and builds climate resilience for the future.

Obj. 1: Take proactive and reactive measures to promote the protection and restoration of the MLCD marine ecosystems

Obj. 2: Reduce mauka impacts to the MLCD through expanded efforts to restore and improve nearshore areas, and work with other agencies to reduce land-based threats to nearshore ecosystems.

Obj. 3: Manage for climate resilience of the MLCD by considering rising sea levels, ocean acidification, coral bleaching, warming temperatures, and changes in the wave regime.

Please see each pillar section for more details, including action items and workplan.

# About the Pūpūkea Marine Life Conservation District

## Geography and Location

District: O‘ahu
Moku: Ko‘olauloa and Waialua
Ahupua‘a: Pūpūkea and Waimea
Date est.: 1983

The land and marine areas of the Pūpūkea and Waimea ahupua‘a[1] are important biologically, socially, economically, and culturally. The Pūpūkea Marine Life Conservation District (MLCD) is a major feature of this area and is the most protective level of state marine managed area designated to conserve marine life and provide educational and recreational opportunities for residents and visitors.

The Pūpūkea MLCD consists of three areas known as Waimea Bay, Kalua o Māua, and Pūpūkea/Kapo‘o covering almost 180

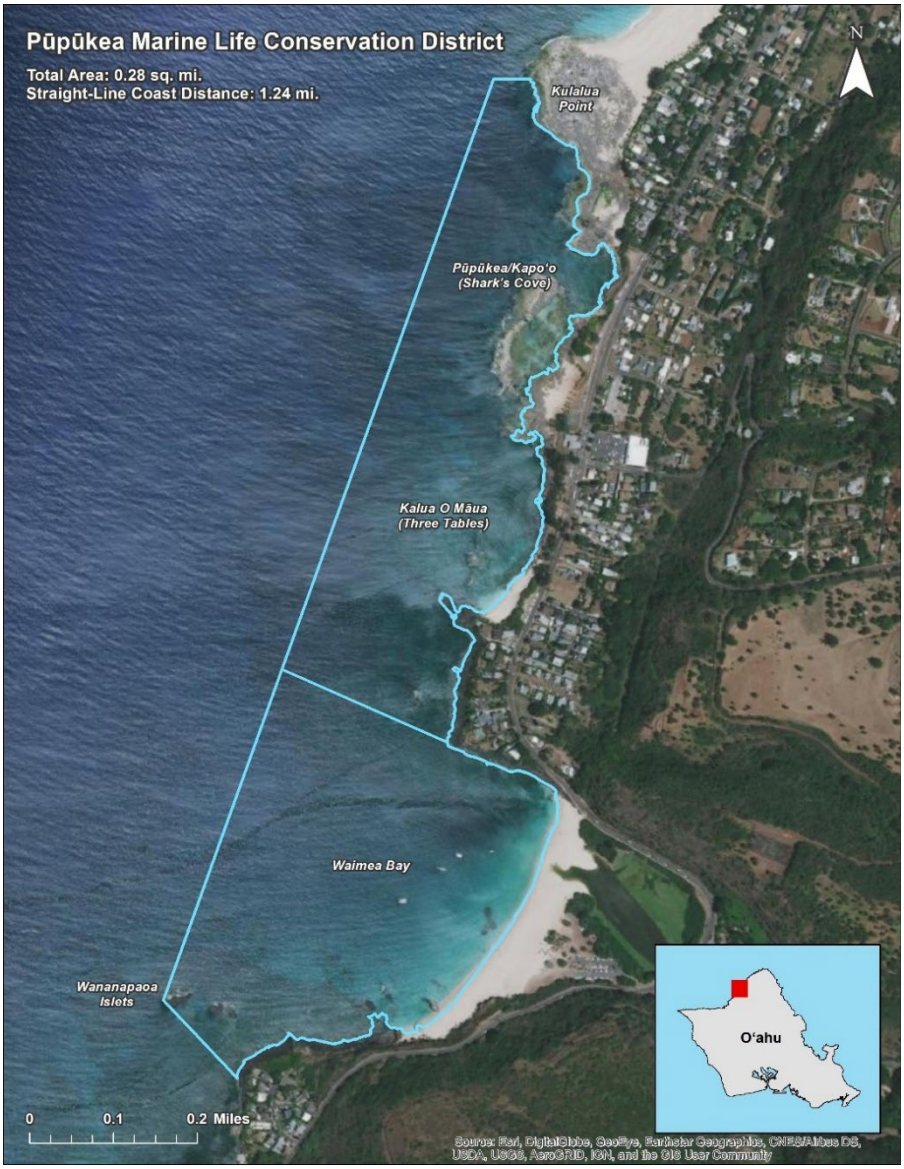
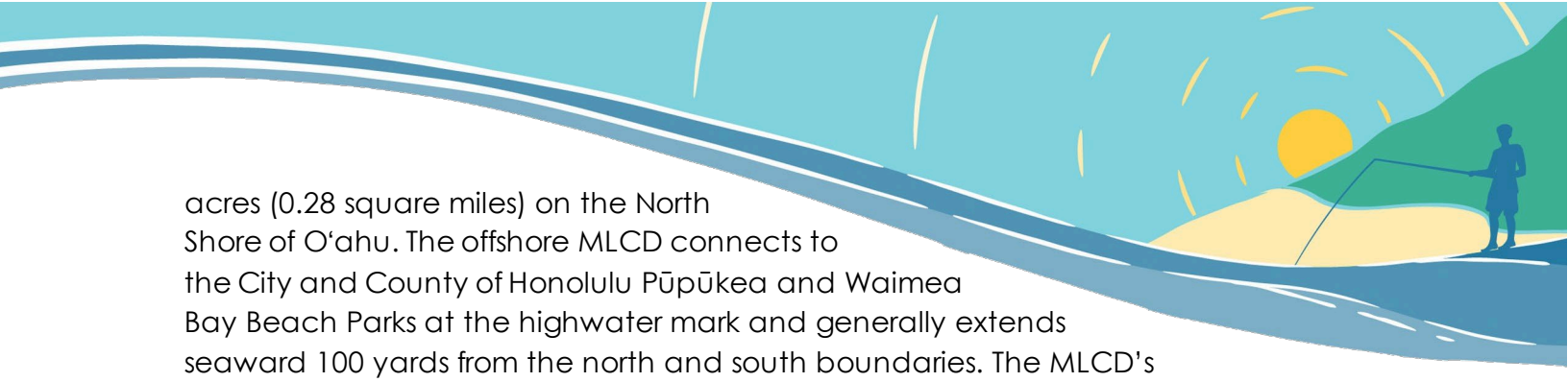



*Figure 1: Map of the Pūpūkea MLCD, including the three main sections: Pūpūkea Kapo'o, Kalua O Māua and Waimea Bay.*

[1] An ahupua‘a is a traditional Native Hawaiian land division roughly equivalent to a watershed, comprising an area from the ocean up to the mountains.



acres (0.28 square miles) on the North Shore of O'ahu. The offshore MLCD connects to the City and County of Honolulu Pūpūkea and Waimea Bay Beach Parks at the highwater mark and generally extends seaward 100 yards from the north and south boundaries. The MLCD's boundary is marked by Kulalua Point at the northern end of Pūpūkea Beach Park and the most seaward exposed rock of the Wānanapaoa islands on the south side of Waimea Bay. The Pūpūkea MLCD lies within the boundaries of the Hawaiian Islands Humpback Whale National Marine Sanctuary and is part of the Kālunawaika'ala watershed and the 12-square-mile Waimea watershed.

## MLCD Designation and Rule Updates

Pūpūkea is one of eleven MLCDs in Hawai'i. Only three MLCDs are designated on O'ahu: Pūpūkea, Hanauma Bay, and Waikīkī-Diamond Head.

The State of Hawai'i initially designated approximately 82 acres including the areas around Kalua o Māua (also known as Three Tables) and Kapo'o (also known as Sharks Cove) as the Pūpūkea MLCD in 1983. The designation was sparked by the high use of the Pūpūkea area and by the Coral Reef Assessment and Monitoring Program (CRAMP) study carried out by the University of Hawai'i. In 1975, a scientific study by the University of Hawai'i Sea Grant program recommended the area as a site for a MLCD[2] (Kimmerer & Durbin, 1975). More than 500 people were interviewed for the study, and Pūpūkea/Kapo'o was the top choice for the future location of a new MLCD. Divers approached the North Shore Neighborhood Board, expressing an interest in better management for the area. According to divers and fishers alike, marine life was becoming scarcer, according to divers and fishers alike, and the increased use of the area by commercial dive operators and fishers was cited as a source of concern.

In 1978, the State of Hawai'i Department of Land and Natural Resources (DLNR) initiated public meetings to discuss possible designation. Fishers were not opposed to making the area an MLCD, but they did not want to be restricted from accessing the area and traversing to popular spearfishing sites. For this reason, in 1983, when the Pūpūkea MLCD was established, certain types of fishing and limu (marine algae, or seaweed) collecting were allowed.

By the 1990s, DLNR recognized that the existing MLCD rules were too difficult to enforce and began discussing amendments to the rules. The North Shore Neighborhood Board again became involved, drafting amendments to the rules and presenting them to the

[2] Kimmerer, William J., and Woodrow W. Durbin. *The potential for additional marine conservation districts on Oahu and Hawaii*. Vol. 76, no. 3. NOAA Office of Sea Grant, Department of Commerce, 1975.

DLNR. In 1999, State Senator Robert Bunda and State Representative Alex Santiago convened a task force of stakeholders, in conjunction with DLNR, which recommended rule changes and expansion of the MLCD. After an extensive public hearing process, in 2002, the area of the MLCD was expanded to extend to Waimea Bay and further offshore, covering almost 180 acres. Additional rule changes were made in 2003.

In 2008, Governor Linda Lingle issued an Executive Order reclaiming the tidepools at Kapoʻo—the three-acre "Old Quarry" area—as part of the MLCD, reversing the State's 1965 designation of the area as part of the City Beach Park. Over the decades, the tidepools became a unique and important nursery habitat for a variety of marine species, and a site of frequent poaching and overuse. In 2021, again at the request of the community, DLNR adopted new administrative rules to clarify that marine life could not be taken within the boundaries of the tidepools at Kapoʻo and to ban fish feeding throughout the MLCD.

## Current Rules and Management Designations

The ahupuaʻa of Pūpūkea and Waimea that include the MLCD have several top-level, long-standing management designations under Federal, State, and City and County of Honolulu laws. Figure 2 illustrates the interjurisdictional boundaries of natural resource management in the Pūpūkea and Waimea ahupuaʻa.

### *State Department of Land and Natural Resources*

**DAR**

In 1983, DLNR designated the Pūpūkea MLCD pursuant to Hawaiʻi Revised Statues (HRS) Chapter 190 by adopting a specific chapter of Hawaiʻi Administrative Rules (HAR) § 13-34 – 1 through 5 "Pupukea Marine Life Conservation District, Oahu." The Pūpūkea MLCD rules were amended in 2002, 2003, and 2021.[3] See Figure 1 for map of the MLCD boundaries.

[3] The Pūpūkea MLCD rules are posted on the DAR web site for Regulated Areas at: https://dlnr.hawaii.gov/dar/files/2021/11/ch34rev.pdf

The current rules of the MLCD provide:

Permitted Activities

- To take and possess up to two pounds (combined total, squeezed dry) of limu kohu and limu lipe'epe'e by hand harvest only, provided the limu's holdfast is left in place.
- To possess a knife for personal safety only.
- Within Waimea Bay only:
- To take and possess any finfish with hook-and-line from shore, with not more than two poles per person and one line per pole with no more than two hooks per line.
- To take with permitted nets and possess 'ōpelu during August and September, and akule during November and December.

Prohibited Activities

- To fish for, take, injure, kill, possess, or remove any marine life (including eggs), except as indicated in permitted activities above.
- To take, alter, or remove any geological feature including sand, coral, or rock, or specimen.
- To possess in the water any device, including spears or nets, that may be used to take marine life, or alter any geological feature or specimen.
- To introduce any food or other substance into the water to attract marine life, except as permitted for fishing in Waimea Bay.
- To snag any akule while fishing from the shore of Waimea Bay according to permitted activities above.

**Other DLNR Regulations and Management Areas**

- Division of Boating and Ocean Recreation Management Rules for Sharks Cove, Three Tables, and Waimea Bay[4] designates four zones (A, B, C, D) with varying restrictions on boating and recreational activities in each zone (Figure 2). Zone A (Waimea Bay) prohibits motorized vessels and limits the sailing vessels with auxiliary engines to sail or oar power only; allows manually propelled vessels (e.g., kayaks) to embark and disembark from shore; prohibits vessels anchoring within 200 feet of shore and allows anchoring only in sandy areas; restricts all vessels to slow-no-wake speed in Waimea Bay. Zone B (Kalua o Māua, or Three Tables) allows manually propelled vessels (e.g., kayaks) to embark and disembark from shore; prohibits motorized vessels. Zone C (Kapo'o, or Sharks Cove) prohibits all vessels from embarking or disembarking from the shoreline;

[4] The DOBOR rules, Title 13 chapter 256 include specific areas rules for Sharks Cove, Three Tables, and Waimea, HAR § 13-256-63. The correct Exhibit Q showing Zones A-D can be found at: http://pupukeawaimea.org/wp-content/uploads/DOBOR-Map.pdf

restricts commercial SCUBA and snorkel activities to operators with valid commercial permits and a "use permit" for Zone C allocated through a reservation and fee system,[5] requires education of customers and shuttles, and restricts all commercial activities from November 1 to March 31, and from 9:00 pm to 8:00 am. Zone D (offshore) requires all vessels to proceed at slow-no-wake speed and requires any moored vessels to anchor in sandy areas or use installed day-use-moorings. Special event permits are required in all zones for certain activities.

- The Pūpūkea Forest Reserve, established by the State in 1920 to conserve and protect the remaining forest and increase local water supply, comprises 782 acres and is managed by the DLNR Division of Forestry and Wildlife[6] (Figure 2).
- In 2019, the State acquired 3,716 acres in upper Waimea Valley and, in 2021, added that area as the "Waimea Section" of Pūpūkea Forest Reserve.
- The State Parks Division manages the two-acre Pu'u o Mahuku Heiau State Historic Site that overlooks Waimea Bay and is accessed from Pūpūkea Road.[7] In 1962, the four-acre property encompassing the heiau was placed under the jurisdiction of State Parks to preserve this significant site for future generations and declared a National Historic Landmark in 1962.
- The Commission on Water Resource Management (CWRM) manages groundwater and stream resources.
- The Office of Conservation and Coastal Lands (OCCL) the management and regulation of beach and marine lands.
- Knowing that officers cannot be everywhere all the time, the public can now report resource violations through the DLNRTip App. This can also include observations of illegal fishing, boating or anchoring activities.
- The Division of Conservation and Resources Enforcement (DOCARE) enforces the statutes and administrative regulations related to the MLCD.

[5] Although this reservation system was created by DOBOR, it has never been set up or functioned to restrict commercial SCUBA or snorkel activities in the area.

[6] https://dlnr.hawaii.gov/forestry/frs/reserves/oahu/pupukea-forest-reserve/; see Pūpūkea Forest Reserve Management Plan at https://dlnr.hawaii.gov/forestry/files/2017/10/PupukeaFR_plan.pdf

[7] https://dlnr.hawaii.gov/dsp/parks/oahu/puu-o-mahuka-heiau-state-historic-site/

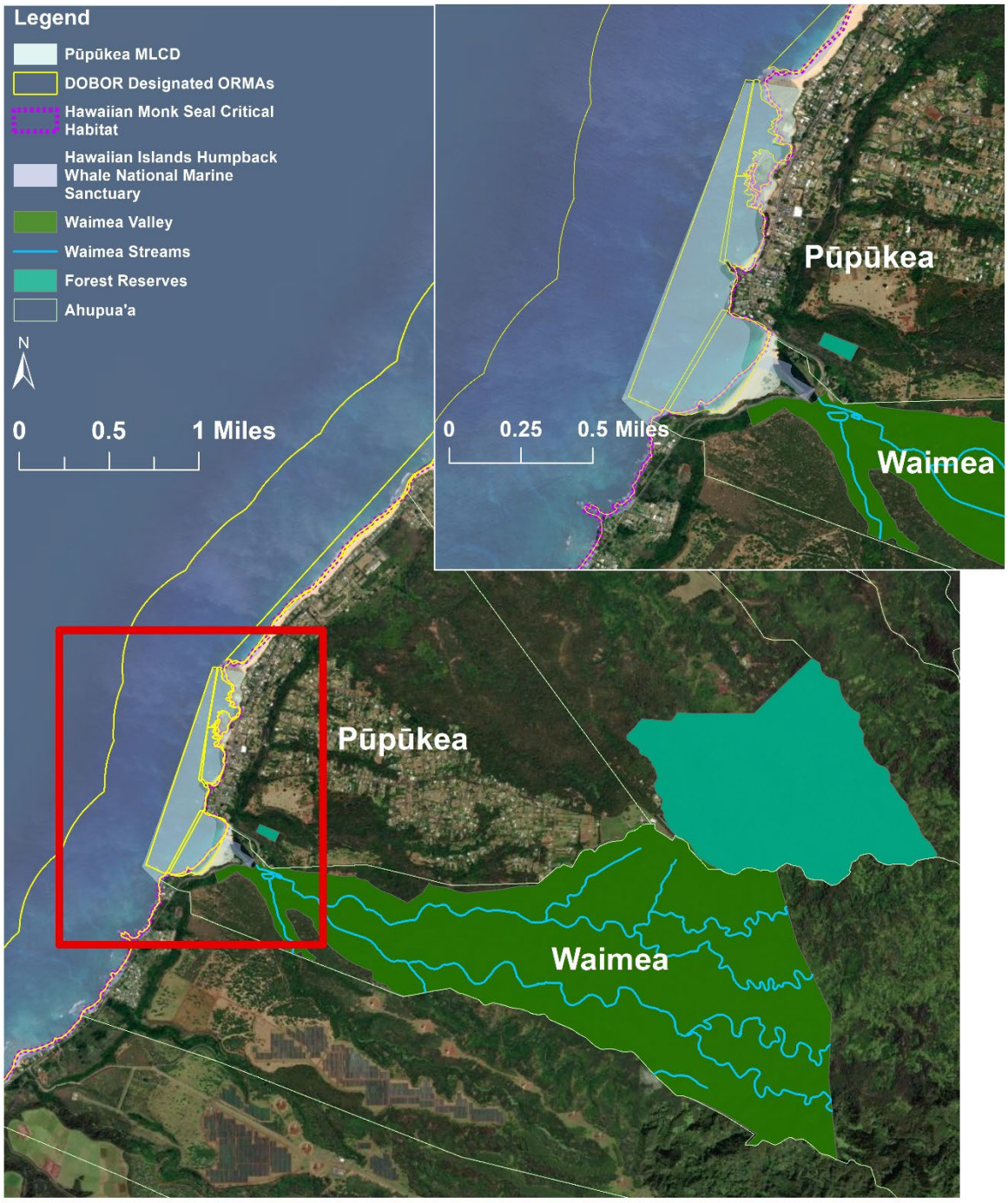



*Figure 2: Map of the Pūpūkea MLCD with interjurisdictional management areas highlighted including the NOAA Hawaiian Island Humpback Whale National Marine Sanctuary, NOAA Monk Seal Critical Habitat, DOBOR designated ocean recreational areas (ORMAs), Waimea Valley and various forest reserves.*

### *Federal*

- The MLCD is included in the federal National Oceanic and Atmospheric Administration (NOAA) Hawaiian Islands Humpback Whale National Marine Sanctuary (Management Plan, 2020[8] (Figure 2).
- NOAA has designated Critical Habitat for Hawaiian Monk Seal around portions of the main Hawaiian Islands. In 2015, NOAA Fisheries Service included the entire marine area of the Pūpūkea MLCD, from Waimea Bay through Kulalua Point (extending to Kahuku shoreline) out to 200-meter depth contour and 5 meters inland from the shoreline[9] as part of the Critical Habitat designation (Figure 2).

### *State*

- Waimea Valley comprises 1,876 acres mauka of Waimea Bay Beach Park. The valley was acquired for conservation, cultural, and recreational purposes in 2006 by the State of Hawai'i, with title held by the Office of Hawaiian Affairs (OHA)[10], through a complex land conservation transaction involving the U.S. Army, the State Department of Land and Natural Resources, the City and County of Honolulu, the Trust for Public Land, the North Shore Community Land Trust, the Save Waimea Valley Coalition, and other community leaders and groups (Figure 2). The State of Hawaii DLNR Legacy Land Program, City and County of Honolulu Department of Land Management Clean Waters and Natural Lands Program, the Trust for Public Land, Hi'ipaka LLC, the North Shore Community Land Trust and the Hewahewa 'Ohana acquired a Conservation Easement of an additional 3.75 acres in Waimea Valley in 2019.
- Under Hawai'i's government structure, water quality, including land-based sources of pollution fall under the responsibility of the Department of Health (DOH). The DOH has created a Water Quality Plan with the goal to "Ensure the protection of human health and sensitive ecological systems by outlining a path to protect, restore, and enhance the quality of waters in the State." The entire DOH water quality plan can be found here: https://health.hawaii.gov/water/files/2019/03/FINAL-DOH-Water-Quality-Plan-2019.pdf

[8] https://nmshawaiihumpbackwhale.blob.core.windows.net/hawaiihumpbackwhale-prod/media/docs/2020-hihwnms-management-plan.pdf

[9] https://www.fisheries.noaa.gov/action/critical-habitat-hawaiian-monk-seals

[10] https://www.oha.org/aina/ainawaimea-valley/; https://www.waimeavalley.net/

- The MLCD is bounded on the mauka side by two non-adjacent City and County of Honolulu Beach Parks: Waimea Bay Beach Park and Pūpūkea Beach Park (Figure 3, Figure 4).

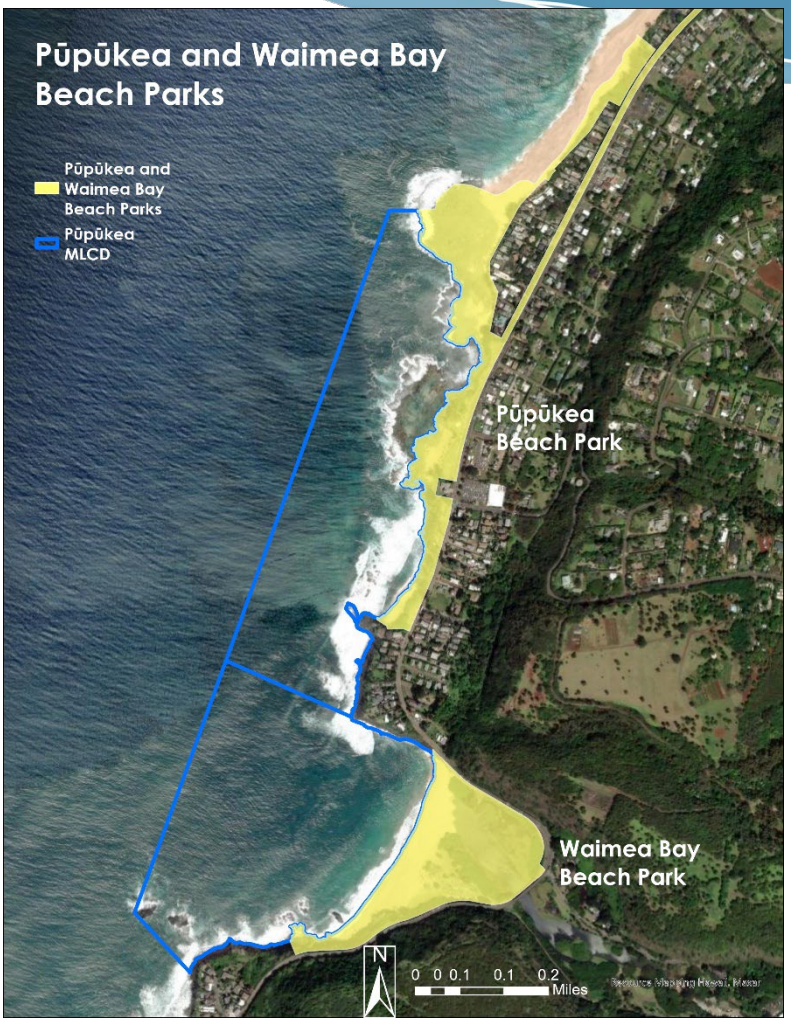



*Figure 3: Map with overview of Pūpūkea MLCD and Honolulu City and County Pūpūkea and Waimea Beach Parks.*

- Pūpūkea Beach Park (Figure 4), which extends further north beyond the MLCD boundary, has an unimplemented master plan[11] focused on the areas adjacent to the MLCD (2015). The Pūpūkea Beach Park has two paved and one unpaved parking areas, and does not have gates or restricted access, other than closed hours at night. The park has a comfort station near Kalua o Māua and one at Kapo'o, with an adjacent outdoor shower. Pūpūkea Beach Park does not have a lifeguard station. A City and County of Honolulu Fire Station is located in the beach park area, mauka of Kamehameha Highway, overlooking the Kapo'o tidepools. In collaboration with the city and other partners, Mālama Pūpūkea-Waimea has installed six interpretive signs about the MLCD and marine life in Pūpūkea Beach Park.
- The issue of visitor safety has been raised by community members that frequent Kapo'o. Now that Hanauma Bay is closed on Mondays and Tuesdays, there have been more novice recreational users visiting Kapo'o, even when ocean conditions are not ideal. There have been some discussions about a First

[11] http://pupukeawaimea.org/wp-content/uploads/Pupukea-Beach-Park-Master-Plan_FINAL_Jan-2015-1.pdf

Responder Center being developed near to Pūpūkea Beach Park. This would allow lifeguards and an Emergency Medical Services Unit with an ambulance to be in closer proximity to the MLCD[12].

- Waimea Bay Beach Park (Figure 4) does not have a master plan. Waimea Bay Beach Park has a paved parking lot that is gated at night, a comfort station, two outdoor showers, and a lifeguard station. Mālama Pūpūkea-Waimea has installed two interpretive signs about the MLCD and marine life in Waimea Bay Beach Park.
- Restrictions on activities in the beach parks are found in the Revised Ordinances of Honolulu (ROH) Chapter 10 and rules promulgated by the Department of Parks and Recreation.[13]

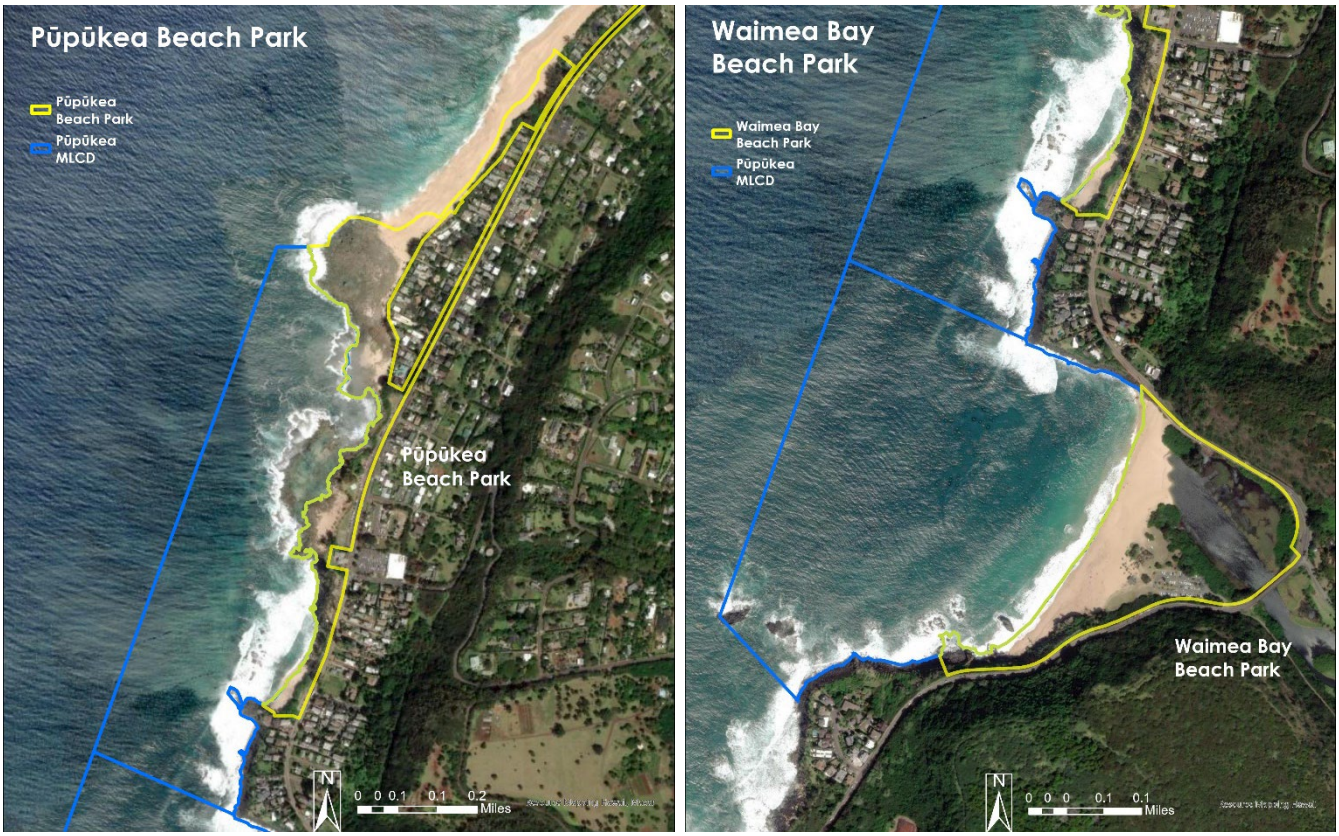



*Figure 4: Maps of Pūpūkea Beach Park (left) and Waimea Bay Beach Park (right) highlighting the adjacent and overlapping boundaries with the Pūpūkea MLCD. Beach park boundaries are outlined in yellow and the MLCD boundaries are outlined in blue.*

[12] Angarone, B. (2023, November 13). Opponents Of Shark's Cove Development Plan Are Pitching An Emergency Services Center Instead. *Honolulu Civil Beat*. https://www.civilbeat.org/2023/11/opponents-of-shark%CA%BBs-cove-development-plan-are-pitching-an-emergency-services-center-instead/

[13] https://www.honolulu.gov/parks/program/182-site-dpr-cat/3850-cityrules-dpr.html

### *Other Agencies*

Other agencies share management responsibility over the lands and waters adjacent to and/or overlapping the Pūpūkea MLCD. These complementary designations highlight the opportunities for partnership, collaboration, and alignment to effectively manage the MLCD.

Other City and County of Honolulu management plans for the area include the North Shore Sustainable Communities Plan[14] (2011, undergoing revision in 2022-2023)[15]; Board of Water Supply North Shore Watershed Management Plan[16]; and O'ahu Bike Plan[17]. The City and County of Honolulu and the State of Hawai'i share responsibility for the O'ahu Metropolitan Planning Organization Regional Transportation Plan[18].

The Honolulu Board of Water Supply developed the North Shore Watershed Management Plan[19], with the aim of balancing the preservation and conservation of O'ahu's watersheds with sustainable agriculture and urban water use. Some of the objectives include preventing erosion and sedimentation and improving nearshore water quality.

The City and County of Honolulu Department of Land Management is responsible for acquiring lands to protect natural environments, important habitats and valued historic and cultural sites. They also develop and implement land management plans, including conservation and stewardship plans.

## Community Stewardship

In addition to the management responsibilities of the state, federal, and local governments, various community groups provide stewardship of the Pūpūkea MLCD or lands contiguous to the MLCD. These groups are important to recognize in the management plan because their contributions help protect the health of the land and waters of the MLCD.

Mālama Pūpūkea-Waimea (MPW) is a community 501(c)(3) nonprofit organization formed in 2005 to replenish and sustain the natural and cultural resources of the

[14] http://www.honoluludpp.org/Portals/0/pdfs/planning/NorthShore/NSSCP_May_2011.pdf
[15] https://www.northshorescp.com/
[16] https://files.hawaii.gov/dlnr/cwrm/planning/wudpoa2016ns.pdf
[17] https://www.honolulu.gov/bicycle/facilities/oahu-bike-plan.html
[18] https://www.oahumpo.org/
[19] https://www.boardofwatersupply.com/bws/media/files/north-shore-wmp-final-2016-12.pdf

Waimea and Pūpūkea ahupua'a for future generations through active community stewardship, education, and public and private partnerships[20]. MPW's stewardship activities at the MLCD include educational programs for preschoolers through college-age youth and adults. The organization's programs develop Hawai'i's future stewards and caretakers by incorporating marine and coastal science, cultural knowledge, and traditional Native Hawaiian kilo (scientific observation) and lawai'a (fisher) practices. In addition, MPW provides public outreach at Pūpūkea Beach Park, with a focus on Kapo'o particularly in the summer months, and at schools and community events throughout the year. MPW has also overseen installation of a series of eight large interpretative signs in collaboration with city, state, and other partners, and launched an Ocean Education Ambassador program in 2022. Since 2014, MPW has restored Native Hawaiian coastal plants to Pūpūkea Beach Park to stem erosion and resulting sedimentation of the reef. To better understand the area and how to manage it, MPW has promoted scientific studies of the MLCD and conditions that affect MLCD health. As a recognized DOCARE Makai Watch program, MPW volunteers also observe and report violations of MLCD rules. MPW conducts other activities related to the long-term health and protection of the MLCD, with community, governmental, academic, and nonprofit partners.

Hi'ipaka LLC, doing business as Waimea Valley, is a 501(c)(3) nonprofit formed by the State Office of Hawaiian Affairs (OHA) in 2007 to manage the valley after the community and key partners secured the transfer of the valley to public ownership after it was threatened by residential and commercial development[21]. Waimea Valley offers numerous recreational, educational and cultural programs for residents and visitors, in addition to providing stewardship of the valley's renowned cultural and ecological resources, including endangered plant and bird species, and managing Kamananui, the major stream that seasonally runs into the ocean at Waimea Bay.

I Nui Ke Aho is a nonprofit cultural organization based in Waialua that maintains and operates a traditional double-hulled Hawaiian sailing canoe, the Wānana Paoa, named for the islets off Waimea Bay, along the North Shore[22]. As stewards of indigenous knowledge and practices involving navigation and marine resources, this community 501(c)(3) nonprofit organization, founded in 2018, offers educational programming about traditional Native Hawaiian navigation and uses Waimea Bay for training and experiential learning programs.

[20] www.pupukeawaimea.org

[21] https://www.waimeavalley.net/about-waimea-valley

[22] https://wananapaoa.org/index.html

Da Hui is a volunteer-run community group. The group conducts one of the largest beach cleanup efforts on the North Shore. An annual event, Da Hui volunteers have targeted Pūpūkea Beach Park and other North Shore beaches for their cleanup efforts[23].

Other active organizations on the North Shore that have contributed to overall community stewardship of the MLCD and adjacent beach parks include the North Shore Community Land Trust, North Shore Branch of The Outdoor Circle, Kōkua Hawai'i Foundation, Junior Lifeguards, North Shore Neighborhood Board, Sunset Beach Community Association, hula halau, Pūpūkea Seniors, Hawaiian Civic Clubs, and the Missions of Sts. Peter and Paul Catholic Church at Waimea Bay.

All these community efforts, whether operating on land or in the ocean, raise awareness about the MLCD and engage community volunteers in caring for the ahupua'a of Waimea and Pūpūkea. Effective management will require continued public-private partnerships among these groups and others that support and encourage community stewardship.

## History of Place

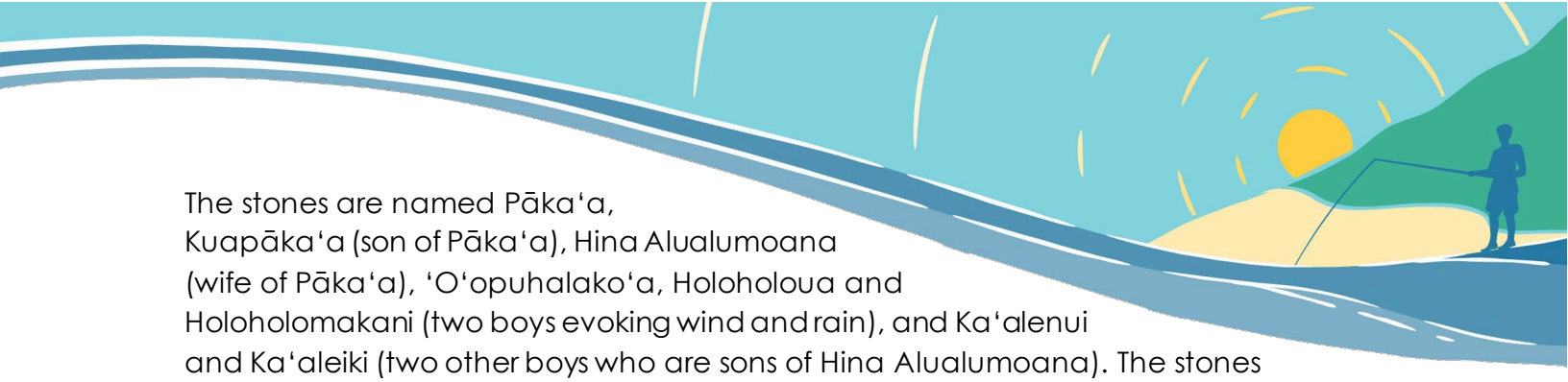
### Ancient History

The names of the places located within and adjacent to the Pūpūkea MLCD speak to its rich history and culture. In the management plan and related materials, DAR will use the traditional Hawaiian names, when known, rather than names created in the modern era. Use of traditional place names not only respects the cultural history of the area, but also provides important biocultural information.

The Pūpūkea MLCD and Pūpūkea Beach Park are named after the ahupua'a in which they are located. Pūpūkea itself refers to a stone used as an octopus lure; it also translates to "white shell" in 'ōlelo Hawai'i (the Hawaiian language). The area is mentioned in 'ōlelo no'eau (traditional Hawaiian sayings or proverbs), especially for its marine abundance.

At the northern end of the MLCD is a group of large calcareous boulders collectively called Nā Ukali O Pele (Pele's Followers). According to the mo'olelo (story), the goddess Pele came across a family watching her from the reef while she was sailing through Pūpūkea. It is said she turned the family to stone so that they might become immortal.

[23] https://www.dahui.com/pages/events



The stones are named Pāka‘a, Kuapāka‘a (son of Pāka‘a), Hina Alualumoana (wife of Pāka‘a), ‘O‘opuhalako‘a, Holoholoua and Holoholomakani (two boys evoking wind and rain), and Ka‘alenui and Ka‘aleiki (two other boys who are sons of Hina Alualumoana). The stones stand 10 to 15 feet high. Associated with this area are two other names: Keauko‘olau, a strong out-going current, and Mailihahe, the sound of laughter and whistling heard in the mountains[24].

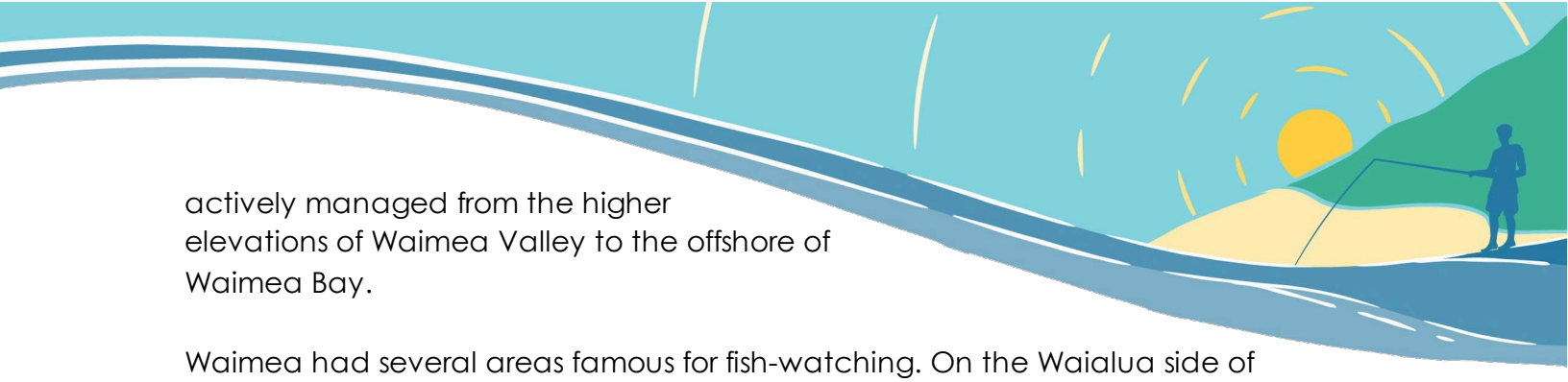
A popular area within the Pūpūkea MLCD is Kapo‘o, the tidepool and cove area, often incorrectly called Sharks Cove. Kapo‘o is translated as “loud echoing sound…as of waves booming.[25]. From October to April, swells bring crashing waves to the seaward ledges of the area, creating explosive displays coupled with thundering booms.

The next main area of the MLCD is Kalua o Māua, often incorrectly called Three Tables. This area received its name from a story about a fisherman’s wife named Māua. She went fishing one night, only to be found later by her husband in the form of a stone floating on the reef. It is said that whenever this stone is “floating” in the form of an exposed, table-like reef, fresh water is bubbling up from the ocean bed. Kalua o Māua translates to the “hole” or “pit” of Māua, referring to the mo‘olelo (story). In times of drought, divers used gourds to retrieve fresh water from the springs flowing out of the ocean floor[17].

Adjacent to Kalua o Māua lies the ahupua‘a of Waimea, which was formed by the erosion of the Ko‘olau volcano[26]. According to Hawaiian historian Sam Kamakau (who was from Waialua on O‘ahu), the ha‘i ‘ōlelo (oral history) of Waimea begins with the high chief Kamapua‘a, who was the kia‘i (caretaker) of lands that begin with the word “wai” (water). This included Waimea, which roughly translates to “sacred waters.” Tradition also states that when Kamehameha took the island of O‘ahu in 1795, he gave Waimea Valley to his Kahuna Nui (high priest) Hewahewa, who chose to live in Waimea Valley. In 1837, Hewahewa died and was buried in the valley.

Ancient Hawaiians managed their natural resources in divisions called ahupua‘a—similar to watershed management that recognizes the direct connection between the land, freshwater, and the sea. Waimea is one of the last remaining intact (undeveloped) ahupua‘a on O‘ahu. The potential to utilize this type of management at Waimea exists because water and land resources are protected as public lands and

[24] Recorded in Sterling, E. P., & Summers, C. C. (1978). *Sites of Oahu*. Department of Anthropology, Department of Education, Bernice P. Bishop Museum, p. 145.
[25] wehewehe.org
[26] Campbell, J. F., & Hwang, D. J. (1982). Beach Erosion at Waimea Bay, Oahu, Hawaii.



actively managed from the higher elevations of Waimea Valley to the offshore of Waimea Bay.

Waimea had several areas famous for fish-watching. On the Waialua side of the bay is a place called Kalakoi, which was used in ancient times to look for fish. A person called a kilo iʻa, or fish spotter, sat on this rock and acted as a spotter for fishers. Located on the Kahuku side of the bay is another famous rock, called Kalaku, used for fish sighting. These fish-spotting areas are also known as puʻu kilo iʻa.

Located on the bluff toward the cliff in Waimea is a large heiau called Kūpopolo. The Kahuna Nui Kaopulupulu built this temple in the 1700s. The aliʻi nui (high chief) of that time was Kahahana. The chief directed the Kahuna Nui Kaopulupulu to construct Kūpopolo to watch out for an attack from Kauaʻi. Kaopulupulu was a great prophet and oracle, but he was unable to "see" a sign of war because he believed the heiau was too low on the horizon. He decided to build a new temple at a higher elevation. This temple, called Puʻu o Mahuka (roughly, "hill of escape"), was built on the cliff on the northern side of Waimea Bay known as Keanaloa. Puʻo o Mahuka is a heiau dedicated to the war god Kū and is the largest luakini (war temple) still standing today on Oʻahu. Today, the restored site is on the register of National Historic Sites and a state park.

Even in ancient times, Waimea was a popular place for heʻenalu (surfing). Ancient Hawaiians also practiced a water sport known as wai puʻuone at Waimea. When large rains caused Kamananui stream to empty into the ocean, Hawaiians rode the standing waves created by that outgoing current. This activity, and heʻenalu, is still practiced at Waimea today.

## Historical Context for Environmental Changes

The Pūpūkea MLCD and its surrounding ahupua'a have experienced many historic events that have affected its nearshore ecosystems and influenced the way these ecosystems look and function today.

In 1779, Captain Cook's ships, the Resolution and the Discovery, landed in Waimea Bay. The ships anchored in the bay after Captain Cook was killed in Kealakekua on the island of Hawai'i. Looking for water, the crew members were the first white men to set foot on O'ahu.

During the 1800s, with the arrival of Europeans and Americans, Waimea Bay became a sandalwood export site. Cargo ships anchored offshore to be loaded with aromatic sandalwood for export to China. By the 1830s, sandalwood began to disappear from overharvesting. The sandalwood trade ended.

In 1898, a flood—likely caused or exacerbated by sandalwood deforestation and cattle grazing—drove the inhabitants from Waimea Valley. Most moved to the beach area and eventually moved away due to recurrent flooding.

The surrounding ahupua'a has experienced great changes from traditional land management, into commercial agricultural development including avocado and pineapple and later into residential and commercial development. In the mid-1900s, sand was mined from Waimea kahakai (beach) to make Waikīkī Beach and other resort areas. This mining exposed a large rock to ocean water, which became the famous jump rock at Waimea Bay, enjoyed by thousands of people every year.

In 1929, C.W. Winstedt was given a contract to build Kamehameha Highway from Waimea Bay to Kahuku. He built a rock quarry in 1930 to produce blue rock gravel. Another area at the shoreline of Pūpūkea was dynamited to make gravel for a road-paving project using excavated coral. This quarry created the 150-foot-wide tidepools adjacent to the existing cove. The tidepools at Kapo'o, a shallow, three-acre, sub-tidal marine pool, are the piko or nursery of the MLCD.

However, stories abound about the modern nickname for the Kapo'o area, "Sharks Cove." One story is about a railroad that used to travel to Kahuku at the turn of the 20th century. According to this story, people riding the train would often see sharks in Kapo'o because cattle carcasses were dumped in the water. According to different versions of this story, the carcasses were dumped either by the train company or by a butcher working across the road from Kapo'o. Another story states that fishers claimed that they

caught sharks when fishing in Kapoʻo.
A third story is that the shape of the cove at Kapoʻo resembles sharks' teeth from overhead.
Although place names can evolve if people create new versions and ideas over time, use of the traditional names shows respect of the cultural context of this special area.

# Contemporary Impacts and Uses

## Contemporary Impacts to the MLCD

Threats to the long-term health and resilience of the MLCD include excessive human use impacts (e.g., trampling of shallow water habitat), illegal harvesting and fishing, natural and human-caused coastal erosion, leaching from sewage disposal systems and showers adjacent to the MLCD, and nonpoint source pollution from the surrounding highway, residential, government, and commercial developments that convey litter, fertilizers, and other chemicals that add excessive nutrients into the nearshore waters of the MLCD.

Some pathways of threats are well understood and documented (e.g., litter, poaching, and erosion). A 2012 geology study commissioned by the City and County of Honolulu of shoreline change around Oʻahu conducted by the University of Hawaiʻi Coastal Geology Group found that the shoreline along Pūpūkea Beach Park was eroding at a rate of up to one foot per year, mainly due to a hodge-podge of dirt paths created by heavy foot traffic [27]. Mālama Pūpūkea-Waimea has also documented erosion hot spots along the MLCD shoreline, particularly at Kapoʻo and Kalua o Māua.

Other threats, such as anthropogenic tracers and coastal erosion, are more complex and require additional research. For example, a 2021 study by Aston Ramos and Dr. Henrietta Dulai indicated that water quality in the Kapoʻo tidepool could be affected by the comfort station at Pūpūkea Beach Park[28] through the leaching into the water of

[27] Fletcher, C.H., Romine, B.M., Genz, A.S., Barbee, M.M., Dyer, Matthew, Anderson, T.R., Lim, S.C., Vitousek, Sean, Bochicchio, Christopher, and Richmond, B.M. (2012). National assessment of shoreline change: Historical shoreline change in the Hawaiian Islands. U.S. Geological Survey Open-File Report 2011–1051, 55 p. (Also available at http://pubs.usgs.gov/of/2011/1051.). The study found that 73% of North Shore beaches were eroding in the long-term and 68% eroding on the short term.

[28] From a presentation by Dr. Henrietta Dulai on September 22, 2021 – Ramos, A. and H. Dulai. (2021). Submarine Groundwater Discharge and Related Contaminants in Shark's Cove Kapoʻo Tide Pool. University of Hawaiʻi at Mānoa, 9 p.

compounds such as ibuprofen and caffeine from human sources. Pinpointing the sources of these compounds and assessing the threat to marine life are key steps toward management solutions.


*Figure 5: Map from City and County of Honolulu Honolulu Land Information System – HOLIS, overlaid with areas/sources of drainage discharge. For a more detailed view of each area, please see Appendix 8.*

Stormwater drainage also affects MLCD ecosystem health. Several storm drains empty into the MLCD nearshore waters off Pūpūkea Beach Park (Figure 5). Hakuola Gulch drains a portion of Pūpūkea Gardens subdivision into the Pūpūkea MLCD through an open culvert that empties onto the rocky shoreline south of the fire station under the bike path bridge. A second storm drain on the north side of the fire station that discharges from an open culvert to the sand and nearby tidepools conveys the runoff from the Foodland parking lot (across Kamehameha Highway from the MLCD), the fire station parking area, and the driveway of the adjacent Hanapohaku commercial properties. Another storm drain discharges onto the shoreline from the Ke Iki Road residential area near Kulalua Point. Finally, natural surface runoff from Pūpūkea to the first house into Waimea Bay and a storm drain system adjacent to Kamehameha Highway on the Waialua side of Waimea Bay Beach Park empties into Kamananui at the Waimea Bay Beach Park parking lot.

The storm drains, under the jurisdiction of the City and County of Honolulu, Department of Facilities Management, do not have any management or control systems in place to mitigate pollution into the MLCD. Studies of storm water impacts on the MLCD are needed particularly given that residential population in the area has substantially increased (doubling from 1970 to 2000, two decades ago) as well as tourism and

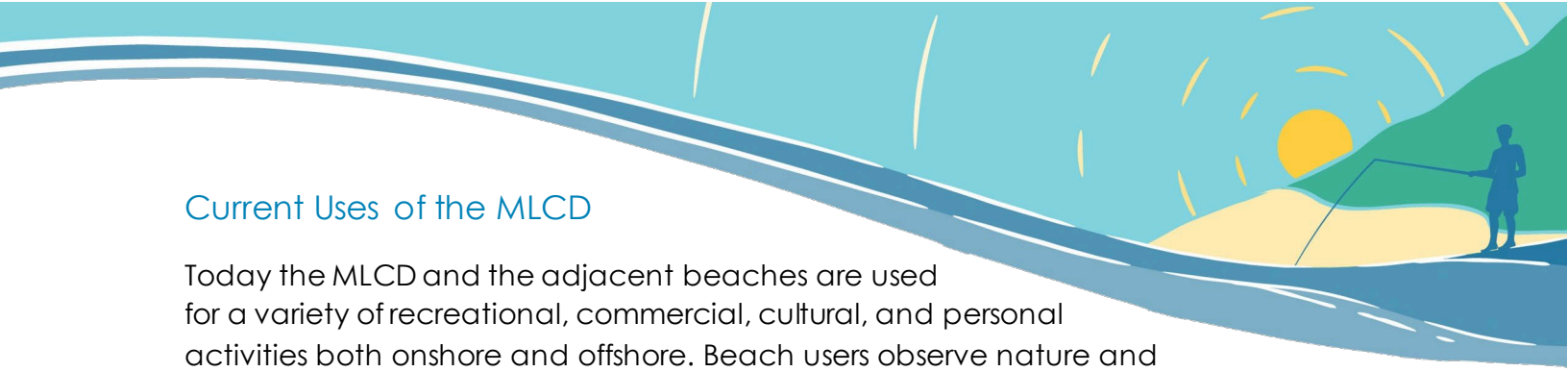
commercial activities, all likely contributing to increases in land-based pollutants conveyed through the stormwater system[29].

Another significant pathway of threats to the MLCD is direct physical impacts from human activity that occurs when users intentionally or innocently come in contact with marine life, change the behavior of species, or trample on habitat or benthic species (e.g., coral, limu, sea cucumbers) when walking, wading, swimming, snorkeling, and diving. Surveys of residents and other stakeholders have expressed concern over improper uses of the area including harassment of marine life, trampling of coral and algae, and lack of awareness and violations of regulations. Residents have voiced concern that record-high levels of visitors are contributing to degradation of resources including fish abundance and coral health. Mālama Pūpūkea-Waimea gathered information about current uses of and impacts to the MLCD by conducting two surveys, interviews of long-time local community members, and two community meetings (one virtual, one in person). The results from those community engagement efforts are presented below ("Community Engagement in Management Planning").

A key factor in understanding and managing these and other threats is that the MLCD has no controlled or limited entry from land or water. People can access the MLCD without any management restrictions (other than nighttime parking lot closures) along its entire length. Numerous designated and undesignated pathways are abundant along the highway, parking areas, and shoreline except for the small residential area between Waimea Bay and Kalua o Māua. The lack of "pinch points" or controls means that no management measures are in place to control the number of people in any particular area of the MLCD at any time.

In response to these issues, the State Legislature passed Act 31 (2022 session), the "Pūpūkea Marine Life Conservation District Carrying Capacity Program," under the direction of the DLNR, "to assess the carrying capacity of certain areas in the Pūpūkea marine life conservation district in light of threats to marine life from human use; monitor, document, and assess the effectiveness of mandatory and voluntary kapu, or closures, of high-traffic areas in the Pūpūkea marine life conservation district and other restrictions on access to these areas, including the imposition of fees; and propose long-term management options to reduce the impact of humans on the health and abundance of marine life in the sensitive areas of the Pūpūkea marine life conservation district" (Act 31, p. 6).

[29] United States Department of Agriculture, Natural Resources Conservation Service. 2009. Rapid Watershed Assessment North Shore Watershed, O'ahu, Hawai'i Hydrologic Unit Code (HUC) – 2006000001.



## Current Uses of the MLCD

Today the MLCD and the adjacent beaches are used for a variety of recreational, commercial, cultural, and personal activities both onshore and offshore. Beach users observe nature and marine life, enjoy the water, exercise, gather with families and friends, explore the shoreline, sunbathe, picnic, jump off rocks, walk and cycle along the beaches, do volunteer work, meet with co-workers, engage in photography and art, and celebrate special events. Residents and visitors use the nearshore area for a range of water activities—primarily wading, swimming, snorkeling, SCUBA, kayaking, standup paddleboarding, bodyboarding, bodysurfing, surfing, boating, fishing at Waimea Bay, and other water sports. Restricted by City and State permitting requirements, various commercial uses, include primarily SCUBA, snorkeling tours, equipment rentals, boat tours, seasonal take of ʻōpelu and akule at Waimea Bay, swim and surf contests, and van tour rest and photo stops. Cultural uses include kilo (observation), legal gathering of limu, traditional canoe paddling and sailing, family events, and educational events. Lifeguards, surfers, and military often use Waimea Bay for physical and skill training.

Users frequent four major swimming areas within the MLCD: Waimea Bay, Kalua o Māua (Three Tables), the tidepools, and Kapoʻo (Sharks Cove). Kapoʻo/Pūpūkea is one of Oʻahu's most popular SCUBA destinations, with an abundance of marine life, high rugosity, caves, and significant habitat variation. At the mouth of the cove, depths are in the range of 20 feet, increasing to about 45 feet outside the cove. Waters around the "tables" at Kalua o Māua are about 15 feet deep, increasing to 30 to 45 feet beyond the reef. Waimea Bay is a well-known swimming and surfing destination. In the summer, the bay is flat and frequented by swimmers of all abilities. In the winter, the large swells attract recreational and professional surfers, including world-renowned surf competitions such as the Eddie Aikau.

Both Pūpūkea and Waimea Bay Beach Parks experience high visitor usage, from hundreds to thousands of visitors each day, all times of the year. The beach parks have bus stops, parking lots, park benches, signage, restrooms, and showers for public use. Waimea Bay has a lifeguard tower; Pūpūkea does not. The two beach parks provide public access to the MLCD shoreline makai of Kamehameha Highway. Connected by Kamehameha Highway, informal pathways, and portions of the Ke Ala Pūpūkea Bike Path, the two beach parks are separated by a residential area between Kalua o Māua and Waimea Bay, where the bike path currently ends.

## User Groups and Activities within the MLCD

When considering management strategies, it is important to consult with the diverse stakeholders that interact with the area and consider the various activities that occur within the area, the potential impacts (positive and negative) of those activities on the environment and the potential impacts of management action. The following list may serve as a checklist for community engagement and considerations when management actions are being planned, scoped and implemented. Some of these sections include shoreline activities and while these activities may take place beyond the boundaries of the MLCD, they may impact the nearshore ecosystem and require considerations in strategic management planning and thus are included in this list.

**a. Traditional and customary Native Hawaiian practices**

- ʻOli, mele, moʻolelo
- Kilo (observation)
- Education (MPW's Ka Papa Kai and Lawaiʻa Pono programs)
- Limu gathering (allowed under HAR)
- Hawaiian sailing canoe (I Nui Ka Aho)
- Surfing using traditional methods

**b. Fishing/harvesting: Limited legal take per regulations**

- Commercial surround net fishing for ʻōpelu (August and September), and for akule (November and December) in Waimea Bay only
- Noncommercial hook and line fishing for "finfish" per current rules and regulations
- Common/top species: ʻoama, ʻōpelu, halalū, pāpio/ulua, lae, ʻōiʻo, awa, kawakawa—in Waimea Bay only
- Hand-harvest of limu kohu and limu lipeʻepeʻe

**c. Resident recreation and tourist (non-commercial/ recreation), land-based activities are in italics.**

- SCUBA diving
- Snorkeling
- Swimming
- Surfing
- Bodysurfing
- Boogieboarding
- Wading
- Standup paddleboarding
- Jumping off the "rock"
- Water polo "shootout"
- *Basketball*
- *Sunbathing*
- *Exercise*
- *Lifeguarding*
- *Family and community gatherings*
- Sightseeing
- Photography (underwater, drone, social media, special events)
- Volunteer programs (MPW)
- In-water debris removal
- Marine science projects
- Coastal restoration/native planting

**d. Commercial/tour activities**

- Surf/Watersports (swimming/paddleboarding) competitions and events
- SCUBA diving
  - Boat-based and shore-based, guided
  - Clubs
  - Rental of equipment
- Snorkel tours
  - Boat-based and shore-based, guided and unguided
  - Rental of equipment
  - Unofficial mooring during the summer offshore of the fire station (e.g., by catamaran)
- Freediving APNEA courses
- Photography (surf, underwater, special events)
- *Weddings*

**e. Boating**

- Day boating in Waimea Bay
- Mooring overnight in Waimea Bay
- Boat sightseeing tours through MLCD
- Boat SCUBA and snorkel tours, temporary mooring
- Kayaking
- Jet skiing offshore

## Community Engagement in Management Planning

In developing the management plan, DAR worked with Mālama Pūpūkea Waimea to consult with the community adjacent to the Pūpūkea MLCD about key issues such as history, cultural context, current ecological condition, human use, and management needs. This community engagement process occurred over a one-year period, with expert interviews, community input meetings (by Zoom and in-person), surveys, an on-site visit, and updates through social media and public meetings of the North Shore Neighborhood Board and Sunset Beach Community Association. This section summarizes the scaffolded six steps of this process.

From October 2021 to January 2022, MPW contracted with two cultural research experts to interview long-time community members, starting with kūpuna, about their relationship to the MLCD and its management. MPW used the information from these interviews to inform the development of an electronic survey. From January to February 2022, using SurveyMonkey, MPW disseminated the survey to the North Shore community through MPW's social media, the North Shore Neighborhood Board, and the Sunset Beach Community Association (SBCA) mailing list. Open for three weeks, the survey garnered 45 responses (15 from the SBCA outreach and 30 from social media). Next, in October 2022, MPW held a facilitated online community forum attended by 28 participants, advertised through social media, to gather more community input for the management plan. Also in October 2022, MPW hosted a two-hour "walk story" on-site at the MLCD for a group of 10 community members interested in further discussion. As the final step in this phase of community engagement, on November 5, 2022, MPW hosted a facilitated community meeting in person in Waimea Valley, with approximately 30 attendees, to gather additional community ideas.

Participants in the online and in-person community meetings were North Shore community members. Announcements and updates throughout this phase were provided by MPW to the SBCA and NSNB as well as social media. A DAR representative attended both community meetings, which were organized and hosted by MPW and facilitated by a North Shore community member employed by Hawai'i Sea Grant and North Shore Community Land Trust. In total, over 139 people were consulted during this community engagement process, providing valuable input and expressing a strong interest in continued involvement with the Holomua marine management plan process.

## Participants

The combined efforts of interviews, surveys, and community meetings primarily reached North Shore residents. Twenty-three interviewees were North Shore residents, while three were government agency personnel. All 68 community meeting participants were North Shore residents. As indicated in Table 1, of the 45 survey respondents, 73% lived in North Shore communities, 9% lived in Honolulu in what is considered "town," 11% lived elsewhere on O'ahu, and 2% lived outside of Hawai'i. Two people (4%) did not identify their residence.

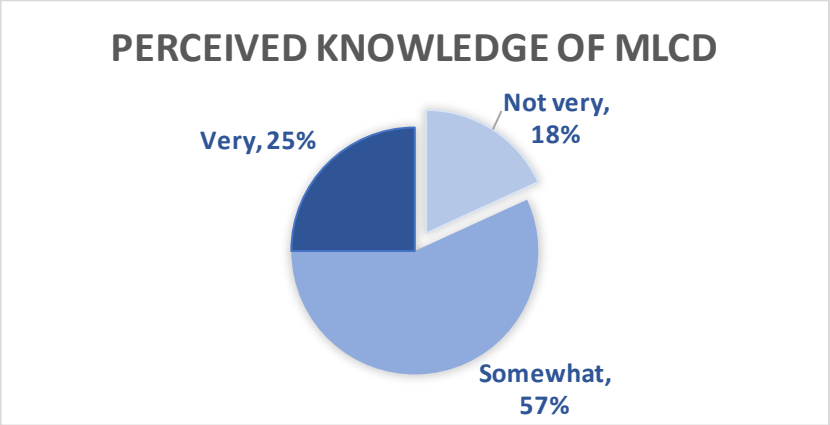



*Figure 6: Perceived knowledge of the MLCD*

*Table 1: Combined Online Survey Results – Residency of Respondents*

| | |
|---|---|
| Pūpūkea/Waimea | 29% |
| Sunset Beach | 22% |
| Waialua | 9% |
| Waiale'e | 7% |
| Hale'iwa | 7% |
| Honolulu "Town" | 9% |
| Elsewhere on O'ahu | 11% |
| Not in Hawai'i but visit | 2% |
| NA | 4% |

As indicated in Figure 6, of the 45 survey respondents, 82% said they were very or somewhat knowledgeable about the MLCD. North Shore residents were more likely than residents of other areas to say that they were very or somewhat knowledgeable about the MLCD.

## Sources of Information

MPW asked how respondents learn about the MLCD in order to more efficiently target outreach information to the community. Survey respondents said they learn about the MLCD in various ways. 43% said they learn about the MLCD from personal use and observation, while 38% said they learn from family, friends, and neighbors. Fewer (24%) said they learn about the MLCD from social media or the internet, with Instagram and Facebook specifically cited, and with MPW's social media and the North Shore Community Hub (a Facebook page) also specifically cited. 21% named MPW as a source of information (respondents from the SBCA were more likely to name MPW than was the general community). 17% named local news and community meetings, with the SBCA and North Shore Neighborhood Board specifically cited (this was especially true for the SBCA survey).Five people each named site-based signage and personal research as sources of information. Finally, one person each said they learn about the MLCD from the DLNR, mo'olelo (traditional stories), school, and community meetings.

## Community Use of the MLCD

MPW asked how community members use the MLCD. Survey respondents said they most regularly used the MLCD for its beaches and water-based activities. Most respondents did *not* regularly use the MLCD for boating or fishing. Figure 7 provides more details.

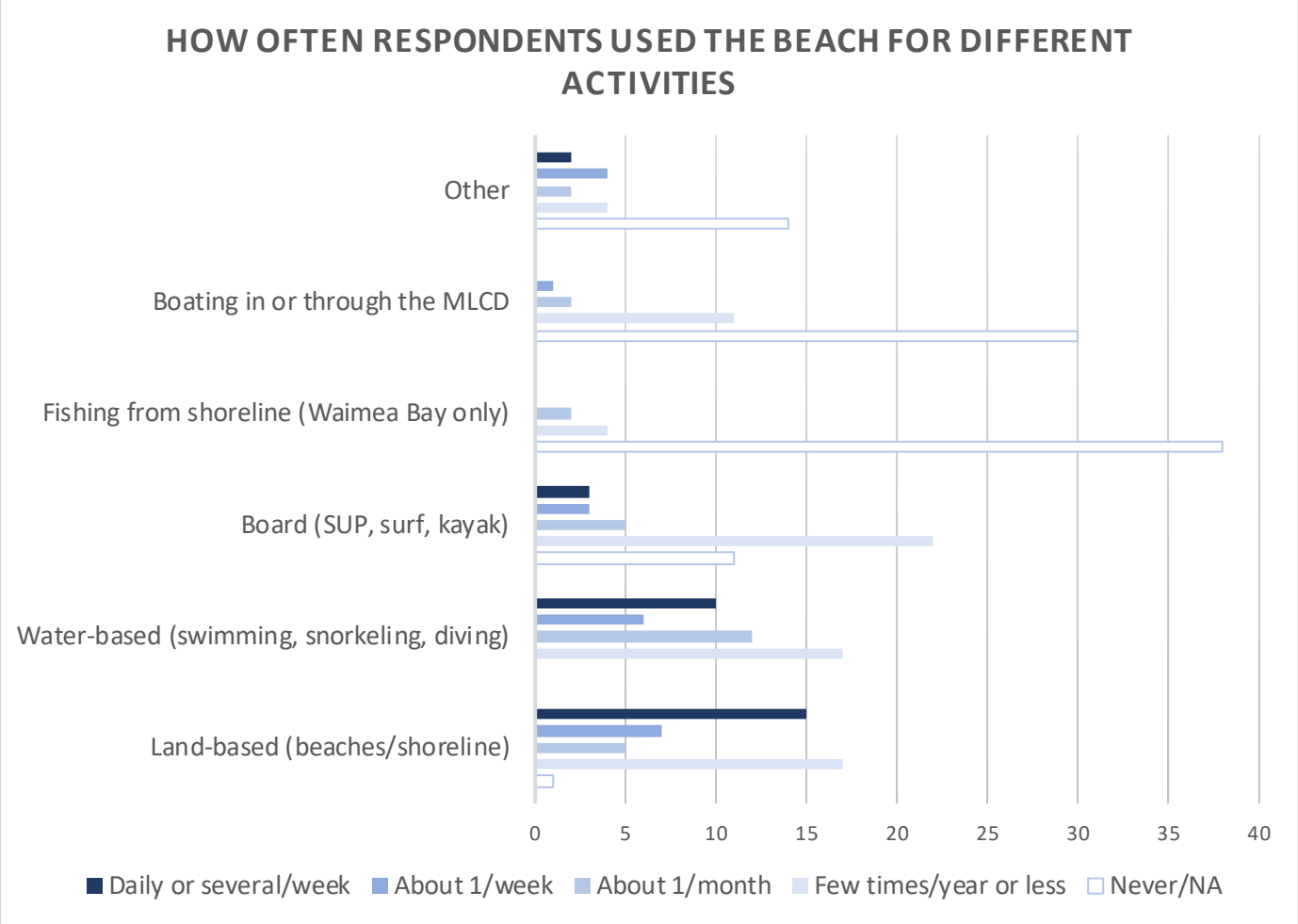



*Figure 7: Use of the MLCD by Community Members*

## Community Member Concerns

To better understand community concerns and desires for the MLCD, MPW asked community members to share observations about abundance and scarcity in the MLCD. Long-time residents indicated they see more fish and other marine life in the area compared with the time before the MLCD was created, and others commented about the distinct difference in marine life abundance within the MLCD compared with areas outside the MLCD. At the same time, some residents expressed concern about a decrease in fish populations and limu, in addition to changes in the type of marine life (for example, more jellyfish).

Overall, community residents communicated a sense of grief over loss of access to a place with which they have a relationship, and they were interested in regaining access. Residents were highly concerned about how crowded the area is, especially due to increased tourism, "terrible" parking and traffic, and "masses of tour groups." Some spoke about taking their children to the area years ago but not being able to take their grandchildren due to the crowds. Others were concerned about specific types of activities people engage in at the MLCD, mentioning trampling of coral and other substrate surfaces, fish feeding, and "divers using underwater scooters through dolphin pods." Overuse and inappropriate human uses of the area were the top concerns discussed by community members.

> *I used to take my children, and later grandchildren to Sharks Cove to snorkel on a regular basis. Now, there are too many people, and often the water is not as clear. Also, the parking lot is chaotic.*
>
> *– Community member*

In addition, community members voiced concern about a decline in water quality from high human use, saying that they can sometimes see a noticeable sheen of sunscreen on the water's surface and smell urine. One long-time resident reminisced that she used to smell salt when at the MLCD, and she now smells sunscreen. Residents were concerned about water quality impacts from coastal development, rubbish, and "freshwater input and the amount of nutrients coming into the MLCD through those sources."

> *It's turned into a total tourist destination that locals are desperately trying to protect and preserve.*
>
> *– Community member*

Additional concerns included the impacts on the MLCD health of shoreline fishing and commercial netting (allowed in Waimea Bay during certain times of the year), climate change, coastal erosion, and coastal development. Several respondents, especially from the SBCA survey, were concerned about the food trucks and other commercial development across the highway from the

MLCD as a source of pollution, increased tourism, parking issues, beach park comfort station decline, and safety issues.

*My mother's family is from Waialua and I was raised in Wahiawa, so I spent a lot of time in the area from Mokule'ia to 'Ehukai swimming, diving, surfing, and fishing as a youth. Of course, the ocean and the roads are a lot more crowded than it was in the 60s and 70s. I can remember halalu and 'oama runs that were 10 times bigger than they are now. There seems to be less limu in the area. Ironically, in recent years and especially since the Covid lockdowns, I've seen a lot more large sea creatures like dolphins, sharks, turtles, rays, and seals in the area. During the lockdown, I saw paku'i and Kona crabs in Waimea Bay that I'd never seen before.*

*– Community member*

## Community Members' Ideas for Changes

*Typically, the only time I notice local families there anymore is when they're volunteering with MPW. It used to be a spot for local families to spend the day with their families. That's a rarity now due to the overcrowding by tourists.*

*– Community member*

When asked what types of changes they want to see, most community members said they would like to see limits on access and use, including additional regulations on commercial use. Some suggested hours set aside for local use, with one person recommending a special resident use permit to bring locals back to the MLCD's beaches.

Some respondents urged a fee-for-use system or paid parking, with funds directed to MLCD management and site-based outreach and education. A lot of support was voiced for continued and increased education and outreach at the MLCD, supported by public funds. Several commenters urged improved signage and environmental interpretation information to inform the public around the clock.

Some community members spoke about the need for infrastructural changes, including moving the parking to an area across Kamehameha Highway, building a lookout area with environmental interpretation, and establishing a clear pathway or boardwalk from parking to the beach to prevent erosion. Others wanted scientific studies to fill gaps in scientific knowledge about the MLCD. Still others wanted additional or dedicated officers from DLNR Division of Conservation and Resources Enforcement (DOCARE) to enforce against violators of the MLCD rules and reduce poaching. Several people discussed their desire to expand the MLCD or enact more protections, including removing the current allowances for fishing in Waimea Bay.

On the other hand, some respondents wanted rules to be relaxed to allow spearfishing. Some Native Hawaiian community members advocated for a more traditional Native Hawaiian management approach with adaptive harvest so that once a certain species reached a state of abundance, it could be harvested under Native Hawaiian gathering practice and protocol.

*It's more crowded, yes, but also, there's way more pressure and people trying to put rules on the place. It feels sometimes like too many rules, especially when enforcing the rules isn't consistent.*
*– Community member*

Input from the North Shore community through the interviews, surveys, and meetings was used to inform the goals, objectives, and activities for this management plan. Continuing community engagement will be important for plan implementation as effective management relies on community compliance with rules, support for management, and collaboration.

*During the summer, I snorkel in the area a few times a week. I have seen the coral on the shelf on east side of Three Tables get trampled by the tourists from the commercial boat that ties up there every day. It's such a bummer to encounter that tour with all the tourists walking around on the shelf and trampling the coral…I clean up fishing gear from the east end of the MLCD every time I go. And I cringe at all the people walking around the tidepools all year. I would like to see the number of visitors limited and everyone be charged for access. The funds collected could go back into enforcement and restoration within the MLCD.*
*– Community member*

## Environmental Setting of the MLCD

Effective management of the Pūpūkea MLCD needs to be based on a thorough understanding of the area's environmental setting and conditions, both terrestrial and marine. A primary aspect of the setting that affects all management strategies is the extreme seasonal variation in the wave regime. Situated on the North Shore of O'ahu, the MLCD experiences little to no wave action in summer and turbulent surf breaks, high surf, and strong currents in the winter due to the North Pacific swell. These seasonal changes directly affect both the environmental conditions and the human use of the area, in complex and site-specific effects, and are key to understanding appropriate management options.

A 2022 literature review by Mālama Pūpūkea-Waimea of scientific studies of the Pūpūkea MLCD synthesized information from six biological studies of the tidepools at Kapoʻo (1975-2021), nine fishery-focused studies of or including the Pūpūkea MLCD (2007-2020), and eight non-fishery studies of or including the Pūpūkea MLCD (2003-2021)[30]. These studies provided information about the environmental setting and condition of various ecological characteristics of the MLCD over a span of 46 years. (The review is included as Appendix 6.) The environmental setting information below is derived from many of these studies. Some of the key conclusions from the scientific research in this literature review include:

> Fish, invertebrates, and limu in the MLCD tend to be rich in diversity and abundance; the Tidepools act as a "nursery" for the MLCD; the MLCD provides spillover to the outer unprotected areas; human use in the area has increased drastically over time; human presence changes fish behavior; visitors often come into destructive contact with the reef; the Tidepools receive substantial submarine groundwater discharge; and terrestrial mauka (upland) sources of pollution, from commercial development and the beach shower and wastewater, pose threats to the Tidepools.

## Distinctive Ecological Features

- The northern boundary of Pūpūkea MLCD features steep drop off, excellent water clarity, and high rugosity
- Papakahāohina located on the North side of Kapoʻo is an intermittently exposed papa (reef flat) where more than 40 different varieties of limu can be found seasonally (see Appendix 6).

**Rugosity:** Measurement of the surface roughness/ complexity routinely used by coral reef biologists. For example, areas with mostly sandy substrate would have relatively low rugosity whereas reefs would have relatively high rugosity. Habitats with greater structural complexity generally have a greater diversity of species. Healthy coral reefs generally have high rugosity, which provides ample habitat for reef organisms and areas for new corals to settle and grow.

Limu is important to the Hawaiian diet and cultural practice, in addition to its

[30] Jones, E.S., Mālama Pūpūkea-Waimea (2021) Mālama Pūpūkea-Waimea Literature Review: Reports and Publications in the Pūpūkea MLCD from 1975-2021.

critical role in ecological health throughout the life cycles of different marine animals

- Kapoʻo cove includes features such as submarine caves, arches, shelves, and large boulders, creating unusually high rugosity.
- Kapoʻo tidepools are a shallow, protected, three-acre coastal embayment within the Pūpūkea MLCD. Although created as a result of dynamiting for coral and rock rubble in the 1930s, Kapoʻo has dynamic flushing from the adjacent areas of the MLCD as well as calm protected zones and a fringing rock "wall" has become an important nursery and habitat for the MLCD. Appendix 5 highlights species found within the tidepools.
- The steep limestone vertical walls are punctuated by the cove that run from Kulalua Point to the fire station, creating topography and features that create unique opportunities for marine recreation, like underwater archways and caves. Near Kalua o Māua there are some popular SCUBA diving spots and Rubber Duckies surf spot, the only surf spot within the MLCD outside of Waimea Bay.
- Kalua o Māua, which has the papa, substantial reef "tables", features freshwater springs bubbling up from beneath the substrate. Freshwater infusion affects marine habitat and marine life, and the springs were used by Hawaiians during times of drought as a source of fresh water.
- Waimea Bay has a unique wave regime in the outer bay that is world renowned. The sand bottom within Waimea Bay and scattered throughout the MLCD provides important habitat for marine species such as goatfish, akule, and ʻōpelu. This area is flat in the summer and is a popular recreational spot, including a jump rock. This section of the MLCD also features a river mouth and expansive boulder habitat and cliffs to the south.
- Wānanapaoa Islets represent the southern boundary of the MLCD and features steep rock faces. These rock faces attract abundant marine life, including both reef-associated and pelagic species.

## Distinctive Socio-Cultural Features and/or Practices

- Nā Ukali o Pele at Kulalua Point (described under "History of Place")
- Makapāpipi (salt pans) at Kapoʻo near Papakahāohina reef flat and Kulalua Point
- Freshwater springs and freshwater gathering, including at Kalua o Māua (as described above)

- Harvesting of limu kohu and limu lipe'epe'e (allowed with limits under current MLCD regulations)
- Cultural/historical sites in Waimea Valley (many described under "History of Place")
- Heiau and ahu near the area (described under "History of Place")
- Standing wave surfing at Waimea (described under "History of Place")
- Traditional sailing canoe, Wānanapaoa, made possible by a local nonprofit organization, I Nui Ke Aho, named after the Wānanapaoa Islets.
- Various sites within MLCD used for pule and ceremony.

## Benthic Structure and Biological Cover

The benthic structure in the Pūpūkea MLCD is mainly composed of pavement, sand, and rock and boulder (see Appendix 1 for categories and descriptions for benthic structure). Pavement makes up the largest percentage (37%, 261,707 m$^2$) of benthic structures within the MLCD. Pavement includes rock that is covered with macroalgae, coral, and other non-mobile invertebrates. Sand makes up the second largest structure and is found mainly in the Waimea Bay portion of the MLCD. Sand covers just over a third of the MLCD (34%, 236,111 m$^2$). On the shoreline, sand is eroding at

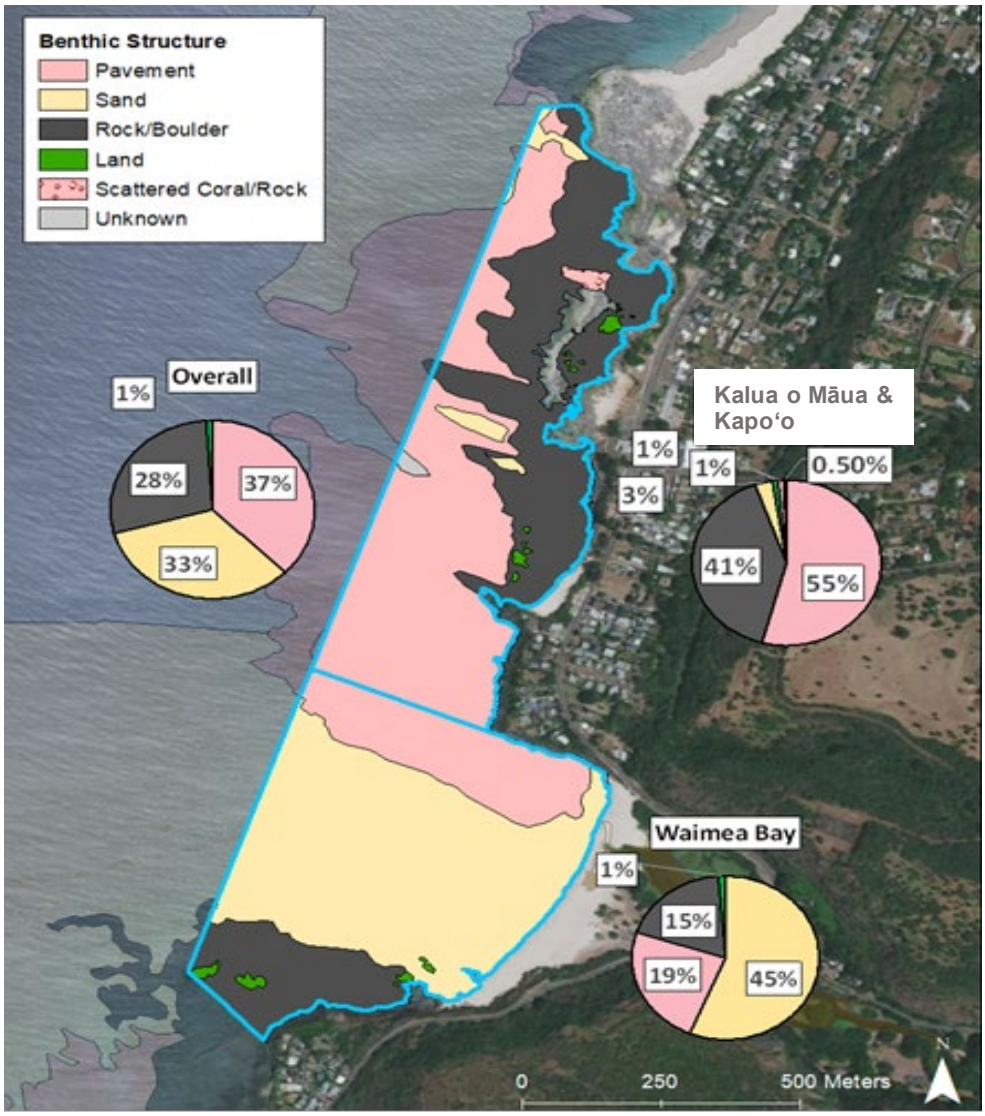



*Figure 8: Map of the distribution of habitat types within the Pūpūkea MLCD.*

approximately one foot per year[31].
Less than 1% of the cover is comprised of land (5,423 $m^2$), scattered corals (2,727 $m^2$), and unknown (1,703 $m^2$).

Focusing on sub-sections of the MLCD, pavement composes more than half (55%, 191,987 $m^2$) of the total area, whereas rock and boulder take up two-fifths (40%, 143,145 $m^2$), and sand takes up about 3%, or 9,403 $m^2$ of the Kalua o Māua and Kapoʻo sections, respectively. Scattered coral (2728 $m^2$) and land (2521 $m^2$) and unknown (1704 $m^2$) still make up less than 1% of the sub-sections of Kalua o Māua and Kapoʻo each. In both the Kalua o Māua and Kapoʻo areas, pavement is the most dominant structure, providing hard substrate that may encourage coral or limu growth. Rock and boulder habitat is the second major benthic structure that could provide favorable habitat for some fish, but may have less coral growth than the pavement structure.

In the Waimea Bay section, most of the benthic structure is sand (65%, 226,604 $m^2$). A strip of pavement on the northern, or right side of the bay that accounts for a fifth of the benthic structure (20%, 68,325 $m^2$). A lesser amount of rock and boulder (15%, 52,686 $m^2$) flanks the left side of the bay. Land makes up less than 1% (2906 $m^2$).

The substrate of the Pūpūkea MLCD is renowned for its rugosity, including large boulders, reef flats, and hard rock with sand patches. The Kapoʻo cove features multiple submarine caves ranging from 20-foot depth at the cove's mouth to 45-foot depth outside the cove and dynamic upwelling areas on the reef shelves. Kalua o Māua features many ledges, arches, and remnant lava tube structures near the "tables" or exposed sections of reef. The tables are remnants of basalt and carbonate cobble overlying the carbonate platform in the subtidal area adjacent to the beach. The surrounding shoreline consists of eroding limestone formations overlaying basalt. Waimea Bay is primarily sandy bottom, with large boulders clustered on either side of the bay and at each seaward point. The sand throughout the MLCD is particularly high quality, with large particles, making it coarse to very coarse and poorly sorted. This carbonate sand (high content of calciferous algae, coral, and shells) has very little terrestrial material (low sediment), which provides high water clarity and recreational enjoyment.

This turbulent winter environment of the Pūpūkea MLCD results in a general coral cover of 10% and a diversity of wave-adapted species. According to a Hawaiʻi Coral Reef

[31] Coastal Geology Group in the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawai'i. 2021. Hawai'i Shoreline Study. Retrieved from https://www.soest.hawaii.edu/crc/index.php/hawaii-shoreline-study-web-map

Monitoring & Assessment Program (CRAMP) study (last updated in 2008)[32], the benthos of the MLCD is composed primarily of encrusting species such as *Leptastrea purpurea, Pavona varians,* and *Montipora flabellate*, and wave-resistant species such as *Porites lobata* and *Pocillopora meandrina*. Rare corals, such as *Montipora studeri,* have also been identified in the area. For a comprehensive list of species identified through various monitoring programs in the MLCD, please refer to Appendix 5. Certain more sheltered areas of the MLCD, such as Kalua o Māua and parts of Kapoʻo cove, exhibit higher coral cover and diversity, but corals can also be found in the deeper waters of the MLCD. Waimea Bay features some coral growth at depths of 20 feet off the rocky points on each side of the bay.

## Other Marine Life

The complex substrate and extreme seasonal changes affect the marine life that thrive in the Pūpūkea MLCD and affect the ability of scientific studies to document biological diversity on a year-round basis. Over the past decade, longitudinal and other studies have documented an extensive list of species within the MLCD (see Appendix 5) including species of:

- shellfish (ʻopihi, pipipi, pu ʻolēolē, ʻopae)
- seaweed (limu)
- sea cucumber (loli)
- nudibranchs
- sea urchin (wana, hāʻukeʻuke, haʻukeʻuke ʻulaʻula, hāwaʻe)
- eel (puhi, puhi kāpā, puhiʻoniʻo)
- goatfish (kūmū, moano, weke pueo)
- surgeonfish (palani, maʻiʻiʻi, ʻapi, pualu)
- other reef fish (humaumau, puʻu olaʻi, kala, nakea, nenue, humuhumunukunukuapuaʻa, hīnālea lauwili, hinalea ʻakilolo, manini, kihikihi, awela, kikakapu, ʻaha, ʻopule, āholehole)
- endemic Hawaiian stream gobies (ʻo'opu nakea, 'o'opu akupa, 'o'opu alamo'o, 'o'opu nopili, 'o'opu naniha)
- Spotted Eagle Rays (hīhīmanu)
- Green and Hawksbill Sea Turtles (honu, honu eʻa)
- Whitetip Reef Sharks (manō lalakea)
- Hawaiian Monk Seals (ʻĪlioholoikauaua)

[32] http://cramp.wcc.hawaii.edu/LT_Montoring_files/lt_study_sites_Oahu_Pupukea.htm

A 2005 statewide study of Hawai'i's eleven MLCDs[33] found that overall fish biomass was four times higher in the Pūpūkea MLCD compared to the outside areas open to fishing. Species richness also was greater within the Pūpūkea MLCD than in areas outside and adjacent to it. The study concluded that the MLCD's protective measures have a "spillover effect" that benefits adjacent areas.

The MLCD also provides important habitat for several marine species, seabirds, and shorebirds with special legal protected status:


- The National Oceanic and Atmospheric Administration (NOAA) manages the Hawaiian Islands Humpback Whale National Marine Sanctuary, which is a seasonal home to more than 10,000 Humpback Whales (koholā, *Megaptera novaeangliae*), approximately half of the North Pacific population. They mate, calve, and nurse their young in the winter months in Hawai'i. The sanctuary includes waters off Maui, the north shore of Kaua'i, the Kōhola coast of Hawai'i, and the north and south shores of O'ahu including the Pūpūkea MLCD. The Kapo'o areas of the Pūpūkea MLCD is a popular location for observing whales near the shore and is a host site for the annual whale counts.
- Green Sea Turtles (Honu, *Chelonia mydas*) are seen frequently within the Pūpūkea MLCD. This species is of special physical and spiritual importance to Hawaiians and are protected by federal and state law as a threatened species.
- The Hawksbill Sea Turtle (Honu'ea, *Eretmochelys imbricata*) is a rare endangered species protected under federal and state law that is sometimes observed in the MLCD.
- Hawaiian Monk Seals ('Īlioholoikauaua, *Monachus schauislandi)* utilize all areas of the MLCD and often haul out on during the winter on the small beaches of the Kapo'o cove.

[33] Friedlander, Alan M., E. Brown, M. E. Monaco, and A. Clark. 2005. pp. 45-56.

- Spinner Dolphins (Nai'a, *Stenella longirostris*), estimated at only 300 individuals on O'ahu, utilize Waimea Bay in the summer months for nursing, feeding, and rest. The species is protected under the federal Marine Mammal Protection Act.

- Pacific Golden Plover (kōlea, *Pluvialis fulva*) are commonly sighted between August and May and spend the remainder of the year in Alaska.

- Black-crowned Night Heron ('auku'u, *Nycticorax nycticorax hoactli*) are found in shallow wetlands including along stream mouths.

## Monitoring Management Effectiveness Through Indicators

In developing management plans under the Holomua Marine Initiative, DAR is using a suite of ecological and socio-cultural indicators to measure the condition of the nearshore ecosystem in Hawai'i. An indicator is a metric used to determine the condition of a desired target and assess trends. Indicators are used to track progress towards management objectives over time. Additional indicators may be added at a place-based scale, as needed, based on management objectives. This suite below will be included for each of the management plans.

### Ecological Indicators

Ecological indicators are defined as quantitative measures of the condition of the nearshore reefs of Hawai'i that serve as proxies for effects of human influences on ecosystem status and trends. Analyses of ecological indicator condition were produced by the Hawai'i Monitoring and Reporting Collaborative (HIMARC). HIMARC is a collaboration among organizations that are involved in monitoring and management of the nearshore waters of Hawai'i. HIMARC combines existing data collected by these organizations into a common database, which is used to create products for data-informed management decisions.

Because it is not possible to conduct surveys for every reef, and due to the uneven distribution of monitoring effort, HIMARC has developed methods to estimate indicator values for the entire nearshore area by combining surveys with data on drivers (human, oceanographic, and habitat variables that affect indicator condition). These estimates are then summarized for the MMA below in two ways:

- ***Maps:*** For each indicator, a map of the MMA and the predicted values are shown. Predicted values are displayed in 100m x 100m square grids. These values are estimated from models that incorporate the survey point-estimates and data

on fishing, land-based pollution, oceanography, and habitat. The boundary of the MMA is outlined in black.

- ***Plots:*** For each indicator, the mean (average) of predicted values for the indicator condition are shown along with spatial references for comparison. Spatial references include the main Hawaiian Islands (MHI), no-take areas across the MHI, and the island and moku where the MMA is located. Recovery potential shows what the change in range of conditions could be if stressors are minimized (see Appendix 3 for guidelines on how to interpret plots, plots and more information on recovery potential). Recovery potential was calculated for fish indicators and not benthic indicators because scientists have a better understanding of the links between human drivers and fish assemblage indicators than we do for benthic indicators. Research is ongoing to better quantify the relationships between benthic indicators and human drivers that could allow for assessments of recovery potential in the future.

### *Benthic Indicators*

#### *Coral Cover*

Coral is the primary ecosystem engineer for reef systems as a critical form of habitat for other reef species. The abundance of corals is measured as the percentage of the bottom covered in corals of any species.

The best estimate of average coral cover in the Pūpūkea MLCD is predicted to be 25.2% based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 15.6% and 44.4% based on the available information (Figure 9, Figure 10).

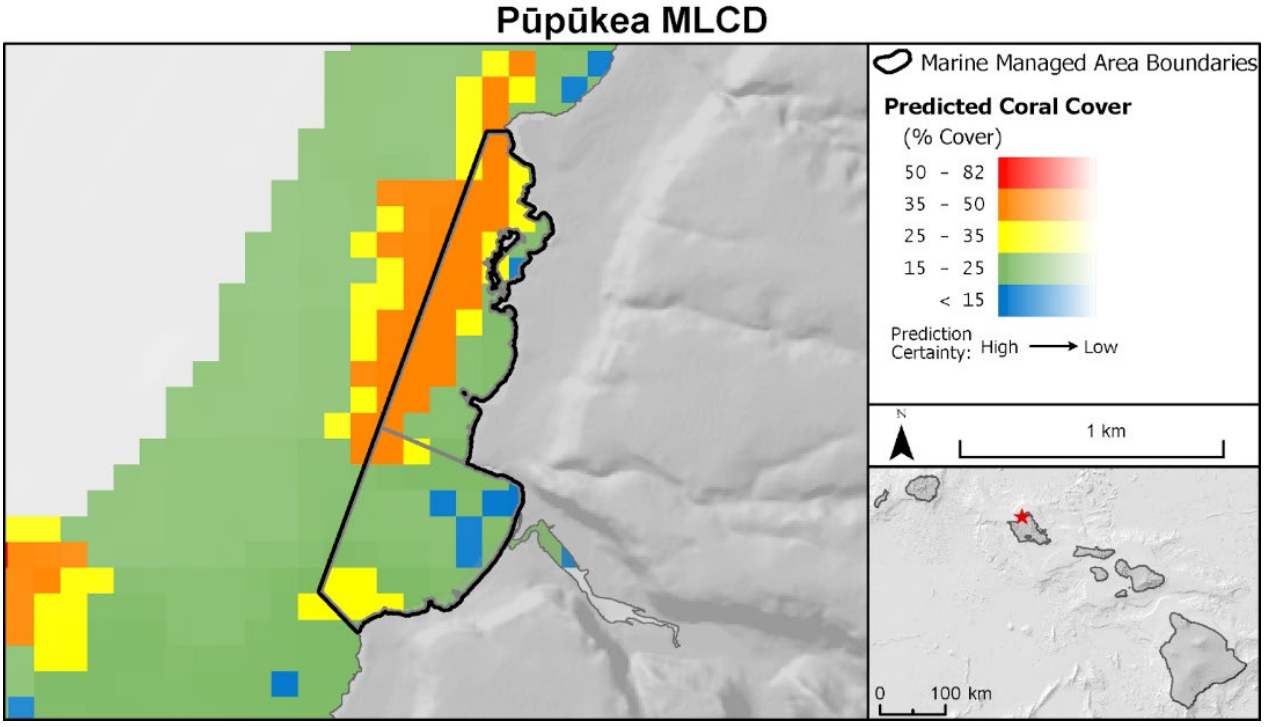



*Figure 9: Predicted coral cover in the Pūpūkea MLCD at a scale of 100m. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders) based on data from 2004-2014. Colors become more transparent as the certainty around the prediction decreases.*

Predicted coral cover in Pūpūkea MLCD is comparable to coral cover of other reefs on O‘ahu in Ko‘olauloa, and coral cover in Pūpūkea MLCD is comparable to reefs overall across the main Hawaiian Islands (MHI) (Figure 10).

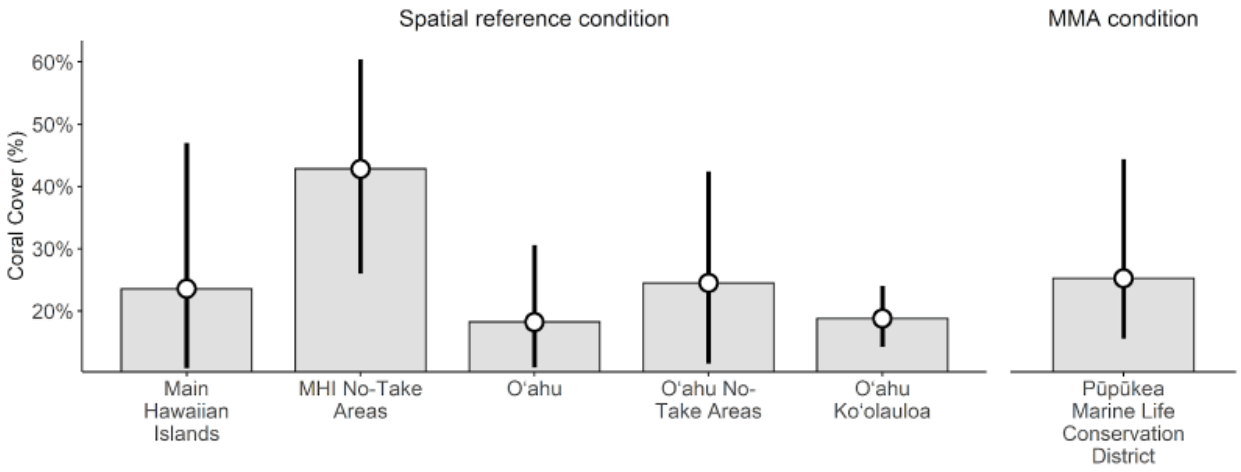



*Figure 10: Comparison of predicted coral cover (%) in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The furthest bar to the right shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions to provide comparisons to other areas.*

## *Ratio of Calcified-Fleshy Cover*

Measuring the ratio of calcified organisms (corals and crustose coralline algae) to fleshy cover (turf and macroalgae) provides an overall indicator of what organisms dominate the reef. This ratio closely relates to mechanisms that determine resilience on reefs: calcified reefs are more resilient because they support higher biodiversity and fish biomass than fleshy reefs. This metric is highly correlated with human impact gradients across the Pacific. When the ratio of calcified to fleshy cover is greater than zero the reef is dominated by more calcified cover and when the ratio is less than zero it is dominated by more fleshy cover (Figure 11).


*Figure 11: Examples of benthic cover to show areas with a high (left), medium (middle), and low (right) calcified to fleshy ratio. The areas with a high calcified to fleshy ratio are areas that are mostly coral or other calcified organisms like crustose coralline algae. Areas with a low calcified to fleshy ratio are areas dominated by fleshy (macroalgae cover). Many areas are somewhere in between these two ends of the spectrum, with a mix of hard, calcified cover and softer, fleshy macroalgae cover.*

The best estimate of average calcified-to-fleshy cover in the Pūpūkea MLCD is predicted to be -0.43 based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within -1.57 and 0.76 based on the available information (Figure 12, Figure 13).

Predicted ratio of calcified to fleshy cover in Pūpūkea MLCD is comparable to ratio of calcified to fleshy cover of other reefs in Koʻolauloa, Oʻahu, and is comparable to reefs overall across the MHI (Figure 13).

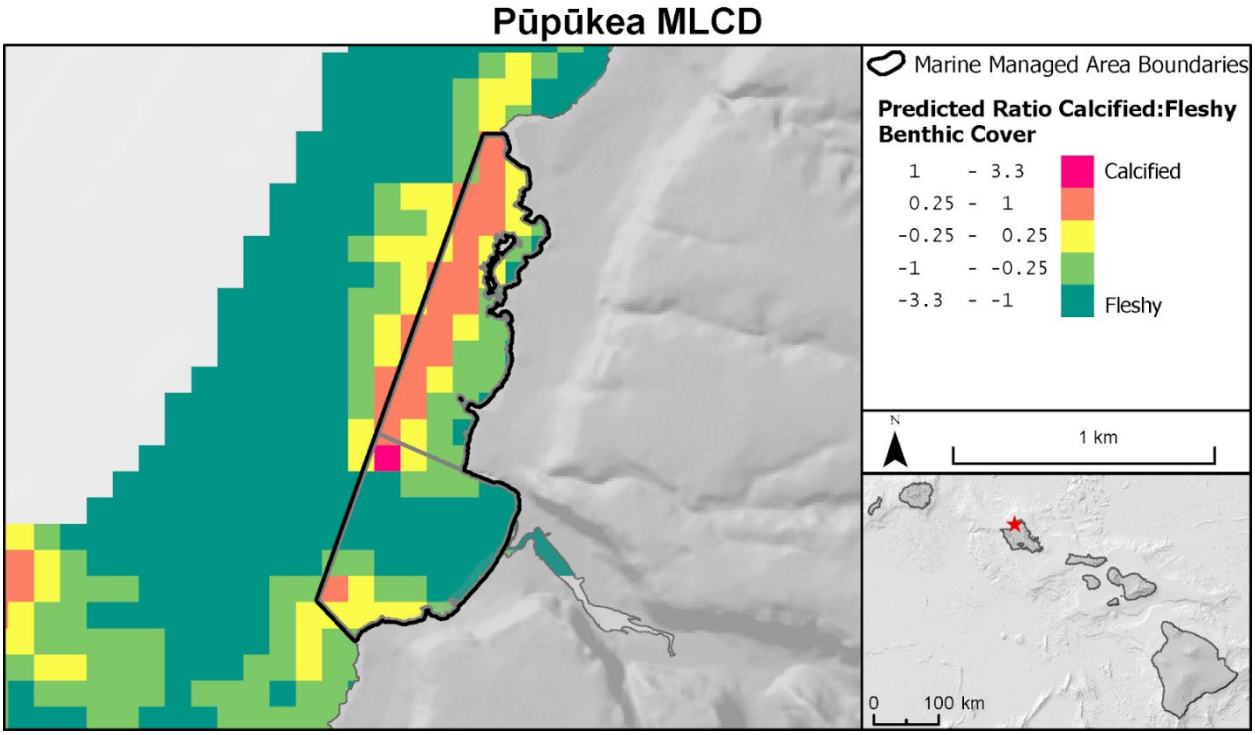



*Figure 12: Predicted ratio of calcified to fleshy cover in the Pūpūkea MLCD at a scale of 100m. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders) based on data from 2004-2014. Colors become more transparent as the certainty around the prediction decreases.*

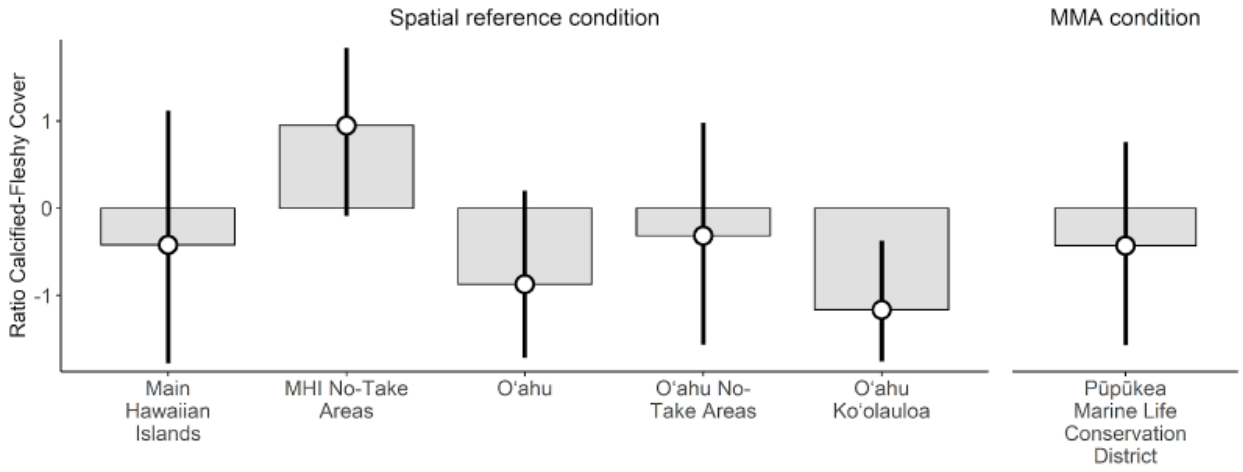



*Figure 13: Comparison of predicted ratio of calcified to fleshy cover in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The furthest bar to the right shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions to provide comparisons to other areas.*

## Fish Indicators

### *Fish Species Diversity*

Species diversity reflects the overall number of different species present in an MMA. A greater number of species on any given reef will support a greater number of critical ecosystem functions, increasing the services that the reef can provide.

Diversity is calculated using the Shannon's Diversity Index, which accounts for both the number and evenness of species. Values range from 0, indicating the presence of one species, to 1, indicating that all species present are evenly represented.

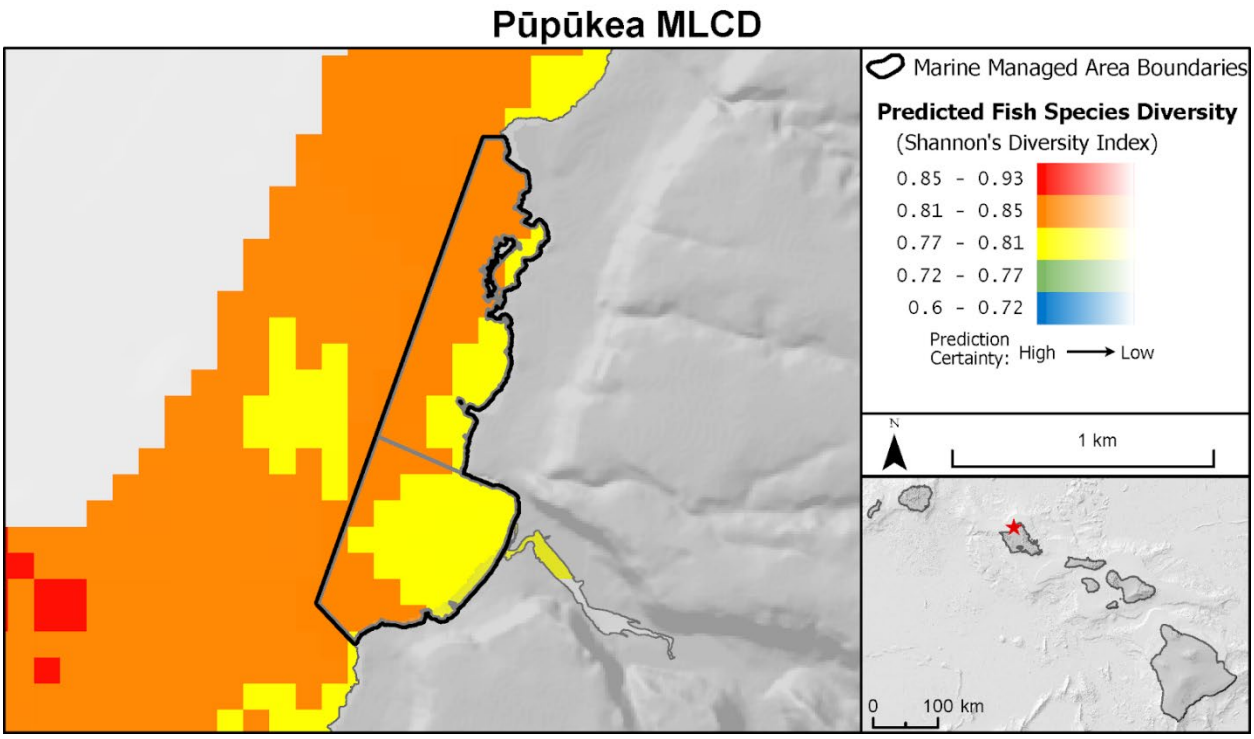



*Figure 14: Predicted fish species diversity in the Pūpūkea MLCD at a scale of 100m. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders) based on data from 2004-2014. Colors become more transparent as the certainty around the prediction decreases.*

The best estimate of average fish species diversity in the Pūpūkea MLCD is predicted to be 0.81 based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 0.78 and 0.85 based on the available information (Figure 14, Figure 15).

Predicted fish species diversity in Pūpūkea MLCD is comparable to fish species diversity of other reefs in Koʻolauloa, Oʻahu, and fish species diversity in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 15).

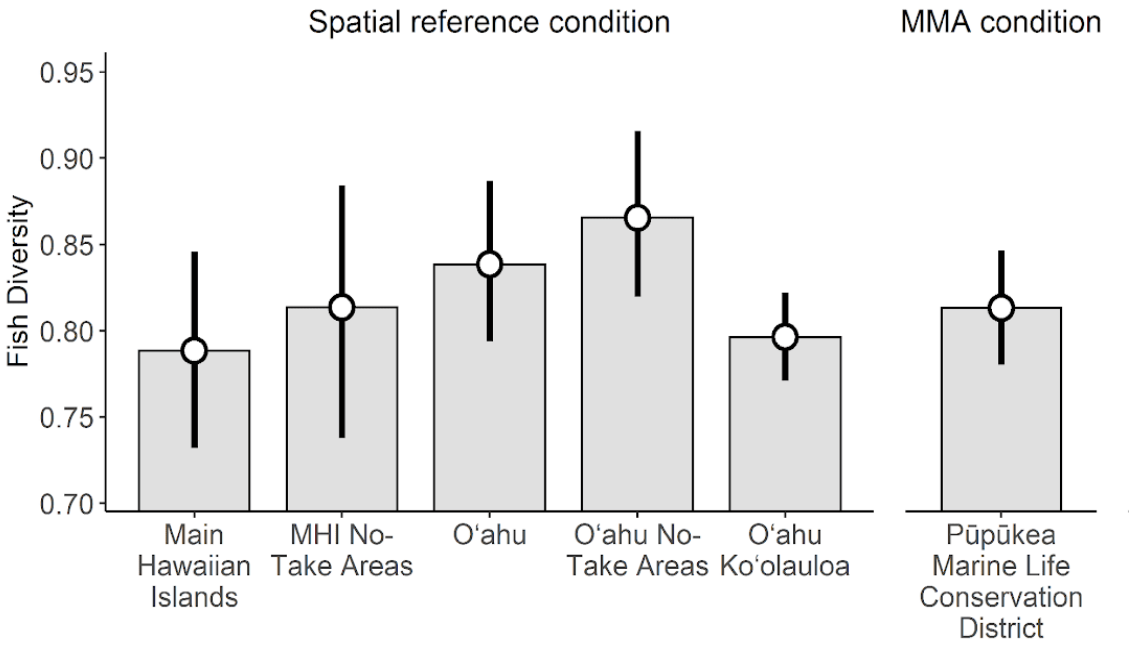



*Figure 15: Comparison of predicted fish species diversity in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions.*

Resource fish biomass measures the weight of species that are targeted by local fisheries, and provides one way to consider the condition of fisheries resources. Given that fisheries are a major component of the well-being of the people of Hawai'i, it is also an indicator of the broader socio-ecological system.

Resource fish are those species targeted by commercial and non-commercial fishing. Predictions are in g/m$^2$ of fish over hard-bottom habitat (453.6 g = 1 lb; 1 m = 3 ft 3 in). A list of species that were considered resource fishes is in Appendix 4.
The best estimate of average resource fish biomass in the Pūpūkea MLCD is predicted to be 88.1 g/m$^2$ based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 37.72 and 198.4 g/m$^2$ based on the available information (Figure 16, Figure 17).

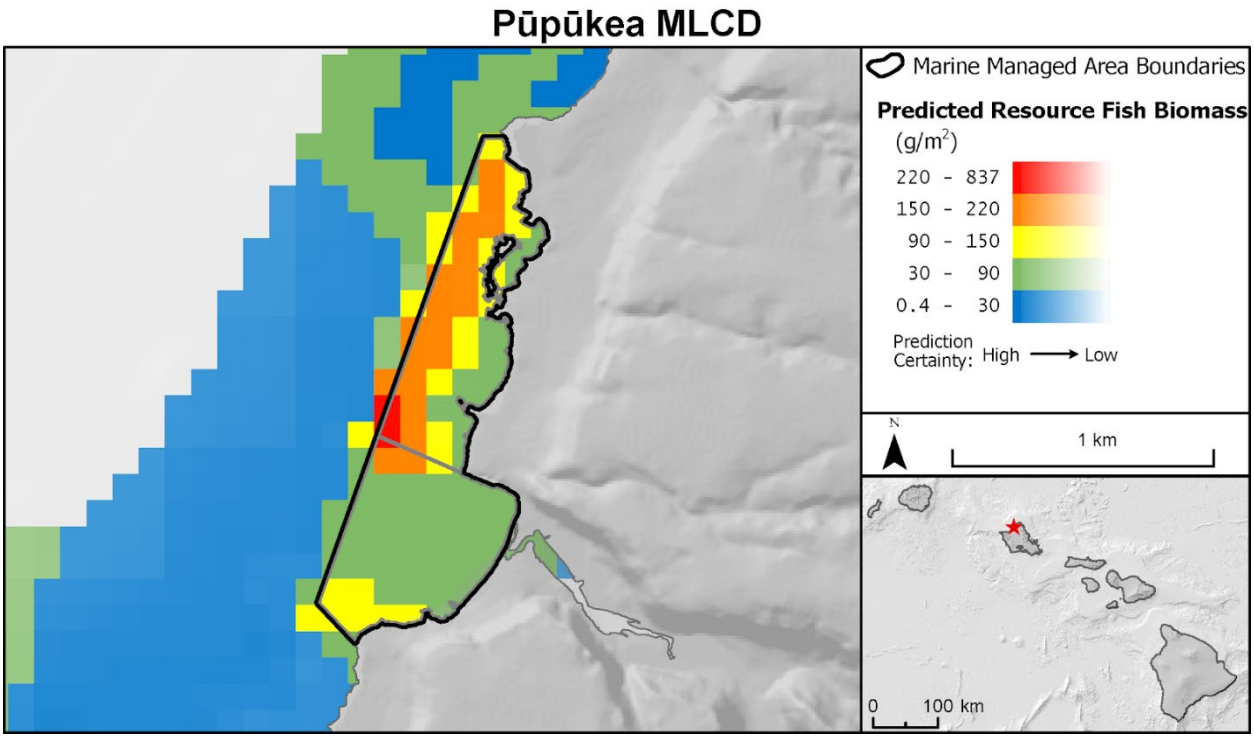



*Figure 16: Predicted resource fish biomass in the Pūpūkea MLCD at a scale of 100m. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders) based on data from 2004-2014. Colors become more transparent as the certainty around the prediction decreases.*

Predicted resource fish biomass in Pūpūkea MLCD is comparable to resource fish biomass of other reefs in Koʻolauloa, Oʻahu, and resource fish biomass in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 17).

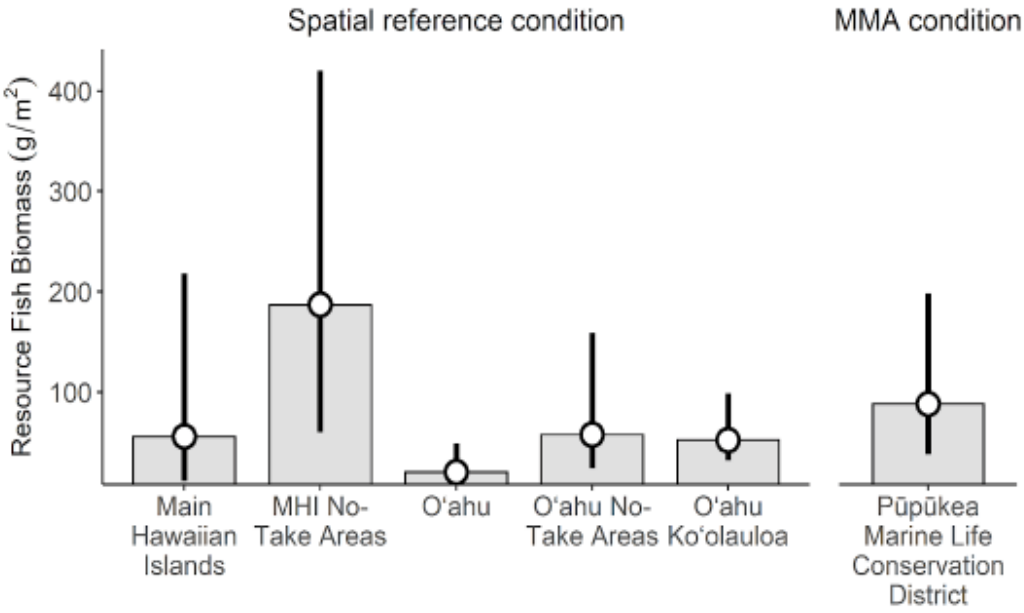



*Figure 17: Comparison of predicted resource fish biomass in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions.*

## *Mean Fish Size*

Mean fish size is an indicator of fish assemblage structure, and provides insight into overall exploitation in fish assemblage. Often, fishing is focused on larger individuals, and over time this removal of the largest individuals can diminish the average size of fish. Fish size is the average length (cm) of all fish species monitored (2.54 cm = 1 in).

The best estimate of average mean fish size in the Pūpūkea MLCD is predicted to be 19.8 cm based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 18.2 and 21.4 cm based on the available information (Figure 18, Figure 19).

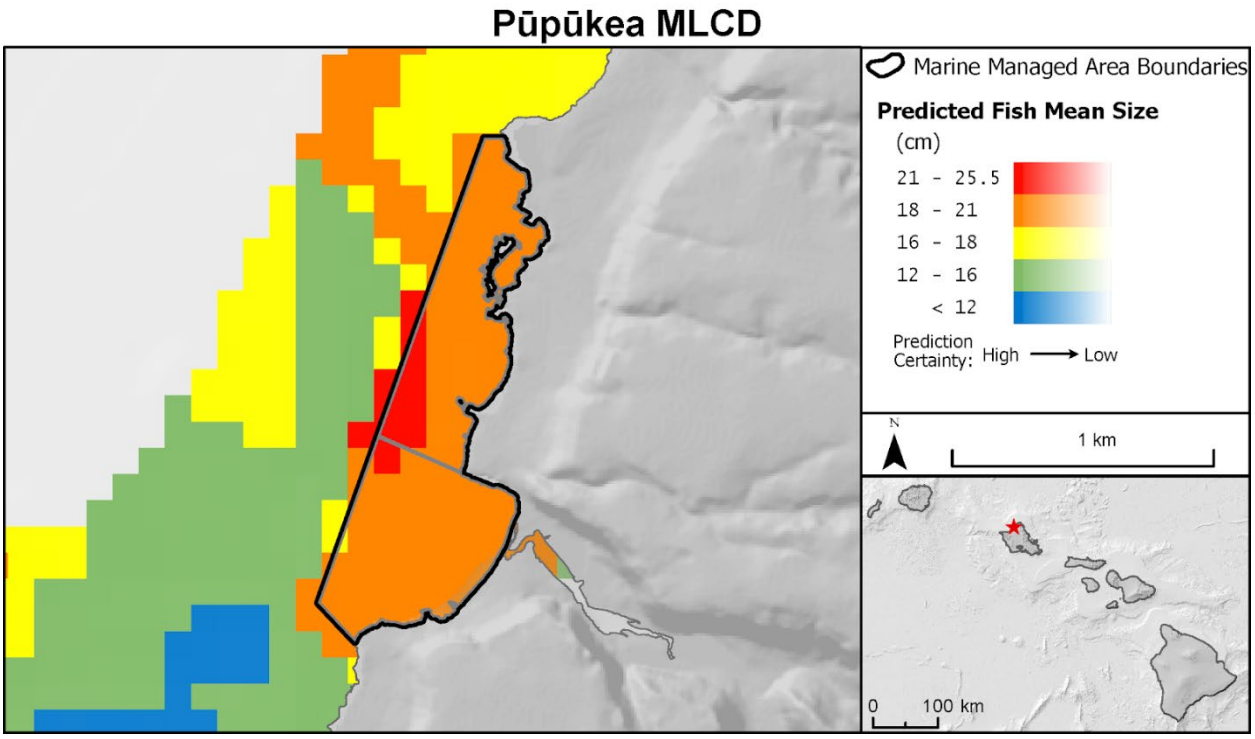



*Figure 18: Predicted mean fish size in the Pūpūkea MLCD at a scale of 100m. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders) based on data from 2004-2014. Colors become more transparent as the certainty around the prediction decreases.*

Predicted mean fish size in Pūpūkea MLCD is comparable to mean fish size of other reefs in Ko'olauloa, O'ahu and mean fish size in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 18).

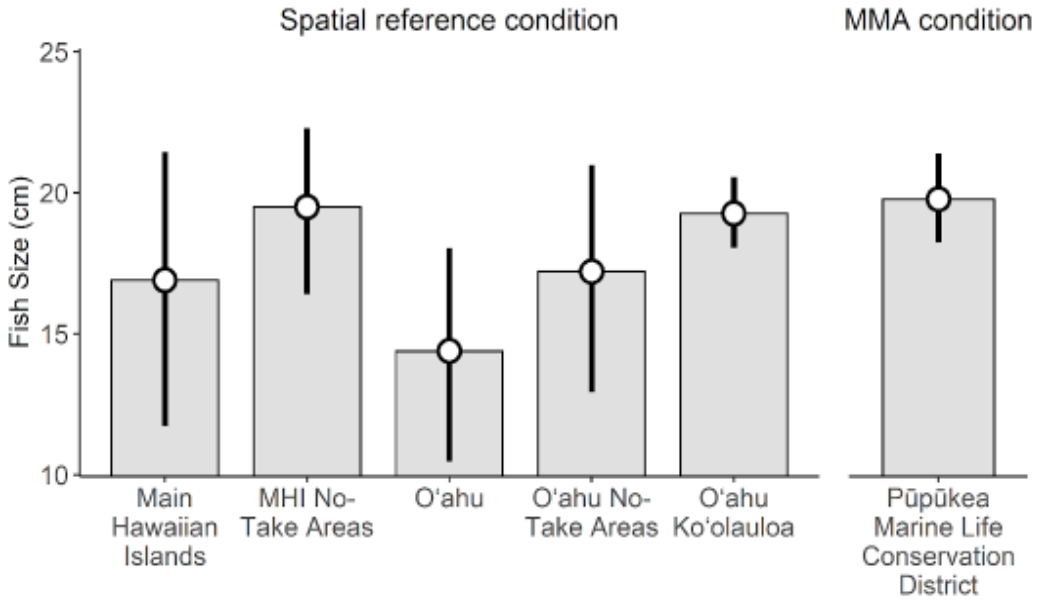



*Figure 19: Comparison of predicted mean fish size in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions.*

## *Total Fish Biomass*

Total fish biomass combines the numerical density of fish with the sizes of fish to provide a measure of the overall fish assemblage. Fish biomass is an important indicator of trophic structure, stock status, and recovery potential. Predictions are in g/m$^2$ of fish over hard-bottom habitat (453.6 g = 1 lb; 1 m = 3 ft 3 in).

The best estimate of average total fish biomass in the Pūpūkea MLCD is predicted to be 102.87 g/m$^2$ based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 47.39 and 201.08 g/m$^2$ based on the available information (Figure 20, Figure 21).

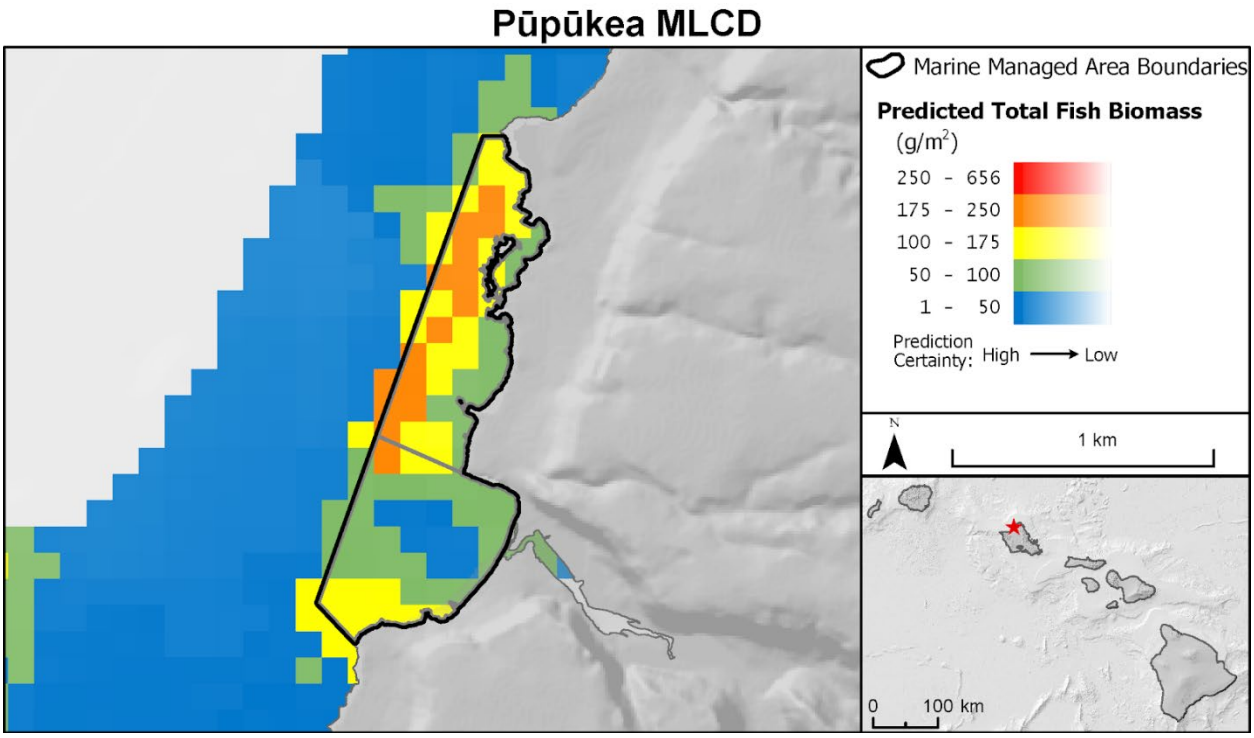



*Figure 20: Predicted total fish biomass in the Pūpūkea MLCD at a scale of 100m. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders) based on data from 2004-2014. Colors become more transparent as the certainty around the prediction decreases.*

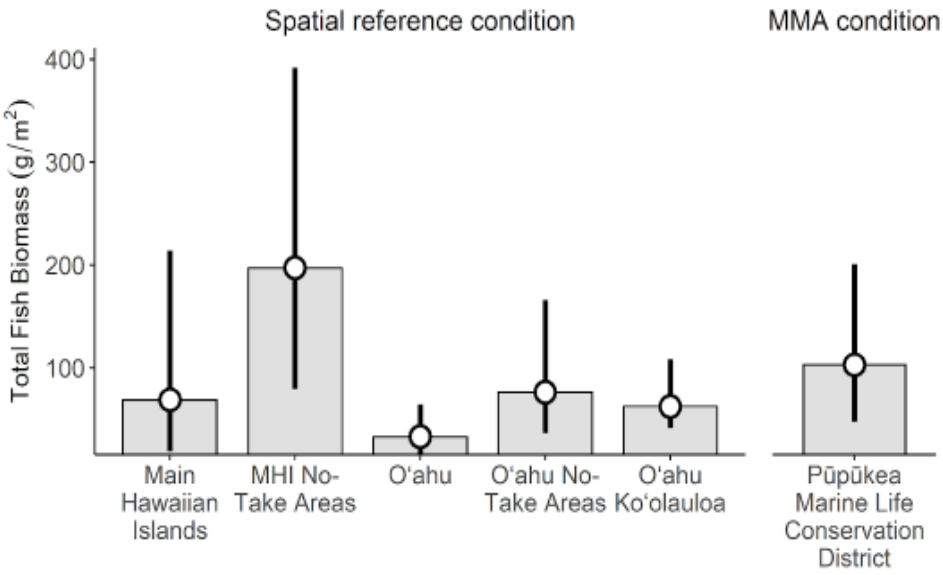



*Figure 21: Comparison of predicted total fish biomass in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions.*

Predicted total fish biomass in Pūpūkea MLCD is comparable to total fish biomass of other reefs in Ko'olauloa, O'ahu, and total fish biomass in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 20).

Herbivorous fish play key roles in maintaining ecological resilience on reefs. Herbivores act as the gardeners of the reef, reducing turf and macroalgae to allow more room for calcified organisms to grow. Predictions are in g/m$^2$ of fish over hard-bottom habitat (453.6 g = 1 lb; 1 m = 3 ft 3 in).

The best estimate of average herbivorous fish biomass in the Pūpūkea MLCD is predicted to be 78.81 g/m$^2$ based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 31.09 and 159.69 g/m$^2$ based on the available information (Figure 22, Figure 23).

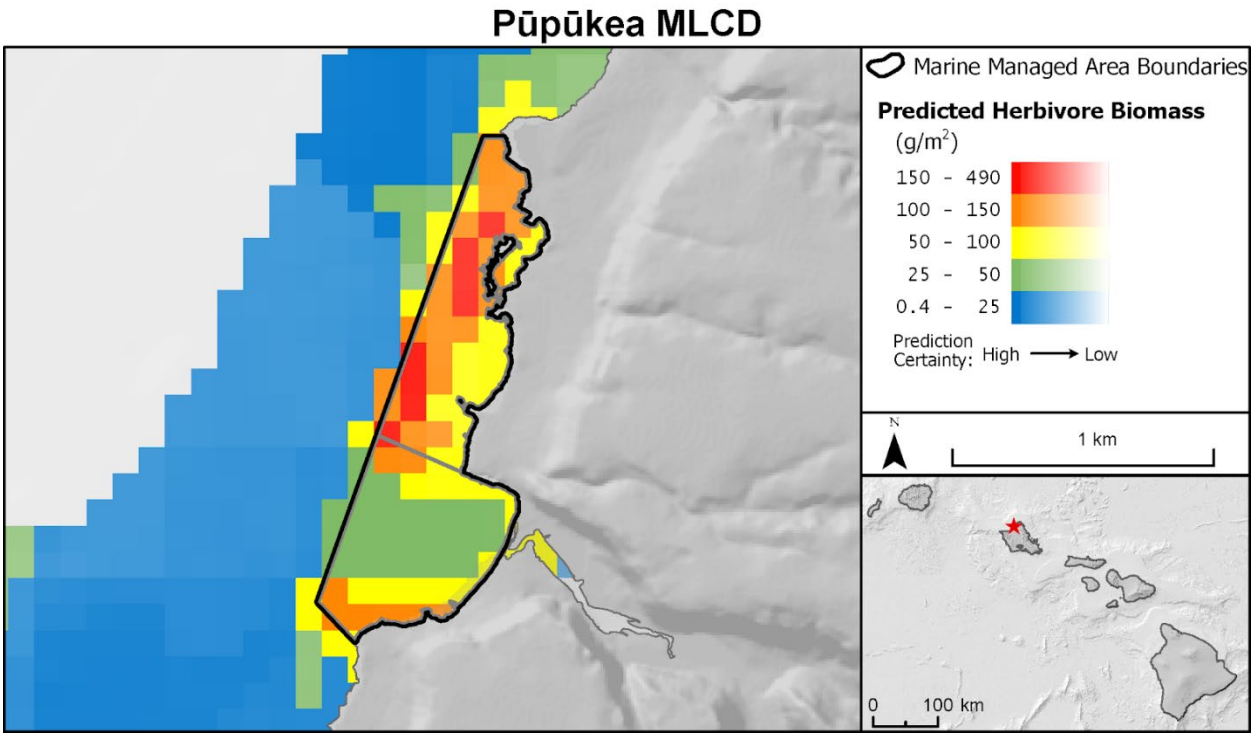



*Figure 22: Predicted herbivorous fish biomass in the Pūpūkea MLCD at a scale of 100m. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders) based on data from 2004-2014. Colors become more transparent as the certainty around the prediction decreases.*

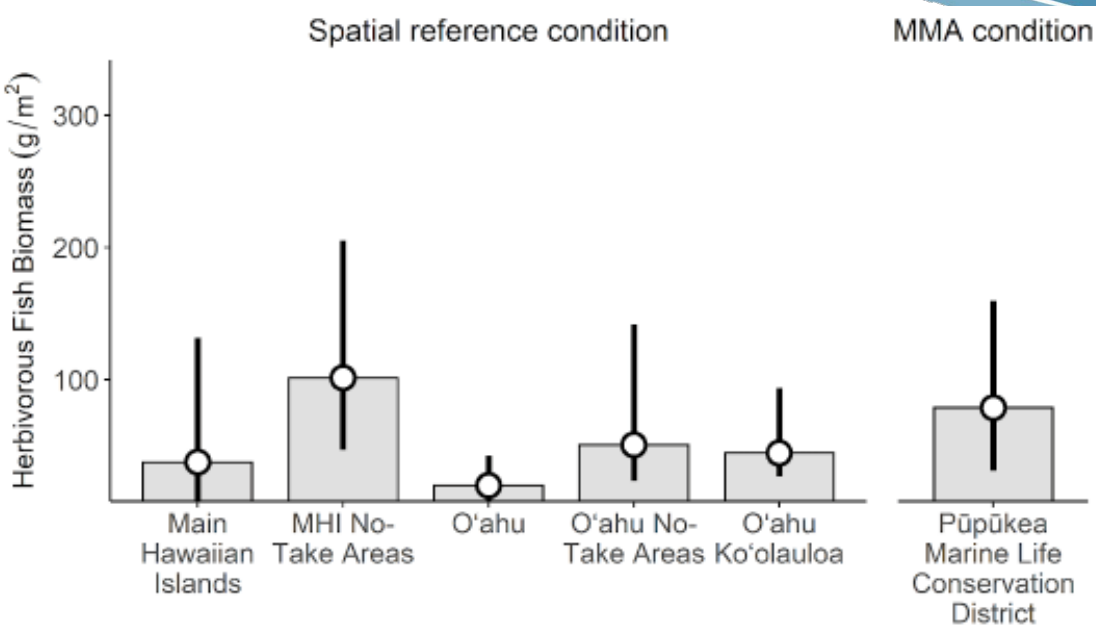



*Figure 23: Comparison of predicted herbivorous fish biomass in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions.*

Predicted herbivorous fish biomass in Pūpūkea MLCD is comparable to herbivorous fish biomass of other reefs in Ko'olauloa, O'ahu and herbivorous fish biomass in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 23).

## Socio-Cultural Indicators

Ecological or physical criteria such as changes in coral cover, fish abundance/biomass, or water quality parameters are usually used to evaluate the effectiveness of MMAs. However, management assessments also need to consider the impacts of MMAs on local and indigenous communities. The social and cultural connections that humans have with the environment is a key factor in management planning. The creation of MMAs can result in greater inequality for indigenous and local communities who fish for subsistence or practice small-scale fishing and harvesting. To create a more holistic approach, frameworks for coastal resource management need to acknowledge social and cultural factors, alongside ecological factors, in the planning and evaluation of MMAs. Across the Holomua Marine initiative, the use of new Hawai'i-specific socio-cultural measures will allow DAR to identify how changes in marine management or the environment affect the local communities that utilize or depend on those ecosystem services through socio-cultural perspectives.

A set of socio-cultural principles have been developed through workshops hosted by DAR and other collaborators, along with a set of socio-cultural indicators to measure the condition or status of each principle. Nine socio-cultural design principles are organized into four categories: place-based knowledge and education; physical, mental and spiritual well-being; community relationships, engagement and commitment; and efficacy and equitable governance. The next step in the socio-cultural assessment process is to test the feasibility of proposed indicators, and to collect baseline data for each MMA in Hawai'i to be used in DAR's future management plans and assessments.

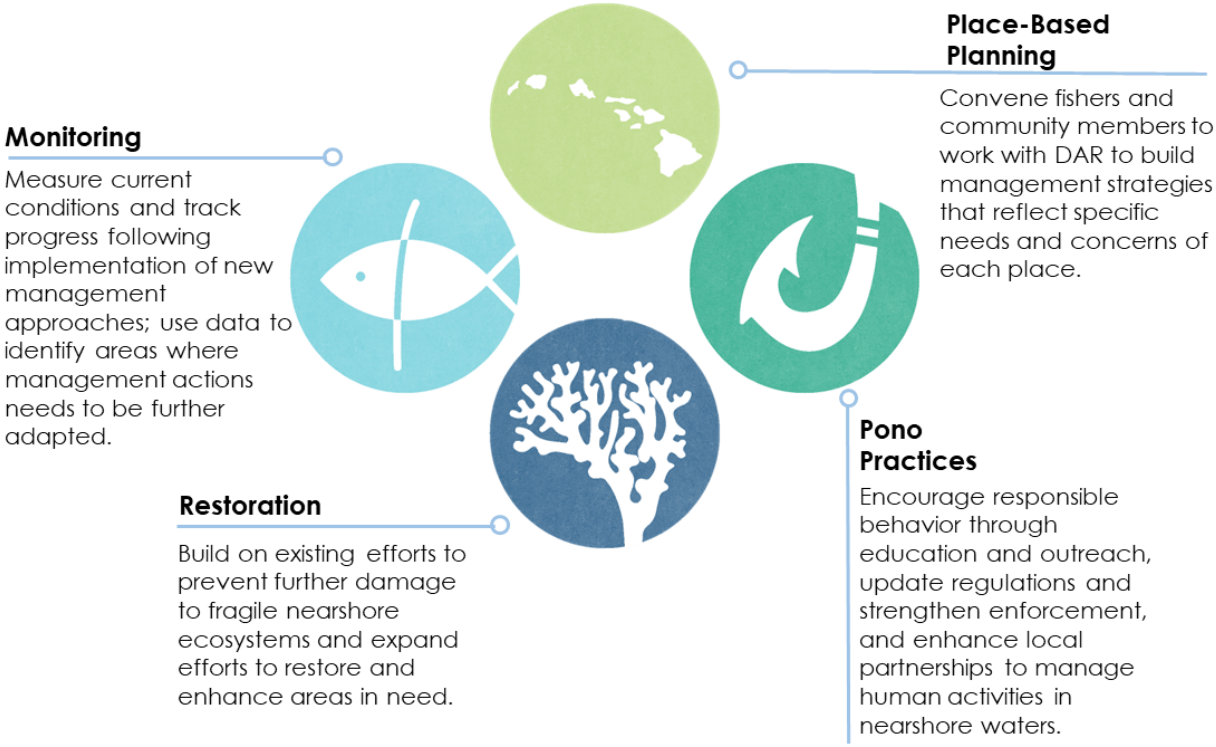
DAR uses three primary methods for socio-cultural monitoring to assess how changes in the environment or management are affecting local community members: 1) Human use surveys, 2) beach user questionnaires, and 3) research through internal and external resources. Human use surveys evaluate the number of people recreating at a marine management area and what activities they are engaged in throughout the day to provide a better picture of how the area is being utilized. These are conducted on site and records the number people gathered there, how people recreate and the types and frequency of commercial activities present. Beach user questionnaires are offered to beach goers on site and ask a series of questions such as how often they visit the location, what impacts their experience and other potential concerns. Survey questions are carefully crafted without technical language to avoid response bias and allow for a deeper dive into stakeholder priorities and perceptions about the marine management area. The last method uses internal and external resources to examine other multiple facets of management, culture, and community connections to place. Examples are

determining if correct place names and mo'olelo are represented in management plans, signage, and other materials, presence of stewardship and community groups, the number of place-based education events, and tracking collaboration between DAR and the community through participation in community work days and educational outreach. These methods are layered to gain a more comprehensive perspective on the social and cultural connections that people have with nearshore areas, in particular marine management areas.

DAR has started testing and measuring indicators at Pūpūkea MLCD. Results of this monitoring will be shared in a future draft of this management plan.

## Pūpūkea MLCD Management Strategy

The Pūpūkea MLCD management strategy begins with target indicators before detailing the objectives and activities to be conducted under the four management pillars of Holomua: place-based planning, pono practices, monitoring, and protection and restoration. A work plan is included that identifies responsible parties and a timeline for the activities.



## Target Indicators

Target indicators were selected based on concerns/threats identified by the Pūpūkea community. These created the framework for the objectives and actions as described later in this section. Perceived status and achievable status are included based on observations of the Pūpūkea community. Through monitoring, these can be better defined and quantified after management plan implementation.

| Target indicator for management action | Habitat or area of concern | Ecosystem function | Current threats or concerns | Current status | Achievable status |
|---|---|---|---|---|---|
| Water quality | Kapoʻo | Ecosystem & public health | Heavy human use (e.g., sunscreen, sediment perturbation), potentially poor groundwater quality, coastal erosion, stormwater runoff | Fair[34] | Good |
| Water quality | Pūpūkea Beach Park | Ecosystem & public health | Non-point and point-source stormwater drainage sites | Fair | Very good |
| Herbivore abundance | Pūpūkea MLCD | Reef resilience | Poaching | Fair | Very good |
| Number of visitors and activity | Pūpūkea MLCD | Reef resilience | Heavy human use, trampling, displacing fish and other marine life, fish feeding, large groups, e-scooters and other devices disrupting marine life | Poor | Good |
| Coral health | Pūpūkea MLCD | Reef resilience | Trampling, contact with and breaking corals due to human impacts | Fair | Good |
| Degree of poaching | Pūpūkea MLCD | Fishery resilience | Illegal fishing in no-take areas | Fair | Good |
| Rate of coastal erosion | Pūpūkea MLCD | Ecosystem & public health | Sedimentation of the reef, eroded and unsafe pathways | 1 foot/year eroding[35] | Fair |
| Climate change | Pūpūkea MLCD | Reef resilience | Coral bleaching | Fair | Fair |

[34] Ramos, A. and H. Dulai. (2021). Submarine Groundwater Discharge and Related Contaminants in Shark's Cove Kapo'o Tide Pool. University of Hawai'i at Mānoa, 9 p.

[35] Coastal Geology Group in the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawai'i. 2021. Hawai'i Shoreline Study. Retrieved from https://www.soest.hawaii.edu/crc/index.php/hawaii-shoreline-study-web-map

## Place-Based Planning

integrates the recognized differences in species diversity, abundance and harvesting practices into management planning. Actions within this pillar identify and develop management strategies for improved marine management in partnership with communities and stakeholders at local to regional scales.

**Overarching goal**: Integrate, activate, and expand management coordination and programs with surrounding jurisdictions, partners, and management/conservation areas.

**Objective 1:** Convene partners at the MLCD at least once yearly for an action planning meeting to identify and align goals, objectives, and commitments. Form working groups as needed to convene at more frequent intervals to accomplish individual action items.

*Action PB 1.1* Develop framework establishing partner benchmarks and progress reporting on annual commitments.

*Action PB 1.2* Advocate collectively to secure funding, support and staffing for priority actions.

*Action PB 1.3* Annually review the need for adaptive management based on the latest science (see Action M 1.4), community suggestions (see Appendix 7), and partner consultations. Update the management plan annually and pursue larger policy changes such as rule amendments as needed every five years.

**Objective 2:** Preserve, protect, and support the unique opportunities for sustainable MLCD use and enjoyment, including education, recreation, and access.

*Action PB 2.1* Support the implementation and completion of long-term biological carrying capacity study to inform the limitations of human use on biological condition and sustainability of resources.

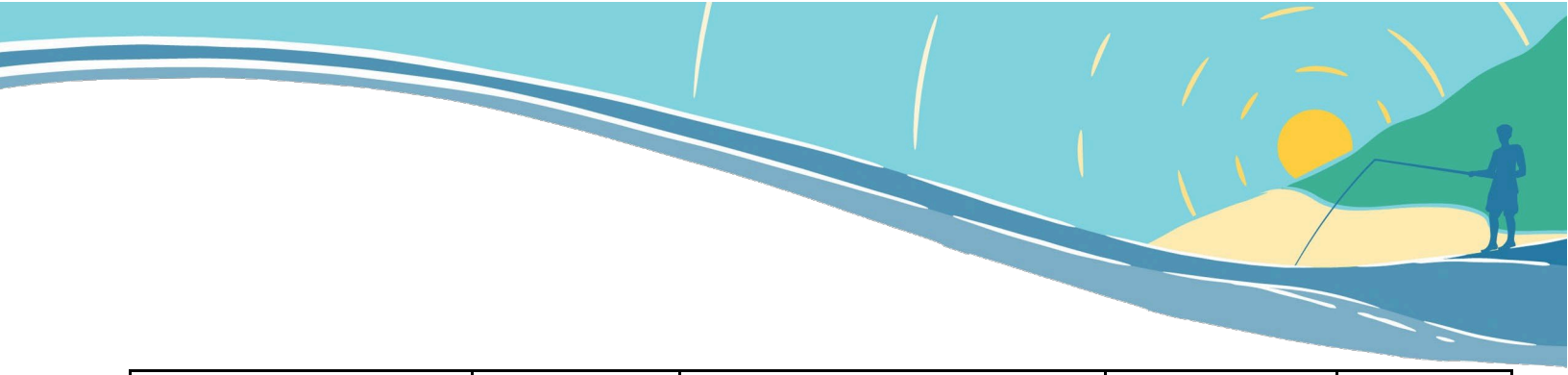
*Action PB 2.2* Develop a plan for environmental and cultural interpretation, potentially including boardwalks, improved signage, and boundary markers to guide people to appropriate and low-impact access to and interaction with the MLCD.

*Action PB 2.3* Consider solutions to limit entry and manage access to the MLCD to avoid overcrowding and reduce subsequent pressure on resources.

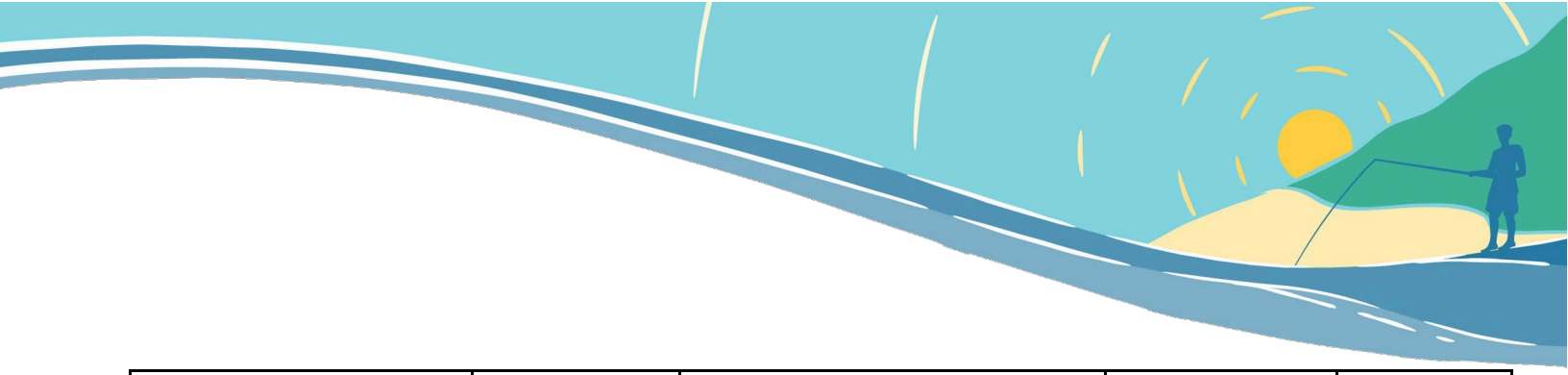
*Action PB 2.4* Promote adaptive management through an annual review of science (see Activity M 1.4), community feedback, and partner consultations (see Action PB 1.4) to identify and prioritize current concerns and potential solutions.

The following table outlines the action items, responsible parties and timeline for each associated action item listed above. This is designed to be a reference for periodic evaluations and management planning for the MLCD.

| ACTIONS | RESPONSIBLE PARTIES | ACTION ITEMS | TIMELINE* | COMPLETION DATE/ PROPORTION COMPLETED AT REVIEW |
|---|---|---|---|---|
| PB 1.1 Develop framework establishing partner benchmarks and progress reporting on annual commitments. | MPW<br>DLNR (DAR, DOCARE)<br>City (Parks & Rec, DFM, DDC)<br>DOH<br>NOAA (Sanctuary, PIRO)<br>Waimea Valley | -Set a mutual schedule<br>-Determine participant list<br>-Send invitations<br>-Coordinate logistical arrangements and budget<br>-Arrange facilitators and notetakers<br>-Create a report<br>-As part of the annual meeting, complete the development of benchmarks for each participating partner. Thereafter, report on benchmark progress. | 12 months from management plan approval and adoption; planning to start 6 months in advance. Repeat on same schedule annually. | |
| PB 1.2 Advocate collectively to secure funding, support and staffing for priority actions. | | As part of the annual meeting, partners report on funding and other resources needed and secured to complete benchmark items. | | |
| PB 1.4 Annually review the need for adaptive management based on the latest science (see Action M 1.4), community suggestions (see Appendix 7), and partner consultations. Update the management plan annually and pursue larger policy changes such as rule amendments as needed every five years. | DAR<br>DOCARE<br>MPW | As part of annual meeting, generate ideas and priorities for, and analysis of, adaptive management via administrative rule changes and other state, federal, or county law or policy initiatives | | |



| | | | | |
|---|---|---|---|---|
| PB 2.1 Support the implementation and completion of long-term biological carrying capacity study to inform the limitations of human use on biological condition and sustainability of resources. | DAR<br>MPW<br>Contractor (TBD) | Complete the biological carrying capacity study/program series with input from stakeholders, and in accord with SB3330.<br>Provide periodic/annual updates to DAR. (Contractor)<br>Analyze and interpret results for management actions and recommendations. (Stakeholders)<br>Write a formal study/program report including actions and recommendations to manage human use. (Contractor)<br>Present results including management actions and recommendations to stakeholders.<br><br>DLNR reports results to Legislature. | - Study launch by May 2023<br>- Annual updates by month annually for three years (2024, 2025, 2026)<br>- Program ends by July 1, 2025<br>- Final report and presentation to stakeholders within six months of the completion of the three-year study series (fall 2025)<br>- DLNR to report to state legislature January 1, 2026 | |
| PB 2.2 Develop a plan for environmental and cultural interpretation, potentially including a boardwalk, improved signage, boundary markers to guide people to appropriate and low-impact access to and interaction with the MLCD. | MPW<br>DLNR (DAR, DOCARE, OCCL)<br>City (Parks & Rec, DFM, DDC)<br>DOH<br>DOT<br>NOAA (Sanctuary, PIRO)<br>Contractor | - DAR, OCCL, City, and MPW consult on creating an RFP scope and deliverables to develop an implementable Pūpūkea Beach Park and MLCD site plan and design that manages human use while addressing multiple purposes including erosion, environmental interpretation, and beach access.<br>Issue the RFP.<br>- DAR/OCCL/City Review proposal submissions and select a contractor.<br>- DAR/OCCL/City<br>Complete a community-engaged process to develop a site plan and design that is permit-ready. (Contractor)<br>- Secure permits to implement the site plan and design.<br>Secure funding to implement the site plan and design. | | |
| PB 2.3 Consider solutions to limit entry and manage | DAR<br>MPW | In conjunction with Act 31 program, convene key | Quarterly | |



| | | | | |
|---|---|---|---|---|
| access to the MLCD to avoid overcrowding and subsequent pressure on resources. | DOCARE<br>City | stakeholders quarterly to focus on entry/access options | | |
| PB 2.4 Promote adaptive management through an annual review of science to inform action PB1.4 (see Activity M 1.4), community feedback, and partner consultations (see Action PB 1.4) to identify and prioritize current concerns and potential solutions. | DAR<br>MPW<br>NOAA<br>UH CC and Mānoa units | Convene annual science meeting to share information, studies (gray and hard literature), and shape a scientific research plan with key partners | Annually | |

* Unless otherwise indicated, timelines will be established at the first partners meeting and updated at least annually to reflect current effort and progress.

## Pono Practices

encourages responsible behavior guided by Hawaiian values and perspectives through education and outreach, statewide rules, strengthened enforcement, and local partnerships to encourage sustainable behaviors and practices in nearshore waters. This pillar of Holomua is a call to action for resource users to interact with nearshore resources in a pono way. Actions within this pillar will encourage ocean resource users to behave responsibly. DAR and DOCARE will work together with community members to increase stewardship and compliance.

**Overarching Goal:** Engage and educate users on responsible and sustainable interactions with the nearshore ecosystem and behaviors that are guided by Hawaiian values and the best available science. Instill sense of responsibility and relationship to Pūpūkea-Waimea and the nearshore ecosystem.

**Objective 1:** Embrace, support, and enhance Hawaiian cultural values and practices (learn, teach, and do).

*Action PP 1.1* Support and integrate kilo (observation) into adaptive management.

*Action PP 1.2* Incorporate waiwai Hawai'i (Hawaiian values) into educational materials, signage, and interpretive points of access.

*Action PP 1.3* Enhance continuing relationship and consultation with kūpuna and practitioners, and deepen their current connection and presence in the MLCD.

**Objective 2:** Increase capacity for outreach and education to discourage poaching and encourage reporting of potentially illegal activity.

*Action PP 2.1* Expand awareness and distribution of materials and resources such as DAR website regulations pages, regulation books and DLNRTip app to promote appropriate harvest practices and encourage identification and reporting of potentially illegal activity.

*Action PP 2.2* Support and expand Makai Watch, outreach and education, intervention, reporting, and collaboration with DOCARE, including following-up and reporting back on enforcement actions.

*Action PP 2.3* Support and expand the community-based MPW Ocean Education Ambassador program within the MLCD.

*Action PP 2.4* Support and expand outreach and education by a steward through the Na Manu Elele program at DOFAW.

**Objective 3:** Promote compliance from resource users and consistent, effective enforcement by DAR, DOBOR, DOCARE, prosecutors, and the Judiciary to support MLCD regulations.

*Action PP 3.1* Support laws and policies that promote a strong enforcement chain.

*Action PP 3.2* Explore new funding mechanisms for expanding DOCARE's enforcement capacity.

*Action PP 3.3* Highlight enforcement actions and successful dispositions through media.

*Action PP 3.4* Design and implement on-shore and in-water boundary markers.

*Action PP 3.5* Update maps and MLCD information across all documents and web sites.

*Action PP 3.6* Update educational and legal signage throughout MLCD. Continue to update as signage falls into disrepair.

The following table outlines the action items, responsible parties and timeline for each associated action item listed above. This is designed to be a reference for periodic evaluations and management planning for the MLCD.

| Actions | Responsible Parties | Action Items | Timeline* | Completion Date/ Proportion completed at Review |
|---|---|---|---|---|
| **PP 1.1** Support and integrate kilo (observation) into adaptive management. | DAR MPW Waimea Valley Civic Clubs | Create checklist for ensuring all plans, programs, and products embrace, support, and enhance Hawaiian cultural values and practices. | Draft and revise annually, use at all times | |
| **PP 1.2** Incorporate waiwai Hawai'i (Hawaiian values) into educational materials, signage, and interpretive points of access. | | | | |
| **PP 1.3** Enhance continuing relationship and consultation with kūpuna and practitioners and deepen their current connection and presence in the MLCD. | | Invite kūpuna and practitioners to "walk story" in the MLCD, join in and lead DAR-MPW programs, share mo'olelo for DAR and MPW news on MLCD | At all times | |
| **PP 2.1** Expand awareness and distribution of materials and resources such as DAR website regulations pages, regulation books and DLNRTip app to promote appropriate harvest practices and encourage identification and reporting of potentially illegal activity. | DAR DLNR Communi-cations DOCARE MPW | Create mini-plan to increase signage, outreach tools about, and social media re DLNRTip App – e.g., hand out cards at community meetings. | Annually, on-going | |
| **PP 2.2** Support and expand Makai Watch, outreach and education, intervention, reporting, and collaboration with DOCARE, including following-up and reporting back on enforcement actions. | DAR DOCARE MPW | Meet with DOCARE to assess enforcement actions and impacts; develop action plan for improved education and enforcement. | Annually | |
| **PP 2.3** Support and expand the community-based MPW Ocean Education Ambassador program within the MLCD. | MPW DAR | DAR to support MPW in developing and supporting this program and identify needs for additional capacity. | Annually | |
| **PP 2.4** Support and expand outreach and education by a steward through the Na Manu Elele program at DOFAW. | DAR DOFAW MPW | Acquire and train steward through the Na Manu Elele program to add outreach and education capacity to the MLCD | 40 hours per week for 2 years | |

| | | | | |
|---|---|---|---|---|
| **PP 3.1** Support laws and policies that promote a strong enforcement chain. | DLNR<br>MPW | | Ongoing | |
| **PP 3.2** Explore new funding mechanisms for expanding DOCARE's enforcement capacity. | DLNR | | | |
| **PP 3.3** Highlight enforcement actions and successful dispositions through media. | DLNR<br>MPW | | | |
| **PP 3.4** Design and implement on-shore and in-water boundary markers. | DAR<br>DOBOR<br>MPW | Identify locations and concepts, design, plan, implement. | | |
| **PP 3.5** Update maps and MLCD information across all documents and web sites. | DAR<br>DOBOR<br>MPW<br>City | | | |
| **PP 3.6** Update educational and legal signage throughout MLCD. Continue to update as signage falls into disrepair. | DAR<br>MPW<br>City | | | |

* Unless otherwise indicated, timelines will be established at the first partners meeting and updated at least annually to reflect current effort and progress.

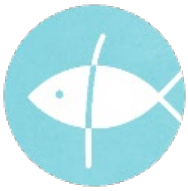
## *Pono Practices: Compliance and Enforcement*

Promoting compliance and upholding conservation rules are essential to increase management effectiveness and improve the overall health of nearshore environments. The Division of Conservation and Resources Enforcement (DOCARE) is the law enforcement agency of DLNR. DOCARE is responsible for enforcing existing regulations and any new fisheries regulations that are implemented. Fisheries regulations serve to protect, conserve, and manage Hawai'i's unique and limited natural, cultural, and historical resources. Knowing that officers cannot be everywhere all the time, the public can now report resource violations through the DLNRTip App. This can also include observations of illegal fishing, boating or anchoring activities. Data reported on this app helps officers better address "hot spots" for violations and work more closely with concerned communities where problems are identified. Violations may incur criminal and civil penalties. These fees are assessed per violation. For example, if there are multiple fish caught below a minimum size limit, as set by the regulation, each fish caught could result in individual and separate penalties/fines. The tables below highlight the fee schedule for marine resource violations:

*Table 2: Schedule of criminal and civil fines for marine resource violations. Fines increase if there is no response within 21 days. Fines are assessed per violation.*

| | 1st Offense | | 2nd Offense | | 3rd Offense | |
|---|---|---|---|---|---|---|
| **Violation** | **Criminal Fine** | **Civil Fine** | **Criminal Fine** | **Civil Fine** | **Criminal Fine** | **Civil Fine** |
| Fishing within an MLCD | $250-$1,000 | Up to $200 | $500-$1,000 | Up to $400 | $1,000 | Up to $600 |
| Fishing in prohibited area | $100-$1,000 | Up to $200 | $200-$1,000 | Up to $400 | $500-$1,000 | Up to $600 |
| Gear restriction Violation | $100-$1,000 | Up to $200 | $200-$1,000 | Up to $400 | $500-$1,000 | Up to $800 |
| Size Limit Violation | $100-$1,000 | Up to $200 | $200-$1,000 | Up to $400 | $500-$1,000 | Up to $800 |
| Bag Limit Violation | $100-$1,000 | Up to $200 | $200-$1,000 | Up to $400 | $500-$1,000 | Up to $800 |

## Monitoring



is an essential component that measures and documents current mauka-to-makai conditions and uses data to identify areas where management actions need to be further adapted. Monitoring provides a way to measure the changes occurring and if implemented actions are effective. Monitoring should include people, cultural resources, biological resources, and include the interaction between ecosystems and people throughout the ahupua'a. A robust monitoring program entails a science and kilo program, a sound human use monitoring protocol, and data banks that are accessible for input and output.

**Overarching Goal:** Promote management effectiveness by monitoring the health and abundance of biological and cultural resources in the MLCD, assessing ecological stressors, evaluating management effectiveness, identifying data gaps, and determining areas where the plan may need to be adapted.

**Objective 1:** Conduct regular monitoring of biological management effectiveness indicators, including those that help to track climate change impacts.

*Action M 1.1* Develop a monitoring plan that is intentional about the purpose of data collection, who collects the data, when the data should be collected, how data should be collected, how the data are input and stored, who completes analysis and reporting, and when.

*Action M 1.2* Continue longitudinal biological monitoring program inside and outside of the MLCD by DAR, Dr. Alan Friedlander, Dr. Kosta Stamoulis, and others.

*Action M 1.3* Continue community biological monitoring of Kapo'o and other areas within the MLCD. Coordinate with DAR to implement the Kōkua Community Based Monitoring framework and compare or integrate with existing monitoring plan.

*Action M 1.4* Continue and expand water quality monitoring to assess impact from facilities, infrastructure, development, and wastewater.

*Action M 1.5* Promote collaborative science and monitoring efforts that utilize a watershed perspective and consider mauka activities, impacts from human use, and all areas of the MLCD[36].

[36] *Community members named as science priorities (1) investigating the impacts of human manipulation of the Kamananui freshwater flow, (2) impacts from boating and anchoring in the MLCD, (3) impacts from commercial fishing in the MLCD, (4) annual variability and seasonality of fish schooling in Waimea Bay, and (5) protected or keystone species concerns (rays/mantas, whales, dolphins, monk seals, turtles). See Appendix 7 for other community suggestions.*

**Objective 2:** Conduct regular monitoring of human use and impacts.

*Action M 2.1* Support regular community monitoring of human use.

*Action M 2.2* Support a biological carrying capacity study (see activity PB 2.1).

**Objective 3:** Conduct regular kilo practices based on cultural knowledge.

*Action M 3.1* Continue kilo of marine life behaviors and relationships, including mauka-makai connections; limu; and areas within and adjacent to the MLCD.

*Action M 3.2* Support integrating kilo findings into management through management plans and proposals.

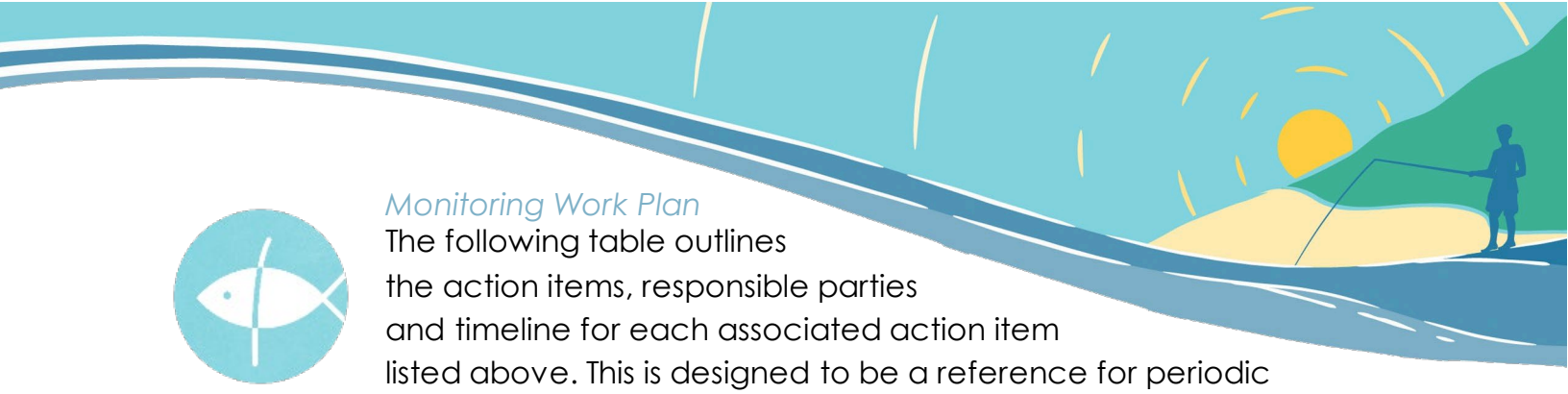
**Objective 4:** Integrate the results across all types of monitoring for decision-making and application to inform updates to the management plan (see Activity PB 2.4). Focus on methodology where results are replicable so they can be compared with other areas, identify trends, and focus management priorities.

*Action M 4.1* Review the monitoring results annually.

*Action M 4.2* Engage scientists, partners, and the community in integrating the scientific results into an annual update to the management plan.

*Action M 4.3* Coordinate with MPW to host a once-annual update to community on monitoring efforts and results from the past year.

*Action M 4.4* Coordinate with MPW to host a once-annual update to scientific and academic partners on monitoring efforts and results from the past year to better facilitate alignment between projects and planning for future projects.



## *Monitoring Work Plan*

The following table outlines the action items, responsible parties and timeline for each associated action item listed above. This is designed to be a reference for periodic evaluations and management planning for the MLCD.

| ACTIONS | RESPONSIBLE PARTIES | ACTION ITEMS | TIMELINE* | COMPLETION DATE/ PROPORTION COMPLETED AT REVIEW |
|---|---|---|---|---|
| **M 1.1** Develop a monitoring plan that is intentional about the purpose of data collection, who collects the data, when the data should be collected, how it should be collected, how the data is input and stored, who completes analysis and reporting, and when. | DAR<br>MPW<br>City Parks<br>Lifeguards | Develop a three-year monitoring plan with partners. Seek funding and support. | | |
| **M 1.2** Continue longitudinal biological monitoring program inside and outside of the MLCD | DAR<br>MPW<br>Dr. Alan Friedlander<br>Dr. Kosta Stamoulis<br>UH<br>NOAA | Report to partners at annual meeting. Integrate independent work into Science Plan (above) | | |
| **M 1.3** Continue community biological monitoring of Kapo'o and other areas within the MLCD. | MPW<br>Waimea Valley | Report to partners at annual meeting. | | |
| **M 1.4** Continue and expand water quality monitoring to assess impact from facilities, infrastructure, and wastewater. | DAR<br>DOH<br>MPW<br>Surfrider<br>City - DFM | Meet twice a year to review, update, implement SAP WQ program. | | |
| **M 1.5** Promote collaborative science and monitoring efforts that utilize a watershed perspective and consider mauka activities, impacts from human use, and all three areas of the MLCD (Waimea Bay, Kalua o Maua, and Pūpūkea). | DAR<br>DOFAW<br>Waimea Valley<br>MPW | Include DOFAW review and collaboration in science and monitoring plans, | | |
| **M 2.1** Support regular community monitoring of human use. | MPW<br>DAR | | | |
| **M 2.2** Support a biological carrying capacity study ( see activity PB 2.1). | DAR<br>MPW | | | |
| **M 3.1** Continue kilo of marine life behaviors and relationships, including mauka-makai connections; limu; and areas within and adjacent to the MLCD. | MPW<br>Community partners | | | |

| | | | | |
|---|---|---|---|---|
| **M 3.2.** Support integrating kilo findings into management through management plans and proposals. | DAR<br>MPW | Highlight summary findings from kilo in management plans | | |
| **M 4.1** Review the monitoring results annually. | DAR<br>MPW<br>UH<br>Other monitoring partners | Annual meeting | | |
| **M 4.2** Engage scientists, partners, and community in integrating the scientific results into an annual update to the management plan. | DAR<br>MPW<br>UH<br>Other monitoring partners | | | |
| **M 4.3** Coordinate with MPW to host a once-annual update to community on monitoring efforts and results from the past year. | DAR<br>MPW | | | |
| **M 4.4** Coordinate with MPW to host a once-annual update to scientific and academic partners on monitoring efforts and results from the past year to better facilitate alignment between projects and planning for future projects. | DAR<br>MPW<br>UH<br>Other monitoring partners | | | |

* Unless otherwise indicated, timelines will be established at the first partners meeting and updated at least annually to reflect current effort and progress.

### *Overview of Existing Monitoring in Pūpūkea MLCD*

Many existing monitoring activities help to inform the status of ecological and socio-cultural indicators. There have been extensive long-term monitoring efforts using underwater visual surveys by various organizations including, but not limited to the Nature Conservancy, University of Hawai'i, NOAA, and DAR. There has also been dedicated community-based monitoring efforts and independent research projects supported by the Pūpūkea community and Mālama Pūpūkea Waimea for almost two decades. DAR is now implementing socio-cultural monitoring to add this dimension as part of the comprehensive management strategy. This section provides an overview of the types and locations of surveys that are currently incorporated into indicator evaluation and management planning but does not represent all past monitoring efforts in the MLCD.

**Nearshore Visual Surveys (Monitoring) Included in the HIMARC Database**

Nearshore waters in Hawai'i are monitored by scientists involved in HIMARC in multiple ways, including underwater visual surveys conducted via SCUBA to measure both fish and benthic assemblages. These surveys are conducted by multiple monitoring programs run by federal and state agencies, non-profit organizations, and academic institutions. HIMARC combines these surveys into a single database as a resource for management and decision making. Benthic surveys within Pūpūkea MLCD included in HIMARC database have largely been conducted by the Nature Conservancy, the University of Hawai'i Fisheries Ecology Research Lab (FERL), and NOAA's Fish Habitat Utilization Study (FHUS). Several long-term sites are also surveyed by the University of Hawai'i Coral Reef Assessment and Monitoring Program (CRAMP) (Figure 24).

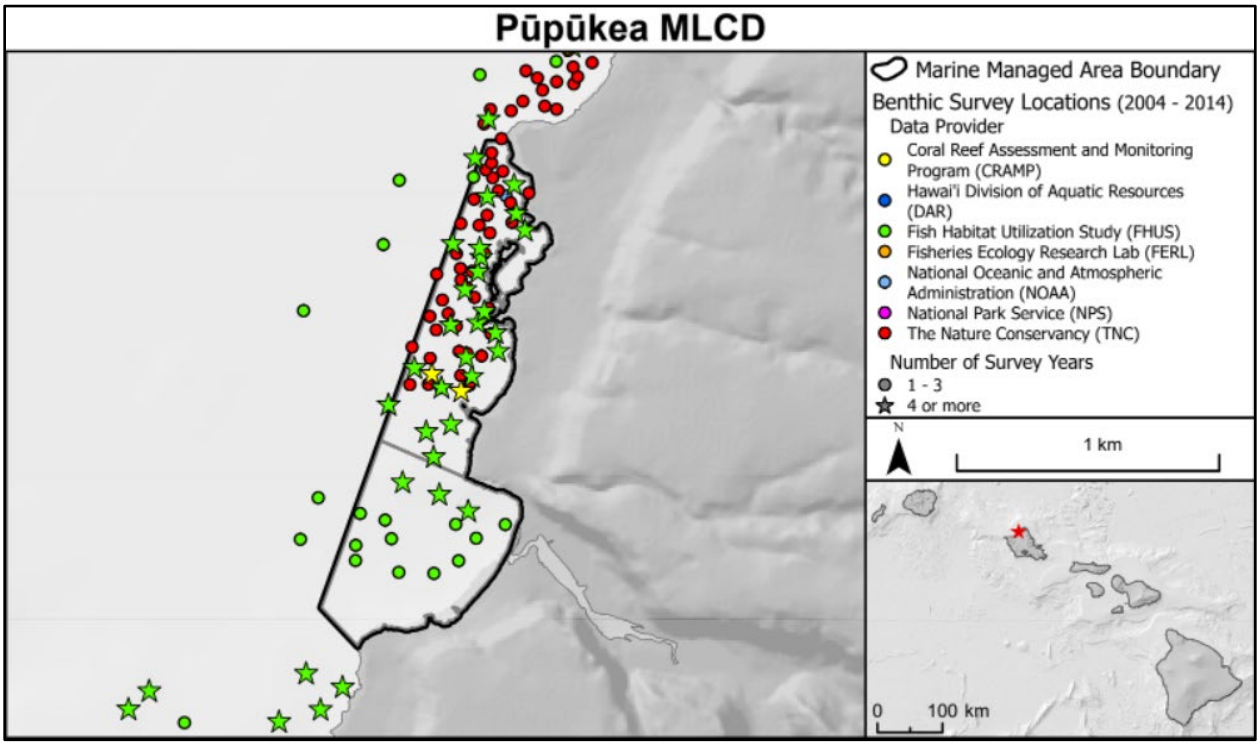



*Figure 24: Benthic survey locations by data provider collected between the years 2004 and 2014 that are incorporated in the HIMARC database. Sites with 4 or more years of surveys are stars and those with 1-3 years of surveys are circles.*

Fish surveys within Pūpūkea MLCD included in HIMARC database have been conducted by the Nature Conservancy, University of Hawai'i Fisheries Ecology Research Lab (FERL), and the NOAA's Fish Habitat Utilization Study (FHUS). Two long-term sites are also surveyed by the State of Hawai'i Division of Aquatic Resources (DAR) (Figure 25).

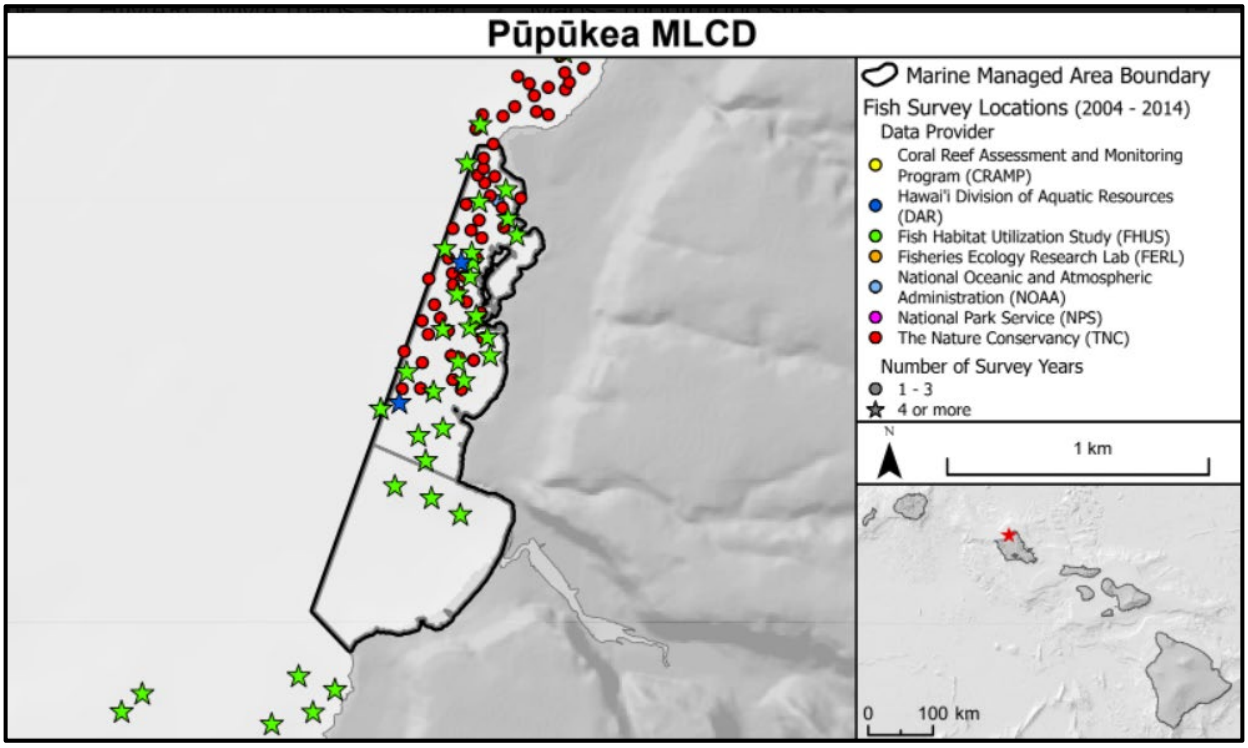



*Figure 25: Fish survey locations by data provider collected between the years 2004 and 2014 that are incorporated in the HIMARC database. Sites with 4 or more years of surveys are stars and those with 1-3 years of surveys are circles.*

## Community Supported and Community-Based Monitoring

Mālama Pūpūkea Waimea has supported and collaborated on numerous research projects since 2005. Priorities identified by the Pūpūkea community have been investigated through independent projects including supporting numerous graduate students and engaging volunteers from the community. Additionally, community members have conducted kilo, making observations of the nearshore resources such as limu for more than a decade. These community-based observations, build the record to changes to specific nearshore resources that are not routinely monitored by DAR and other agencies or academic monitoring programs.

- MPW training for and implementation of Makai Watch protocols for community-based human use monitoring, weekly (weather permitting), from 2005 to present

- MPW training for and implementation of Makai Watch protocols for community-based biological monitoring, weekly (weather permitting), from 2005-2018
- MPW regular (at least weekly) kilo (observation) of Kapoʻo, reef flats, native planting areas, and environment overall (weather permitting), from 2007-present
- Community engagement via iNaturalist- any member of the public can submit observations of flora or fauna to the iNaturalist website to be added to a global database of where species occur.
- MPW biological and environmental monitoring of Kapoʻo (June 2020-present, June-August 2012)
- MPW sea cucumber study (June-August 2015)
- MPW Kapoʻo survey (Alan Friedlander, Cindy Hunter, Whitney Goodell), summer 2020
- MPW study of fish outside Kapoʻo (Kosta Stamoulis), summer 2019
- MPW water quality SAP (Marvin Heskett, Surfrider) with testing by AECOS Lab (Snookie Mello)

These multi-faceted collaborative efforts between government agencies, university researchers, non-profit organizations and community members help to build a better understanding of the current status and management needs of the Pūpūkea MLCD.

**Monitoring Activities**

Collaboration and coordination in monitoring efforts is imperative to evaluate management effectiveness and track progress towards management plan objectives. In order to prevent redundancy and achieve a comprehensive approach, this monitoring table provides an overview of different monitoring efforts as they pertain to this management plan including what and who is conducting the monitoring and the where and how information is stored and shared.

| **What data/ document** (e.g. meeting notes, monitoring data, photos, social survey)**?** | **Source** (e.g., DAR monitoring, community-based monitoring survey, community organization) | **Whose data/ document is it** (community / organization /agency)**?** | **How will it be recorded?** | **How it will be stored, cataloged, and processed?** | **Indicator of importance of data/ document** (specific indicator if applicable, or purpose of data/ document) |
|---|---|---|---|---|---|
| Biological monitoring | Community organization | Mālama Pūpūkea-Waimea (MPW) | Input directly into Google Form<br><br>Commissioning studies | Google Form<br><br>Studies are published, shared via MPW | Tide pool study, sea cucumber study, etc. |
| Biological monitoring | DAR | DAR | | | |
| Biological monitoring | CRAMP | CRAMP | | | |
| Education/ outreach efforts and activities | MPW | MPW | | | |
| Rubbish/beach cleanups | MPW | MPW | | | |
| Human uses, censuses | Community organization | MPW | Input directly into Google Form and studies | Google Form | |
| Meeting notes | Multiple | MPW, DAR | Meeting minutes | Google Drive and MPW web site | |
| Photos/Kilo | Community organization | MPW | Photographs | Google Drive, MPW web site | |
| MLCD violations | DAR | DOCARE | DLNRTip App, called-in | MPW Wufoo database | |
| Commercial catch in Waimea Bay | DAR | DAR | | | |
| Socio-cultural monitoring | DAR | DAR, MPW | DAR data sheets/ Google form | Google form | |

## Restoration

The restoration pillar builds on existing strategies to promote resilience and prevent damage to fragile nearshore ecosystems from human use, terrestrial threats, and biological stressors including climate change. This pillar expands efforts to protect, restore, and enhance cultural and biological resources by strengthening and supporting community and agency partnerships, programs, and projects.

**Overarching Goal:** Develop a holistic approach to restoration by considering nearshore, coastal and land-based impacts to nearshore ecosystems that addresses current ecosystem threats and builds climate resilience for the future.

**Objective 1:** Take proactive and reactive measures to promote the protection and restoration of the MLCD marine ecosystems.

*Action R 1.1* Take action to identify and enhance essential habitat for at-risk marine species.

*Action R 1.2* Control and remove invasive species, such as alien limu, at the earliest practicable time.

*Action R 1.3* Prevent and remove marine debris from within the waters of the MLCD.

*Action R 1.4* Consider coral restoration projects for damaged corals.

**Objective 2:** Reduce mauka impacts to the MLCD through expanded efforts to restore and improve nearshore areas, and work with other agencies to reduce land-based threats to nearshore ecosystems.

*Action R 2.1* Support natural systems to reduce coastal erosion and sedimentation of the reef through native vegetation and other natural means. This may include, for example, continued native plant installation and maintenance and a bioremediation rain garden at shower sites.

*Action R 2.2* Reduce impacts from rubbish and marine debris through preventing introduction of waste into the marine ecosystem and removing waste that accumulates.

*Action R 2.3* Mediate and prevent future damage from foot traffic through working with the responsible agencies to effectively guide and control means of shoreline access.

*Action R 2.4* Work with the responsible agencies to improve and sustain healthy water quality through mitigating impacts from human use, infrastructure, runoff, and other sources of nonpoint and point source pollution.

**Objective 3:** Manage for climate resilience of the MLCD by considering rising sea levels, ocean acidification, coral bleaching, warming temperatures, and changes in the wave regime.

*Action R 3.1* Implement recommended human impact management actions that result from a biological carrying capacity study (see activity PB 2.1).

*Action R 3.2* Integrate with other climate change related plans, including City and County of Honolulu Climate Resilience Plans, the North Shore Sustainable Communities Plan, and the North Shore Coastal Resilience Working Group Report (2022).

*Action R 3.3* Support and plan for resilient infrastructure, beach, and pathways that are adaptable to climate change (e.g., boardwalks, Native Hawaiian plant coastal restoration, removable steps).

*Action R 3.4* Consider coral restoration opportunities to outplant climate resilient coral species.

The following table outlines the action items, responsible parties and timeline for each associated action item listed above. This is designed to be a reference for periodic evaluations and management planning for the MLCD.

| Actions | Responsible Parties | Action Items | Timeline* | Completion Date/ Proportion completed at Review |
|---|---|---|---|---|
| **R 1.1** Take action to identify and enhance essential habitat for at-risk marine species. | NOAA<br>DAR<br>MPW | Develop an essential habitat team, meet quarterly. | | |
| **R 1.2** Control and remove invasive species, such as alien limu, at the earliest practicable time. | DAR<br>MPW | MPW SAP permits, monitoring by Limu Hui, DAR | Ongoing | |
| **R 1.3** Prevent and remove marine debris from within the waters of the MLCD. | DAR<br>DOBOR<br>NOAA<br>MPW<br>Sustainable Coastlines Hawai'i<br>Kōkua Hawai'i Da Hui | Annual marine debris clean up | Ongoing | |
| **R 1.4** Consider coral restoration projects for damaged corals. | DAR<br>DOBOR<br>MPW | Identify locations and concepts, design, plan, implement. | | |
| **R 2.1** Support natural systems to reduce coastal erosion and sedimentation of the reef through native vegetation and other natural means. This may include continued native plant installation and maintenance, a bioremediation rain garden at shower sites, and other means. | MPW<br>City Parks, DFM<br>OCCL<br>Surfrider | Extend native plant project, continue maintenance, community education, grant funding. | | |
| **R 2.2** Reduce impacts from rubbish and marine debris through preventing introduction of waste into the marine ecosystem and removing waste that accumulates. | | | | |
| **R 2.3** Mediate and prevent future damage from foot traffic through working with the responsible agencies to effectively guide and control means of shoreline access. | | | | |
| **R 2.4** Work with the responsible agencies to improve and sustain healthy water quality | | | | |

| | | | | |
|---|---|---|---|---|
| through mitigating impacts from human use, infrastructure, runoff, and other sources of nonpoint and point source pollution. | | | | |
| **R 3.1** Implement recommended human impact management actions that result from a biological carrying capacity study (see activity PB 2.1). | | | | |
| **R 3.2** Integrate with other climate change related plans, including City and County of Honolulu Climate Resilience Plans and the North Shore Sustainable Communities Plan. | DAR<br>OCCL<br>MPW<br>City OCSR<br>NSNB | | | |
| **R 3.3** Support and plan for resilient infrastructure, beach, and pathways that are adaptable to climate change (e.g., boardwalks, Native Hawaiian plant coastal restoration, removable steps). | DAR<br>OCCL<br>MPW<br>City Parks, OCSR, DFM | | | |
| **R 3.4** Consider coral restoration opportunities to outplant climate resilient coral species. | DAR<br>MPW<br>Coral Gardeners | | | |

* Unless otherwise indicated, timelines will be established at the first partners meeting and updated at least annually to reflect current effort and progress.

## Additional References


https://dlnr.hawaii.gov/dar/marine-managed-areas/hawaii-marine-life-conservation-districts/oahu-pupukea/

https://dlnr.hawaii.gov/dar/files/2014/05/ch34.pdf

http://pupukeawaimea.org/pupukea-waimea-mlcd/history-of-the-mlcd/

https://www.nps.gov/places/pu-u-o-mahuka-heiau.htm

http://www.malamamaunalua.org/wp-content/uploads/Kupu-2013.pdf

http://nature.forestry.oregonstate.edu/sites/default/files/2007-2a%20DAR%20-%20Pupukea%20MLCD%20-%20Final%20Project%20Report%20-%20Needham%20-%20Final.pdf

Summary of Written Testimonies Received After the public Hearing for Proposed Chapter 13-34 Pupukea 1982, DAR Archives, O'ahu folder

Adoption of Chapter 13-34 Administrative Rules Pupukea MLCD, DAR Archives, O'ahu folder

Public Hearing Chapter 34 Pupukea MLCD 1982, DAR Archives, O'ahu folder

Marine Survey of the Sharks Cove Area, Island of Oahu, DAR Archives, O'ahu folder

https://ui.adsabs.harvard.edu/abs/2019AGUFM.H53I1857E/abstract

http://www.honoluludpp.org/Portals/0/pdfs/planning/Koolauloa/KoolauloaSCP.pdf

https://www.boardofwatersupply.com/bws/media/files/koolau-loa-wmp-prefinal-plan-rev2-2009-07-27.pdf

# List of Figures

# Appendices

## Appendix 1: Benthic Structure/ Habitat

Descriptions of Marine Management Areas include the variety of types of habitats that are included inside the designated area, and what those habitats provide for our species, so we can understand the connection between habitat and species abundance and resilience. Species can be adapted to and rely on certain habitat types. A diversity of habitat types provides for a diverse range of species that use them. Identifying the different types of habitats and the species inhabiting them can help inform management actions for Marine Management Area planning.

Descriptions of habitat typically include both the benthic structure as well as the biological cover. The benthic structure is the physical structure, or foundation, on which organisms can grow, and typically changes at a slower pace than the organisms, or biological cover such as corals or algae, that grow on top of that substrate. For the Hawaiian Islands, some major classes of the benthic structure are unconsolidated sediment (like mud and sand), reef and hardbottom (including coral reef structure, and rock and boulder), as well as other delineations such as artificial (human-created), land, and unknown.

The most complete spatial data set for benthic structure across the Hawaiian Islands is from the Mapping of the Benthic Habitats for the Main Eight Hawaiian Islands, completed BAE Systems Sensor Solutions Identification and Surveillance contracted by NOAA in 2007. For the biological cover, such as changes in coral and algae, we will be using more recently updated spatial monitoring data in a later section of this management plan. These more recent spatial data sets are limited in the description of the underlying benthic structure and focus primarily on the biological cover, as they are based on monitoring survey data. The 2007 data has the best statewide spatial coverage of benthic structure and, as it is slower to change than the benthic cover (like coral and algae), it is reasonable to assume that it is still representative of the current structure in most cases.

Excerpt from *Abridged Methods Manual for Shallow Water Mapping of the Main Hawaiian Islands* 2007:

> The structure types are defined as a range of four major classes (coral reef and hardbottom, unconsolidated sediment, other delineations and unknown), that encompass thirteen detailed habitat structure classes (sand, mud, spur and groove, individual and aggregated patch reef, aggregate reef, scattered coral/rock in unconsolidated sediment, pavement, rock/boulder (volcanic and carbonate), reef rubble, pavement with sand channels, artificial, and unknown).

| Benthic Structure | |
|---|---|
| Pavement | Pavement with Sand Channels |
| Mud | Spur and Groove |
| Sand | Artificial |
| Land | Scattered Coral/Rock |
| Rock/Boulder | Rubble |
| Aggregate Reef | Aggregated Patch Reef |
| Individual Patch Reef | Unknown |

Unconsolidated Sediment:

***Sand:*** *Coarse sediment typically found in areas exposed to currents or wave energy.*

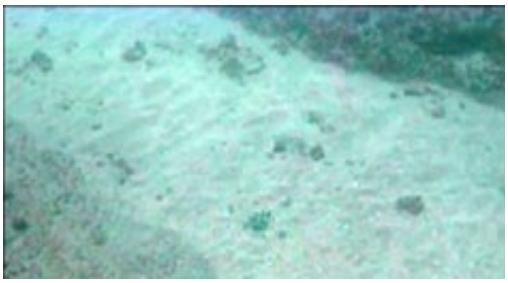
***Mud:*** *Fine sediment often associated with river discharge and build-up of organic material in areas sheltered from high-energy waves and currents.*

## Coral and Hardbottom:

***Pavement:*** *Flat, low-relief, solid carbonate rock with coverage of macroalgae, hard coral, zoanthids, and other sessile invertebrates that are dense enough to begin to obscure the underlying surface.*

***Aggregate Reef:*** *High relief coral reef, with high rugosity. No interruptions of sand channels or spur and groove.*

***Rock/Boulder:*** *Solid carbonate blocks and/or boulders or volcanic rock.*



***Pavement with Sand Channels:*** *Habitats of pavement with alternating sand/surge channel. The sand/surge channels of this feature have low vertical relief relative to spur and groove.*

***Scattered Coral/Rock in Unconsolidated Sediment:*** *Primarily sand or seagrass bottom with scattered rocks or small, isolated coral heads that are too small to be delineated individually (i.e. smaller than individual patch reef).*

***Spur and Groove:*** *Habitat with alternating sand and coral formations that are oriented perpendicular to the shore or bank/shelf escarpment. The coral formations (spurs) of this feature typically have a high vertical relief relative to pavement with sand*

***Individual Patch Reef:*** *Coral formations that are isolated from other coral reef formations by sand, seagrass, or other habitats and that have no organized structural axis relative to the contours of the shore or shelf edge.*

***Rubble:*** *Dead, unstable coral rubble often colonized with filamentous or other macroalgae. This habitat often occurs landward of well-developed reef formations in the reef crest or back reef zone.*


*Unknown: Zone, Cover, and Structure uninterpretable due to turbidity, cloud cover, water depth, or other interference.*

## Other Delineations

*Artificial: Man-made habitats such as submerged wrecks, large piers, submerged portions of rip-rap jetties, and the shoreline of islands created from dredge spoil. Includes active and remnant fish ponds walled off from the open ocean along the shoreline.*

## Appendix 2: HIMARC Introduction and Methods

HAWAIʻI MONITORING AND REPORTING COLLABORATIVE

The Hawaiʻi Monitoring and Reporting Collaborative (HIMARC) manages a database of monitoring data from large-scale monitoring programs, monitoring at specific sites, and one-off surveys by individual researchers. The data are provided by 7 main data sources: (1) Fisheries Ecology Research Lab, University of Hawaiʻi (FERL); (2) The Nature Conservancy Hawai'i Marine Program (TNC); (3) the National Park Service (NPS); (4) Fish Habitat Utilization Study, NOAA Biogeography (FHUS); (5) National Coral Reef Monitoring Program (NOAA); (6) Division of Aquatic Resources, State of Hawaiʻi (DAR); and (7) Coral Reef Assessment and Monitoring Program, University of Hawaiʻi (CRAMP).

These disparate datasets are first compiled into a single database such that synthetic analyses can be conducted across different components of the coral reef assemblage. Each dataset is acquired from partners, transformed into a consistent format, checked rigorously for errors, and formatted in a common framework while retaining important metadata that is needed for analysis. During the data quality assurance and quality control process (QA/QC), HIMARC engages the data providing organizations in an extensive back-and-forth review process. This process accounts for any potential errors in data collection. The clean dataset is then combined into a larger dataset for analysis of reef indicator condition.

Indicator condition is modeled by analyzing survey data (like number and size of fish or percent coral cover in an area during a survey) with driver data (Figure 26). Drivers are factors that we know are connected to the condition of given indicators such as land-based pollution, oceanography, habitat and harvest.

For each indicator, HIMARC estimated indicator condition using statistical models that accounted for variation in space, time, and data source, and were a function of human and environmental variables. As part of the modeling process, HIMARC considered how to achieve the most robust and relevant estimates of indicator condition given the available data. During this process, recommendations were developed for how to account for variability in survey design in the combined dataset, including appropriate methods for hierarchical statistical modeling.

The statistical modeling framework was customized to address the inherent variability of underwater survey data. Further, the approach accounts for "unbalanced" data

(where data are not evenly spread across habitat type, depth, or other important strata). The final models estimated the condition of each indicator using a Bayesian hierarchical model of the relationship between the indicator and drivers, and accounts for variability in the data sampling methods.

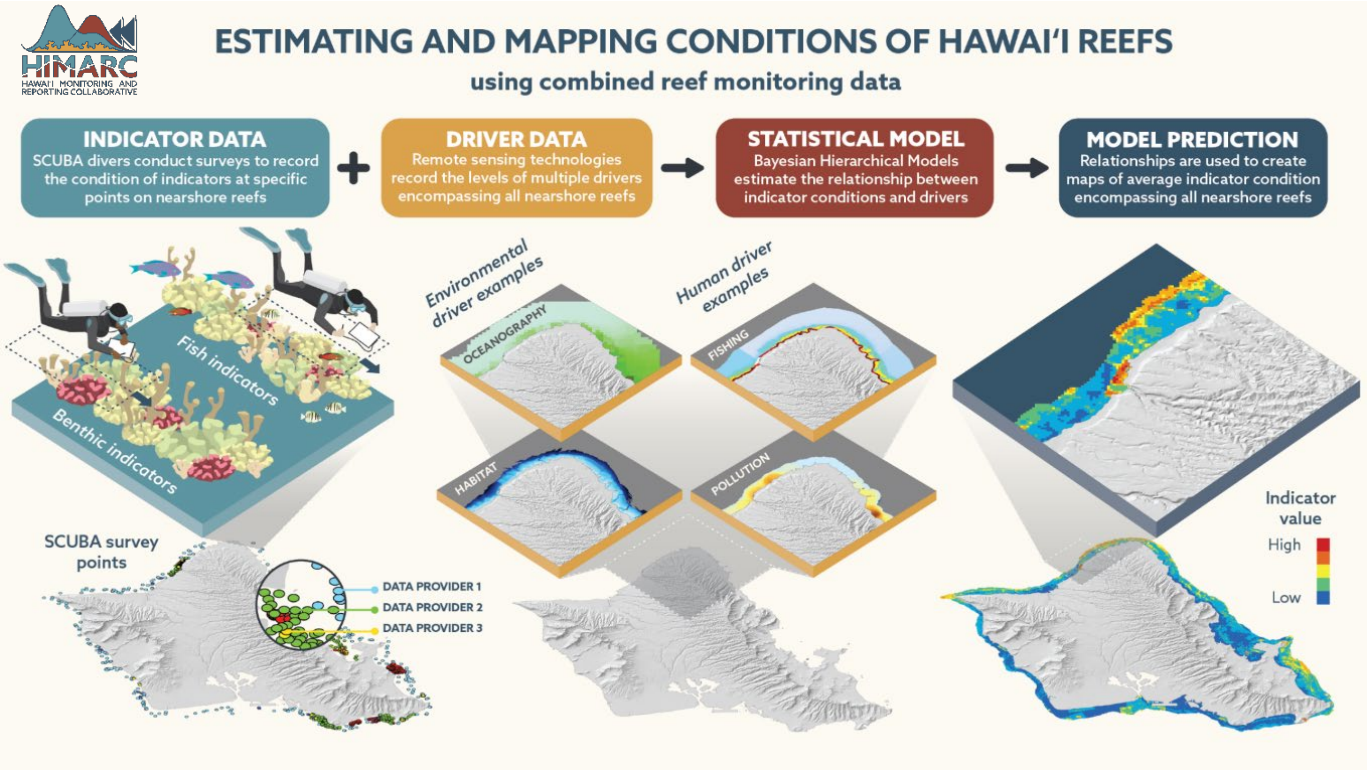



*Figure 26: Methods used by the Hawai'i Monitoring and Reporting Collaborative to model the condition of nearshore reefs in the Main Hawaiian Islands. SCUBA surveys conducted by multiple data providers measure benthic and fish indicator variables that are included in HIMARC analyses (left). The indicator surveys are combined with 27 driver layers that are hypothesized to influence indicator condition, including environmental and human drivers (middle). Both datasets are combined in a statistical model to understand the relationship between indicators and drivers, and are used to make predictions of indicator condition for hardbottom areas at a scale of 100m extending from the shoreline to 30 m depth (right).*

Drivers are factors that influence indicator condition and are broken into four categories: habitat, oceanography, fishing, and land-based pollution. The majority of these data come from the Hawa'i Ocean Tipping Points project, the Global Airborne Observatory (GAO), and the National Oceanic and Atmospheric Administration's (NOAA) Integrated Ecosystem Assessment (IEA) program. These datasets, unlike those for the indicator data, encompass the entirety of the nearshore reefs around the main

Hawaiian Islands due to capabilities of remote sensing to gather data for large areas at a time.

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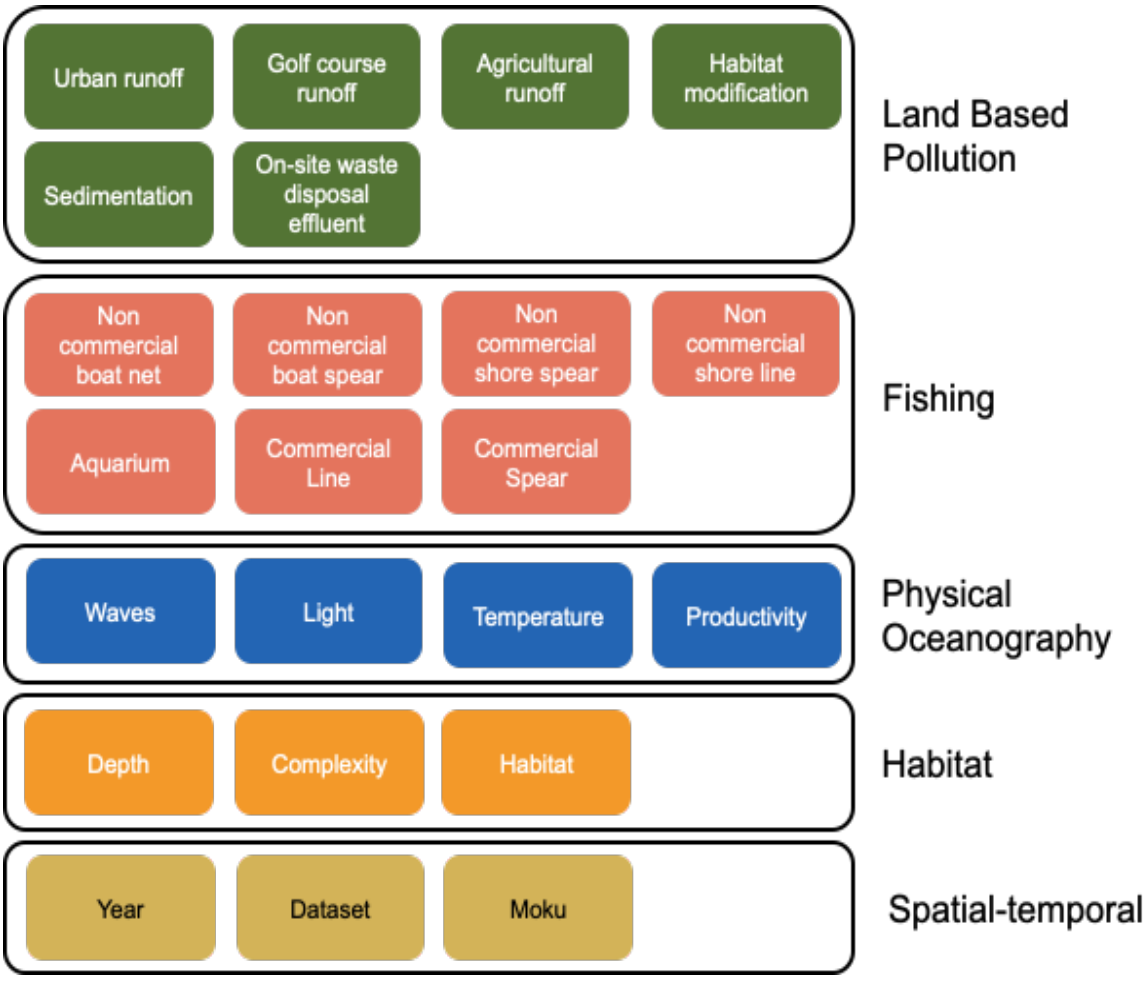
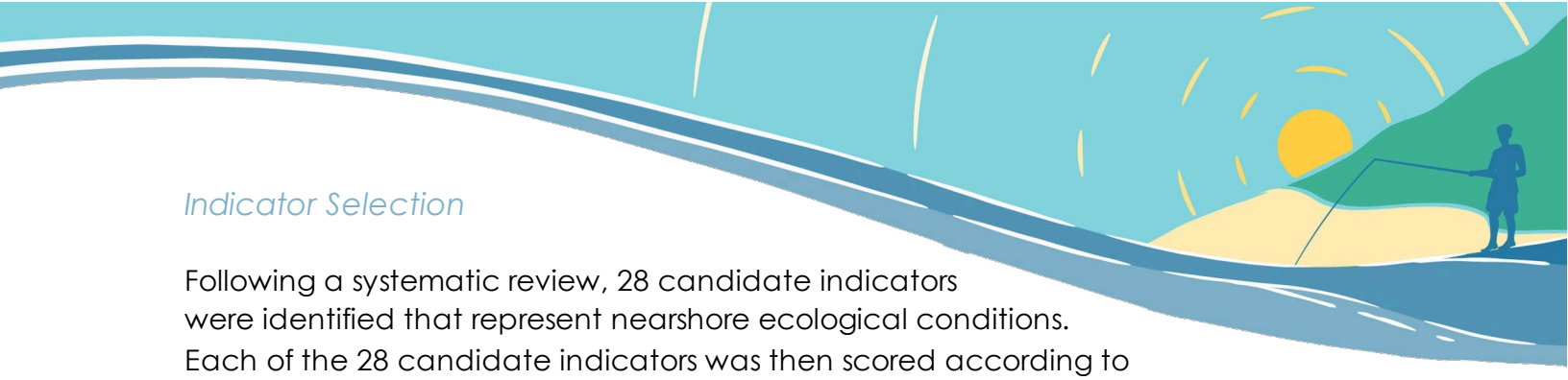
The integrated survey data and the driver datasets were then used to create a statistical model that shows a full picture of each indicator's condition for nearshore reef areas. A Bayesian hierarchical model was used to determine the effects of all drivers on the condition of each indicator.




Using the statistical model, continuous maps were created showing the predicted condition of each indicator for all nearshore areas. Closeup images of these maps are highlighted in this management plan, where each pixel on the map represents the best estimate of indicators for hardbottom areas within a 100m x 100m area. Along with the best estimate for each indicator in each pixel, the uncertainty associated with that best estimate was also calculated and is displayed as increasing transparency for pixels where we are less certain in the estimate.



## *Indicator Selection*

Following a systematic review, 28 candidate indicators were identified that represent nearshore ecological conditions. Each of the 28 candidate indicators was then scored according to established criteria. The criteria were related to (1) theoretical soundness, (2) relevance to management concerns, (3) known responsiveness to management interventions, (4) data availability and measurability, and (5) interpretability by policy makers and the public. Input was gathered at multiple steps in the process from a group of experts in Hawai'i coral reef ecology.

Ultimately, seven indicators (Fish Diversity, Resource (food) Fish Biomass, Mean Fish Size, Total Fish Biomass, Coral Cover, Calcified to Fleshy Ratio, and Herbivore Fish Biomass) were chosen to represent both traditional measurements of coral reef ecosystem state (fish assemblages and benthic cover) and additional measurements that represent biodiversity, reef resilience, and food fish. These indicators span across these five categories that represent five aspects of the condition of nearshore resources: biodiversity, food fish, fish assemblage, benthic cover and resilience.

Because it is not possible to conduct surveys for every reef, and due to uneven distribution of monitoring effort, HIMARC has developed methods to estimate indicator values for all nearshore reef areas (infographic) by combining underwater ecological surveys with data on drivers (human, oceanographic, and habitat variables that affect indicator condition). These estimates are then summarized for the marine managed area (MMA) below in two ways:

**Maps:** For each indicator, a map of the MMA and the best estimated values are shown. Estimated values are displayed in 100m x 100m square grids. These values are the best available estimate of average indicator condition for hardbottom in each grid, estimated from statistical models that incorporate the underwater ecological survey data and data on fishing, land-based pollution, oceanography, and habitat. The boundary of the MMA is outlined in black.

**Bar Plots:** For each indicator, the best estimate of the (average) for the indicator condition are shown along with the uncertainty associated with that estimate. Spatial references are also shown, including the main Hawaiian Islands (MHI), no-take areas across the MHI, and the island and moku where the MMA is located. Recovery potential shows what the change in range of conditions could be if stressors are minimized.

# Appendix 3: HIMARC Fish Indicator Recovery Potential Methods and Plots

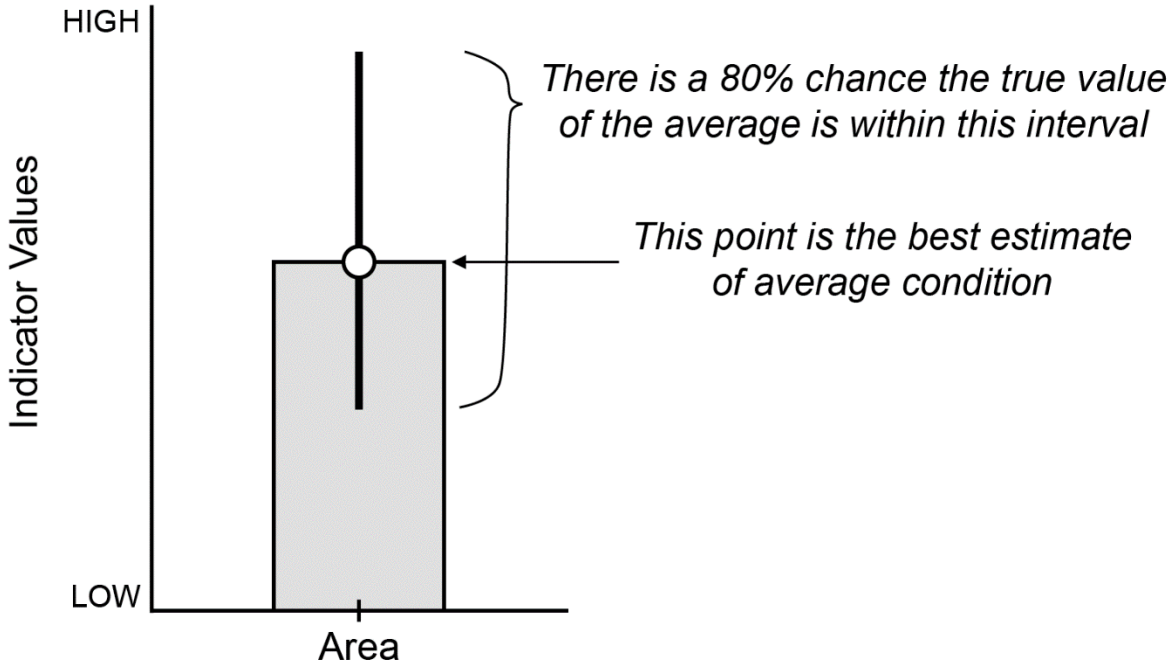
HAWAI'I MONITORING AND REPORTING COLLABORATIVE

## *Estimating Recovery Potential*

Once the model and maps are created, the statistical model can be used to understand potential for recovery of the fish indicators within each studied marine management area (MMA) if certain drivers that negatively affect indicator condition are reduced or eliminated. For example, in the model comparing fish biomass to pollution, value for the pollution driver can be lowered to determine whether fish biomass will fall, rise, or stay the same if pollution near the MMA was reduced. This allows a prediction of what could happen to the condition of indicators in each MMA if certain drivers were reduced. Recovery potential was calculated for fish indicators and not benthic indicators because HIMARC has a better understanding of the links between human drivers and fish assemblage indicators than for benthic indicators. Research is ongoing to better quantify the relationships between benthic indicators and human drivers, which could allow for assessments of recovery potential in the future.

In total, seven ecological indicators were selected for the Pūpukea MLCD Management Plan to provide measurable characteristics of the status and trends of nearshore reefs, including both benthic and fish indicators. Benthic indicators include percent coral cover, and the ratio of calcified to fleshy benthic cover. Fish indicators include fish diversity, average fish size, and biomass of total fish, resource fish, and herbivores.

Bar graphs present the best available understanding of the condition of each indicator, while also communicating the uncertainty associated with that estimate. The height of the bar and circle indicates the best estimate of the average value predicted from the statistical model. The vertical line represents the interval of predicted values within which there is an 80% chance the true average is in.




**Interpreting the uncertainty interval (vertical line)**

*When the vertical line is short*: this indicates the best estimate of the average is similar to the range of values predicted so we have high confidence that the mapped values reflect true conditions of hardbottom habitats from 2004-2014.

*When the vertical line is tall*: this indicates there is a wide range of possible values for the average, so the best estimate should be interpreted as possibly varying within the range of the vertical bar.

*When one vertical line overlaps another*: this suggests that we are not able to interpret whether the two areas are different because they may have possible overlapping estimates of average condition.

*When one vertical line is higher or lower than another*: this suggests that we have confidence that the average conditions of the two areas are different.

The Pūpūkea MLCD has been established for 40 years, with rules that greatly reduce harvest and fishing from within its boundaries. For a marine management area to be effective and have lasting impacts, it is generally recommended not to design rotational closures[37] and that any regulations are in place for a minimum of 20 years[38]. This allows recovery time for the marine organisms affected by the regulations. If regulations are removed, the recovery that resulted from any closure or regulations will likely not be persistent[39]. Given the longevity of the Pūpūkea MLCD, results of recovery potential of fish indicators with reduced fishing pressure should be interpreted with the understanding that fishing pressure has already been greatly reduced within the MLCD, and therefore, significant increases or improvement in the condition of fish indicators with further reduced fishing pressure, would not be expected. MLCDs and reserves in Hawai'i serve as a baseline for statistical comparison as they restrict fishing pressure and can provide an indication of what the natural condition of fish indicators could be, in the absence of fishing pressure, but with other environmental variables and human impacts considered comparable.


[37] Abesamis, R. A., Green, A. L., Russ, G. R., & Jadloc, C. R. L. (2014). The intrinsic vulnerability to fishing of coral reef fishes and their differential recovery in fishery closures. *Reviews in Fish Biology and Fisheries*, 24(4), 1033-1063.

[38] Green, A.L., Fernandes, L., Almany, G., Abesamis, R., McLeod, E., Aliño, P.M., White, A.T., Salm, R., Tanzer, J. and Pressey, R.L., 2014. Designing marine reserves for fisheries management, biodiversity conservation, and climate change adaptation. *Coastal Management*, 42(2), pp.143-159.

[39] Williams, I., Walsh, W., Miyasaka, A. & Friedlander, A. Effects of rotational closure on coral reef fishes in Waikīkī-Diamond head fishery management area, O'ahu, Hawai'i. *Marine Ecology Progress Series* 310, 139–149 (2006).

## Fish Species Diversity

The best estimate of average fish species diversity in the Pūpūkea MLCD is predicted to be 0.81 based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 0.78 and 0.85 based on the available information (Figure 27).

Predicted fish species diversity in Pūpūkea MLCD is comparable to fish species diversity of other reefs in Koʻolauloa, Oʻahu, and fish species diversity in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 27). Fish species diversity is comparable to the estimated diversity if all stressors were minimized, indicating that land-based and fishing-based stressors may not be having a detectable effect on estimated fish diversity inside the MLCD (Figure 27).

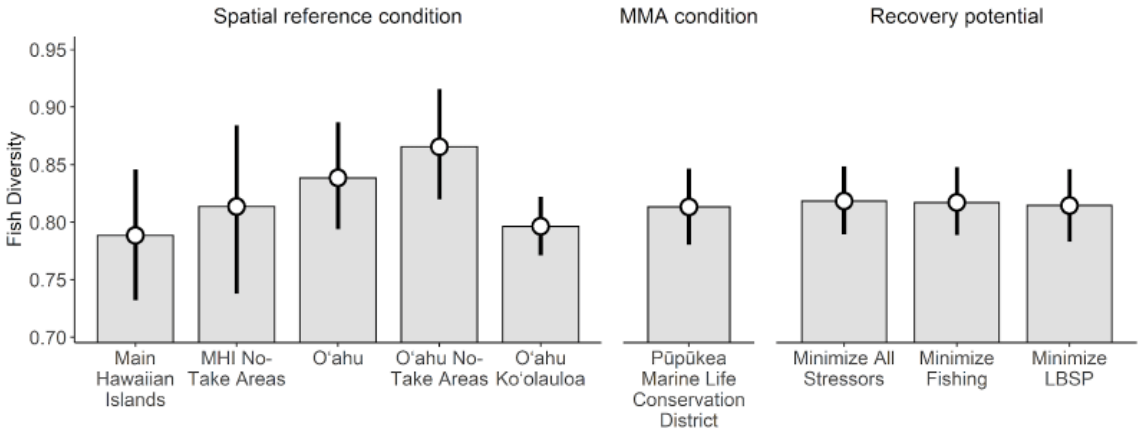



*Figure 27: Comparison of predicted fish species diversity in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions and the bars to the right show recovery potential to provide comparisons based on reducing stressors. LBSP: land-based sources of pollution.*

## Resource Fish Biomass

The best estimate of average resource fish biomass in the Pūpūkea MLCD is predicted to be 88.1 g/m$^2$ based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 37.72 and 198.4 g/m$^2$ based on the available information (Figure 28).

Predicted resource fish biomass in Pūpūkea MLCD is comparable to resource fish biomass of other reefs in Koʻolauloa, Oʻahu, and resource fish biomass in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 28). Resource fish biomass is comparable to the estimated biomass if all stressors were minimized, indicating that land-based and fishing-based stressors may not be having a detectable effect on estimated resource fish biomass inside the MLCD (Figure 28).

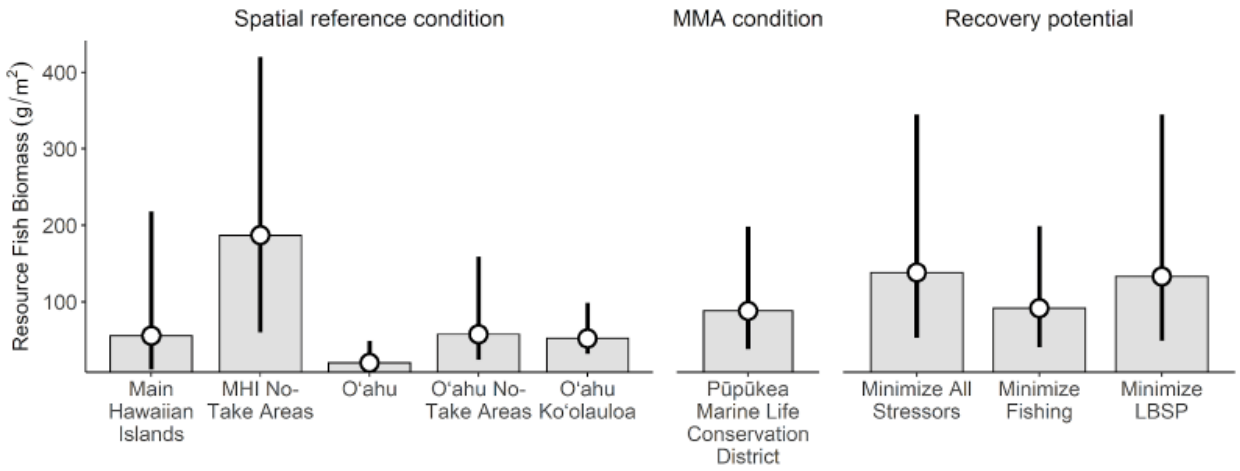



*Figure 28: Comparison of predicted resource fish biomass in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions and the bars to the right show recovery potential to provide comparisons based on reducing stressors. LBSP: land-based sources of pollution.*

## Mean Fish Size

The best estimate of average mean fish size in the Pūpūkea MLCD is predicted to be 19.8 cm based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 18.2 and 21.4 cm based on the available information (Figure 29).

Predicted mean fish size in Pūpūkea MLCD is comparable to mean fish size of other reefs in Koʻolauloa, Oʻahu and mean fish size in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 29). Mean fish size is comparable to the estimated biomass if all stressors were minimized, indicating that land-based and fishing-based stressors may not having a detectable effect on estimated mean fish size inside the MLCD (Figure 29).

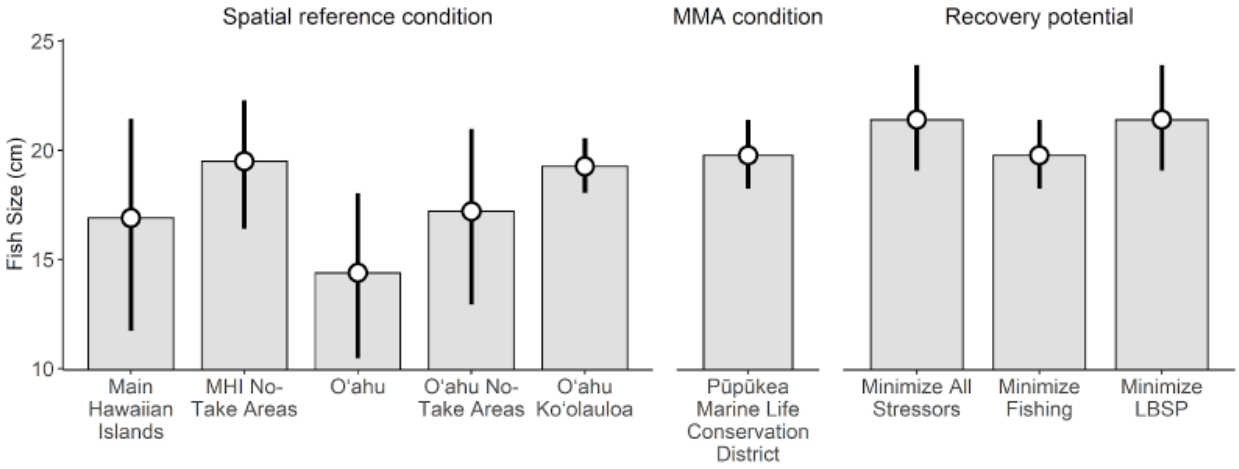



*Figure 29: Comparison of predicted mean fish size in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions and the bars to the right show recovery potential to provide comparisons based on reducing stressors. LBSP: land-based sources of pollution.*

## Total Fish Biomass

The best estimate of average total fish biomass in the Pūpūkea MLCD is predicted to be 102.87 g/m$^2$ based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 47.39 and 201.08 g/m$^2$ based on the available information (Figure 30).

Predicted total fish biomass in Pūpūkea MLCD is comparable to total fish biomass of other reefs in Ko'olauloa, O'ahu, and total fish biomass in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 30). Total fish biomass is comparable to the estimated biomass if all stressors were minimized, indicating that land-based and fishing-based stressors may not be having a detectable effect on estimated total fish biomass inside the MLCD (Figure 30).

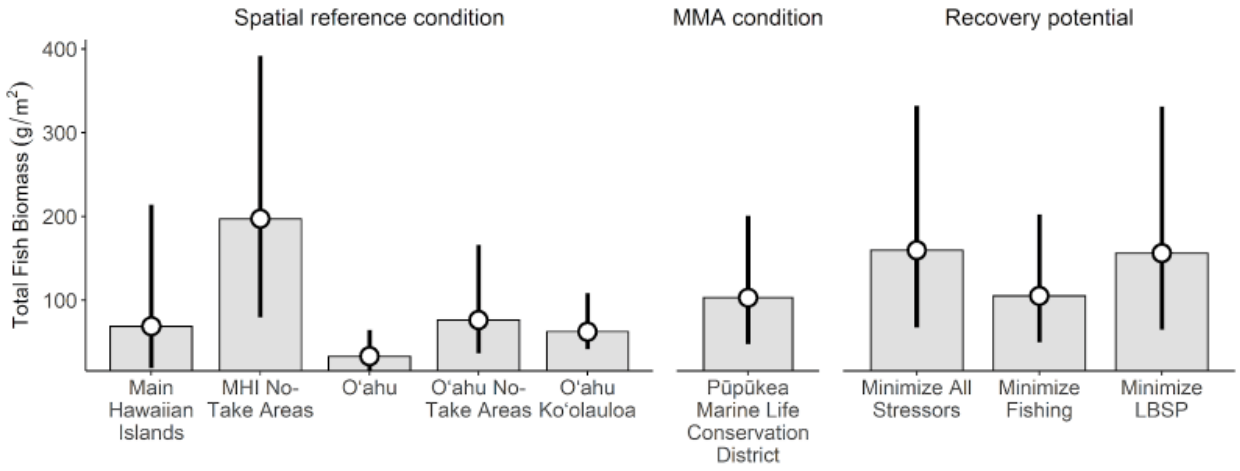



*Figure 30: Comparison of predicted total fish biomass in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions and the bars to the right show recovery potential to provide comparisons based on reducing stressors. LBSP: land-based sources of pollution.*

## Herbivorous Fish Biomass

The best estimate of average herbivorous fish biomass in the Pūpūkea MLCD is predicted to be 78.81 g/m$^2$ based on data from 2004-2014, and an 80% chance exists that the true estimate of the average is within 31.09 and 159.69 g/m$^2$ based on the available information (Figure 31).

Predicted herbivorous fish biomass in Pūpūkea MLCD is comparable to herbivorous fish biomass of other reefs in Koʻolauloa, Oʻahu and herbivorous fish biomass in Pūpūkea MLCD is comparable to reefs overall across the MHI (Figure 31). Herbivorous fish biomass is comparable to the estimated biomass if all stressors were minimized, indicating that land-based and fishing-based stressors may not having a detectable effect on estimated herbivorous fish biomass inside the MLCD (Figure 31).

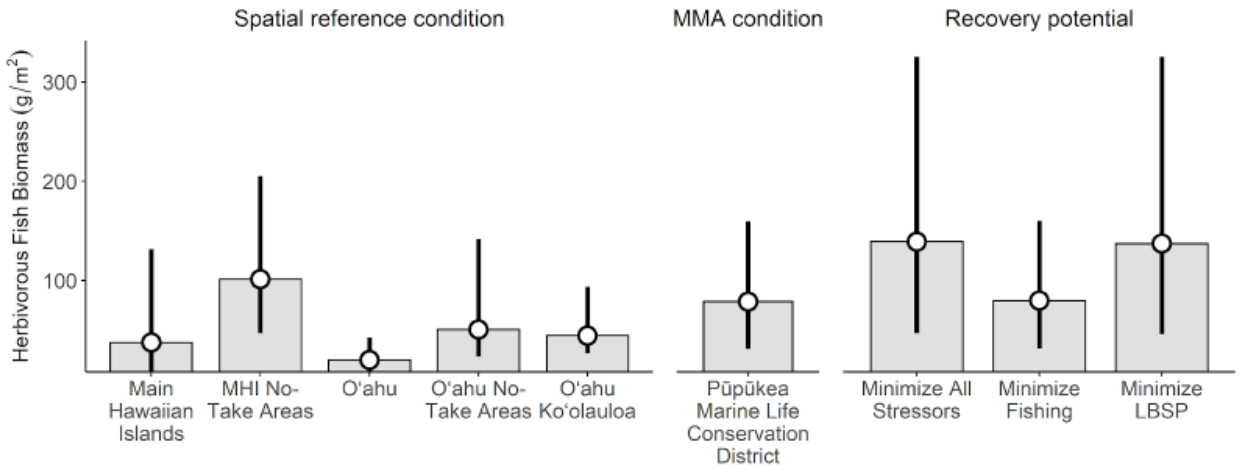
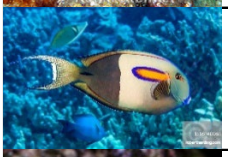
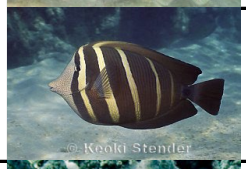


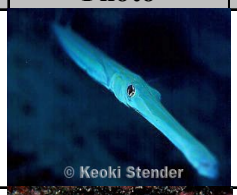

*Figure 31: Comparison of predicted herbivorous fish biomass in the Pūpūkea MLCD with reference conditions. Predictions are for hard-bottom areas (e.g., coral reef, pavement, or boulders). Plots show the average (height of the bar), and the 80% credible interval for the average (vertical lines). The center bar shows the indicator condition in the marine managed area. The bars to the left show spatial reference conditions and the bars to the right show recovery potential to provide comparisons based on reducing stressors. LBSP: land-based sources of pollution.*

# Appendix 4: Resource Fish Species List for HIMARC Analyses

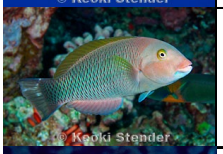
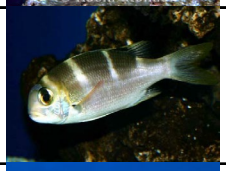
| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Acanthuridae |  | *Acanthurus achilles* | pāku‘iku‘i | Achilles Tang |
| |  | *Acanthurus blochii* | pualu | Ringtail Surgeonfish |
| |  | *Acanthurus dussumieri* | palani | Eye-stripe Surgeonfish |
| |  | *Acanthurus guttatus* | ‘api | Whitespotted Surgeonfish |
| |  | *Acanthurus leucopareius* | māikoiko | Whitebar Surgeonfish |
| |  | *Acanthurus nigroris* | maiko | Bluelined Surgeonfish |
| |  | *Acanthurus olivaceus* | na‘ena‘e | Orangeband Surgeonfish |
| |  | *Acanthurus triostegus* | manini | Convict Tang |
| |  | *Acanthurus xanthopterus* | pualu | Yellowfin Surgeonfish |
| |  | *Ctenochaetus hawaiiensis* | | Black Surgeonfish |
| |  | *Ctenochaetus strigosus* | kole | Goldring Surgeonfish |

| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Acanthuridae |  | *Naso annulatus* | | Whitemargin Unicornfish |
| |  | *Naso brevirostris* | kala lōlō | Paletail Unicornfish |
| |  | *Naso caesius* | | Gray Unicornfish |
| |  | *Naso hexacanthus* | kala holo or 'ōpelu kala | Sleek Unicornfish |
| |  | *Naso lituratus* | umaumalei | Orangespine Unicornfish |
| |  | *Naso maculatus* | | Spotted Unicornfish |
| |  | *Naso unicornis* | kala | Bluespine Unicornfish |
| |  | *Zebrasoma veliferum* | māne‘one‘o | Sailfin tang |
| Albulidae |  | *Albula glossodonta* | ‘o‘io | Bonefish |
| Belonidae |  | *Tylosurus crocodilus* | | Crocodile or Hound Needlefish |

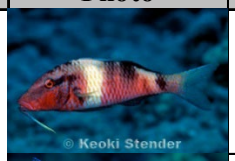
| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Carangidae |  | *Alectis ciliaris* | ulua kihikihi or Kagami ulua | Threadfin Jack |
| |   | *Carangoides ferdau* | ulua | Barred Jack |
| |   | *Carangoides orthogrammus* | papa ulua | Island Jack |
| |   | *Caranx ignobilis* | ‘ulua aukea | Giant White Trevally |
| |   | *Caranx lugubris* | ulua lā'uli | Black Trevally |
| |  | *Caranx melampygus* | ‘ōmilu | Blue Trevally |
| |   | *Caranx sexfasciatus* | pake ‘ulua | Bigeye Trevally |
| |   | *Gnathanodon speciosus* | ulua pa'opa'o | Yellow-barred Jack or Golden Trevally |
| |   | *Pseudocaranx cheilio* | buta ulua | Thicklipped Jack |
| |   | *Scomberoides lysan* | lai | Leatherback |
| |  | *Seriola dumerili* | kahala | Amberjack |
| |   | *Seriola rivoliana* | | Highfin Amberjack |

| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Fistulariidae |  | *Fistularia commersonii* | nunu peke | Cornetfish |
| Holocentridae |  | *Myripristis amaena* | ʻūʻū | Brick Soldierfish |
| |  | *Myripristis berndti* | ʻūʻū | Bigscale Soldierfish |
| |  | *Myripristis chryseres* | paʻūʻū | Yellowfin Soldierfish |
| |  | *Myripristis kuntee* | ʻūʻū | Epaulette Soldierfish |
| |  | *Myripristis vittata* | ʻūʻū | Whitetip Soldierfish |
| |  | *Neoniphon aurolineatus* | ʻalaʻihi | Goldline Squirrelfish |
| |  | *Neoniphon sammara* | ʻalaʻihi | Spotfin squirrelfish |
| |  | *Pristilepis oligolepis* | ʻūʻū | Spinyface Soldierfish |
| |  | *Sargocentron diadema* | ʻalaʻihi | Crown Squirrelfish |
| |  | *Sargocentron ensifer* | ʻalaʻihi | Yellowstriped Squirrelfish |

| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Holocentridae |  | *Sargocentron punctatissimum* | ʻalaʻihi | Peppered Squirrelfish |
| |  | *Sargocentron spiniferum* | ʻalaʻihi | Saber Squirrelfish |
| |  | *Sargocentron tiere* | ʻalaʻihi | Tahitian Squirrelfish |
| |  | *Sargocentron xantherythrum* | ʻalaʻihi | Hawaiian Squirrelfish |
| Kuhliidae |  | *Kuhlia sandvicensis* | āholehole | Reticulated Flagtail |
| |  | *Kuhlia xenura* | āholehole | Hawaiian Flagtail |
| Kyphosidae |  | *Kyphosus* species | nenue | Chubs |
| Labridae |  | *Anampses cuvier* | ōpule | Pearl Wrasse |
| |  | *Bodianus albotaeniatus* | ʻaʻawa | Hawaiian Hogfish |
| |  | *Coris flavovittata* | hilu | Yellowstrip coris |
| |  | *Iniistius aneitensis* | | Whitepatch Razorfish |

| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Labridae |  | *Iniistius baldwini* | laenihi | Baldwin's Razorfish |
| |  | *Iniistius pavo* | laenihi | Peacock Razorfish |
| |  | *Iniistius umbrilatus* | laenihi | Blackside Razorfish |
| |  | *Oxycheilinus unifasciatus* | pōʻou | Ringtail Wrasse |
| |  | *Thalassoma ballieui* | hīnālea luahine | Blacktail or Old Woman Wrasse |
| |  | *Thalassoma purpureum* | hou | Surge Wrasse |
| Lethrinidae |  | *Monotaxis grandoculis* | mu | Bigeye Emperor |
| Lutjanidae |  | *Aphareus furca* | wahanui | Smalltooth Jobfish |
| |  | *Aprion virescens* | uku | Green Jobfish |
| |  | *Lutjanus fulvus* | toʻau* | Blacktail Snapper |
| |  | *Lutjanus gibbus* | | Humpback Snapper |
| |  | *Lutjanus kasmira* | taʻape* | Bluestripe Snapper |

| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Monacanthidae |  | *Aluterus scriptus* | loulu | Blue Scrawled Filefish |
| Mugilidae |  | *Mugil cephalus* | ‘ama‘ama | Striped Mullet |
| |  | *Neomyxus leuciscus* | uouoa | Sharpnose Mullet |
| Mullidae |  | *Mulloidichthys flavolineatus* | weke‘a or ‘oama | Yellowstripe Goatfish |
| |  | *Mulloidichthys mimicus* | | Mimic Goatfish |
| |  | *Mulloidichthys pfluegeri* | weke ‘ula | Orange Goatfish |
| |  | *Mulloidichthys vanicolensis* | weke ‘ula | Yellowfin Goatfish |
| |  | *Parupeneus chrysonemus* | | Yellowbarbel Goatfish |
| |  | *Parupeneus cyclostomus* | moano kea | Blue Goatfish |
| |  | *Parupeneus insularis* | munu | Doublebar Goatfish |

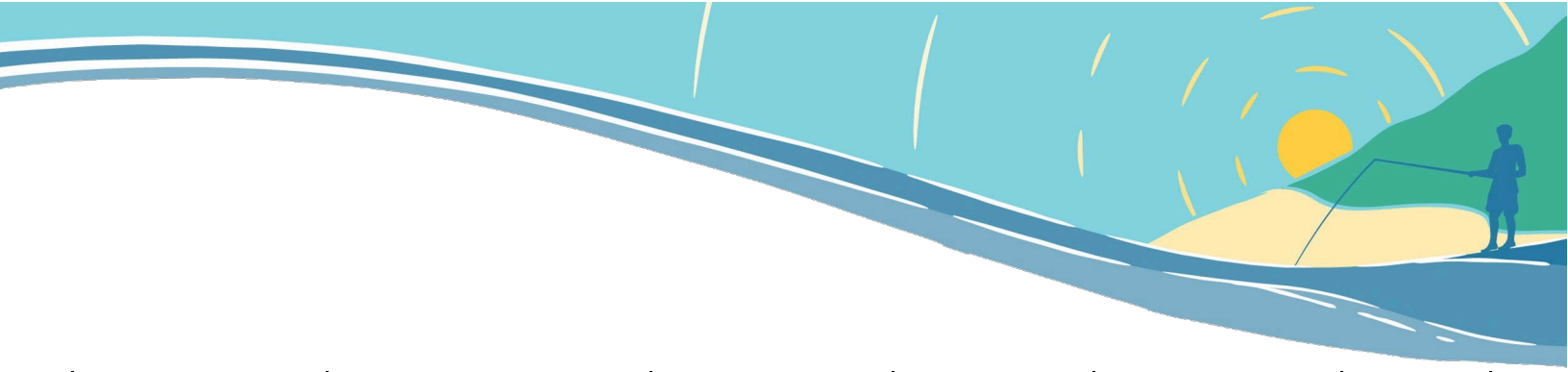
| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Mullidae |  | *Parupeneus multifasciatus* | moano | Manybar Goatfish |
| |  | *Parupeneus pleurostigma* | malu | Sidespot Goatfish |
| |  | *Parupeneus porphyreus* | kūmū | Whitesaddle Goatfish |
| |  | *Upeneus taeniopterus* | weke pueo | Bandtail Goatfish |
| Oplegnathidae |  | *Oplegnathus punctatus* | | Spotted Knifejaw |
| Pomacentridae |  | *Abudefduf abdominalis* | mamo | Sargent Major |
| Priacanthidae |  | *Heteropriacanthus cruentatus* | ‘āweoweo | Glasseye |
| |  | *Priacanthus meeki* | ‘āweoweo | Hawaiian Bigeye |
| Scaridae |  | *Calotomus carolinus* | pōnuhunuhu | Stareye Parrotfish |
| |  | *Calotomus zonarchus* | uhu | Yellowbar Parrotfish |
| |  | *Chlorurus perspicillatus* | uhu uliuli or ‘ahu‘ula | Spectacled Parrotfish |

| Family | Photo | Taxonomic Name | Hawaiian Name | Common Name |
|---|---|---|---|---|
| Scaridae |  | *Chlorurus spilurus* | uhu | Bullethead Parrotfish |
| |  | *Scarus dubius* | lauia | Regal Parrotfish |
| |  | *Scarus psittacus* | uhu | Palenose Parrotfish |
| |  | *Scarus rubroviolaceus* | uhu ʻeleʻele or pālukaluka | Redlip Parrotfish |
| Scorpididae |  | *Microcanthus strigatus* | | Stripey |
| Serranidae |  | *Cephalopholis argus* | roi* | Blue-spotted Grouper |
| |  | *Hyporthodus quernus* | | Hawaiian Grouper |
| Sphyraenidae |  | *Sphyraena barracuda* | kaku | Great Barracuda |
| |  | *Sphyraena helleri* | kaweleʻa | Heller's Barracuda |

*Names listed for these non-native species are common names currently used as they did not originally have a Hawaiian name

# Appendix 5: List of Fish Species Observed in the Pūpūkea MLCD Tidepool

| Family | Scientific Name | Common Name | Hawaiian Name | Source | Endemic |
|---|---|---|---|---|---|
| **Acanthuridae** | *Acanthurus blochii* | Ringtail Surgeonfish | pualu | Anne Rosinski (Chung), 2012 | N |
| | *Acanthurus dussumieri* | Eyestripe Surgeonfish | palani | Anne Rosinski (Chung), 2012 | N |
| | *Acanthurus leucopareius* | Whitebar surgeonfish | mā'ikoiko | Keelan Barcina (2020) | N |
| | *Acanthurus nigrofuscus* | Brown Surgeonfish | mā'i'i'i | Anne Rosinski (Chung), 2012 | N |
| | *Acanthurus nigroris* | Bluelined surgeonfish | maiko | Keelan Barcina (2020) | N |
| | *Acanthurus olivaceus* | Orangebar surgeonfish | na'ena'e | Keelan Barcina (2020) | N |
| | *Acanthurus triostegus sandvicensis* | Convict Tang | manini | Anne Rosinski (Chung), 2012 | Sub-species |
| | *Naso lituratus* | Orangespine unicornfish | umaumalei | Keelan Barcina (2020) | N |
| | *Naso unicornis* | Bluespine unicornfish | kala | Keelan Barcina (2020) | N |
| **Atherinidae** | *Atherinomorus insularum* | Hawaiian silverside | ʻiao | Keelan Barcina (2020) | Y |
| **Aulostomidae** | *Aulostomus chinensis* | Pacific trumpetfish | nūnū | Jenny Yagodich (2020) | N |
| **Balistidae** | *Rhinecanthus rectangulus* | Reef triggerfish | humuhumunukunukuapua'a | Anne Rosinski (Chung), 2012 | N |
| **Belnniidae** | *Blenniella gibbifrons* | Bullethead blenny | pāoʻo | Jenny Yagodich (2020) | N |
| | *Entomacrodus marmoratus* | Marbled blenny | pāoʻo | Anne Rosinski (Chung), 2012 | Y |
| | *Istiblennius zebra* | Zebra Rockskipper blenny | pāoʻo | Anne Rosinski (Chung), 2012 | Y |
| | *Plagiotremus goslinei* | Gosline's fangblenny | | Keelan Barcina (2020) | Y |
| **Belonidae** | *Platybelone argalus* | Keeltail needlefish | ʻaha | Jenny Yagodich (2020) | N |



| | | | | | |
|---|---|---|---|---|---|
| | *Tylosurus crocodilus* | Crocodile needlefish | ʻaha | Alana Friedlander (2020) | N |
| **Carangidae** | *Caranx melampygus* | Bluefin Trevally (juvenile) | omilu (papio) | Anne Rosinski (Chung), 2012 | N |
| | *Caranx sexfasciatus* | Bigeye trevally (juvenile) | pake ulua (papio) | Keelan Barcina (2020) | |
| | *Selar crumenophthalmus* | Bigeye scad | ʻakule | Keelan Barcina (2020) | N |
| **Chaetodontidae** | *Chaetodon auriga* | Threadfin butterflyfish | kīkākapu | Anne Rosinski (Chung), 2012 | N |
| | *Chaetodon lunula* | Racoon butterflyfish | kīkākapu | Anne Rosinski (Chung), 2012 | N |
| | *Chaetodon miliaris* | Milletseed butterflyfish | | Keelan Barcina (2020) | Y |
| **Cirrhitidae** | *Cirrhitops fasciatus* | Redbarred hawkfish | piliko'a | Keelan Barcina (2020) | |
| | *Cirrhitus pinnulatus* | Stocky hawkfish | po'opa'a | Anne Rosinski (Chung), 2012 | N |
| **Diodontidae** | *Diodon holocanthus* | Spiny porcupinefish | kōkala | Keelan Barcina (2020) | N |
| **Engraulidae** | *Encrasicholina purpurea* | Hawaiian anchovy | nehu | Alan Friedlander (2020) | Y |
| **Fistulariidae** | *Fistularia commersonii* | Bluespotted/smooth cornetfish | nūnū | Jenny Yagodich (2020) | N |
| **Hemiramphidae** | *Hyporhamphus acutus pacificus* | Acute halfbeak | iheihe | Alan Friedlander (2020) | Sub-species |
| **Kuhliidae** | *Kuhlia xenura* | Hawaiian flagtail | āhole | Anne Rosinski (Chung), 2012 | Y |
| **Kyphosidae** | *Kyphosus sandwicensis* | Gray/Pacific chub | nenue | Jenny Yagodich (2020) | Y |
| | *Kyphosus hawaiensis* | Hawaiian/bicolor chub | nenue | Anne Rosinski (Chung), 2012 | Y |
| | *Kuyphosus vaigiensis* | Brassy chub | nenue | Alan Friedlander (2020) | N |
| | *Kyphosus spp.* | | nenue | Alan Friedlander (2020) | N |

| | | | | | |
|---|---|---|---|---|---|
| **Labridae** | *Anampses chrysocephalus* | Psychedelic wrass | | Alan Friedlander (2020) | Y |
| | *Anampses cuvier* | Pearl wrasse | ʻōpule | Anne Rosinski (Chung), 2012 | Y |
| | *Coris flavovittata* | Yellowtail coris | hilu | Anne Rosinski (Chung), 2012 | Y |
| | *Coris venusta* | Elegent coris | | Anne Rosinski (Chung), 2012 | Y |
| | *Cymolutes lecluse* | Hawaiian knifefish | laenihi | Anne Rosinski (Chung), 2012 | Y |
| | *Stethojulis balteata* | Belted wrasse | ʻōmaka | Anne Rosinski (Chung), 2012 | Y |
| | *Thalassoma duperrey* | Saddle wrasse | hīnālea lauwili | Anne Rosinski (Chung), 2012 | Y |
| | *Thalassoma purpureum* | Surge wrasse | hou | Jenny Yagodich (2020) | N |
| | *Thalassoma trilobatum* | Christmas wrasse | awela | Anne Rosinski (Chung), 2012 | N |
| **Lutjanidae** | *Lutjanus fulvus* | Blacktail snapper | toʻau | Anne Rosinski (Chung), 2012 | I |
| **Mugilidae** | *Mugil cephalus* | Striped mullet | ʻamaʻama | Alan Friedlander (2020) | N |
| | *Neomyxus leuciscus* | Sharpnose mullet | uouoa | Anne Rosinski (Chung), 2012 | I |
| | *Moolgarda engleli* | Kanda mullet | | Alan Friedlander (2020) | N |
| **Mullidae** | *Mulloidichthys flavolineatus* | Yellowstripe/square-spot goatfish | wekeʻa | Anne Rosinski (Chung), 2012 | N |
| | *Mulloidichthys vanicolensis* | Yellowfin goatfish | weke 'ula | Anne Rosinski (Chung), 2012 | N |
| | *Parupeneus cyclostomus* | Blue goatfish | moano ukali ulua | Alan Friedlander (2020) | |
| | *Parupeneus insularis* | Island/doublebar goatfish | muni | Jenny Yagodich (2020) | N |
| | *Parupeneus multifasciatus* | Many bar goatfish | moano | Anne Rosinski (Chung), 2012 | N |
| | *Parupeneus porphyreus* | Whitesaddle goatfish | kūmū | Keelan Barcina (2020) | Y |
| | *Upeneus taeniopterus* | Bandtail goatfish | weke pueo | Keelan Barcina (2020) | |
| **Muraenidae** | *Echidna nebulosa* | Snowflake moray | puhi kāpā | Anne Rosinski (Chung), 2012 | N |

| | | | | | |
|---|---|---|---|---|---|
| | *Gymomuraena zebra* | Zebra moray | puhi | Keelan Barcina (2020) | N |
| | *Gymnothorax eurostus* | Stout moray | puhi | Keelan Barcina (2020) | N |
| | *Gymnothorax flavimarginatus* | Yellowmargin moray | puhi paka | Jenny Yagodich (2020) | N |
| **Ostraciidae** | *Ostracion meleagris* | Spotted boxfish | moa | Anne Rosinski (Chung), 2012 | N |
| **Pomacentridae** | *Abudefduf abdominalis* | Hawaiian sergeant | mamo | Anne Rosinski (Chung), 2012 | Y |
| | *Abudefduf sordidus* | Blackspot sergeant | kūpīpī | Anne Rosinski (Chung), 2012 | N |
| | *Abudefduf vaigiensis* | Indo-Pacfic sergeant | mamo | Anne Rosinski (Chung), 2012 | N |
| | *Dascyllus albisella* | Hawaiian dascyllus | ʻālo‘ilo‘i | Jenny Yagodich (2020) | Y |
| | *Plectroglyphidodon i mparipennis* | Bright eye damselfish | | Anne Rosinski (Chung), 2012 | N |
| | *Plectroglyphidodon johnstonianus* | Blue-eye damselfish | | Anne Rosinski (Chung), 2012 | N |
| | *Plectroglyphidodon sindonis* | Rock damselfish | | Anne Rosinski (Chung), 2012 | Y |
| | *Stegastes marginatus* | Hawaiian gregory | | Keelan Barcina (2020) | Y |
| **Scaridae** | *spp.* | Parrotfish | uhu | Anne Rosinski (Chung), 2012 | N |
| **Scorpaenidae** | *Dendrochirus barberi* | Hawaiian green lionfish | nohu | Anne Rosinski (Chung), 2012 | Y |
| | *Scorpaenopsis diabolus* | Devil scorpionfish | nohu ʻomakaha | Jenny Yagodich (2020) | N |
| **Serranidae** | *Cephalopholis argus* | Peacock grouper | roi | Anne Rosinski (Chung), 2012 | I |
| **Synodontidae** | *Synodus dermatogenys* | Clearfin lizardfish | ʻulae | Anne Rosinski (Chung), 2012 | N |
| | *Synodus ulae* | Hawaiian lizardfish | ʻulae | Whitney Goodell (2020) | |
| **Tetraodontidae** | *Canthigaster amboinensis* | Ambon puffer | | Anne Rosinski (Chung), 2012 | N |
| | *Canthigaster jactator* | Hawaiian whitespotted toby | | Alan Friedlander (2020) | N |
| **Zanclidae** | *Zanclus cornutus* | Moorish Idol | Kihikihi | Anne Rosinski (Chung), 2012 | N |

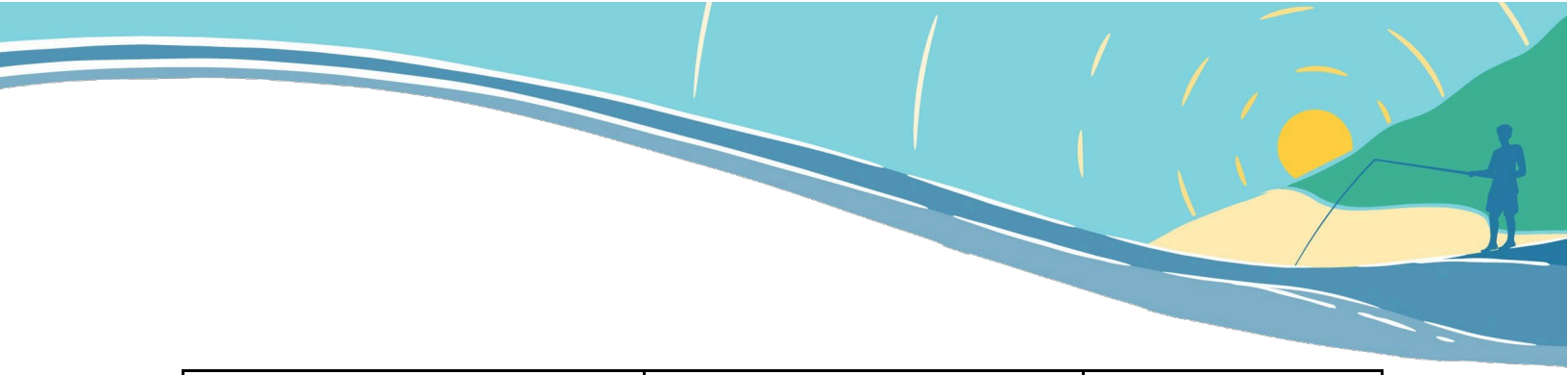
# Appendix 6: List of Limu and Invertebrate Species Observed in the Pūpūkea MLCD Tidepool

| Limu Species Observed* | | |
|---|---|---|
| **Scientific Name** | **Common Name** | **ʻŌlelo Hawaiʻi Name** |
| *Acanthophora spicifera* | Prickly Seaweed | |
| *Asparagopsis taxiformis* | Asparagus Seaweed | limu kohu |
| *Botrycladia skottsbergii* | Skottsberg's Seaweed | |
| *Caulerpa racemosa* | Coin Caulerpa | |
| *Chaetomorpha antennina* | Brush Chaetomorpha | |
| *Chnoospora minima* | Small Chnoospora | wāwahi waʻa |
| *Chondrophycus* spp. | | lipeʻepeʻe |
| *Cladophora* spp. | | |
| *Codium edule* | Creeping Antler Seaweed | wāwaeʻiole |
| *Colpomenia sinuosa* | Sinuous Seaweed | puhā |
| *Dictyosphaeria* spp. | | pohāpoha |
| *Dictyota acutiloba* | Twisted Dictyota | alani |
| *Dictyota* spp. | | alani |
| *Galaxaura* spp. | | |
| *Gracilaria* spp | | manauea |
| *Grateloupia phuquocensis* | Phu Quoc Seaweed | nei, kōʻeleʻele |
| *Halimeda discoidea* | Rosette Halimeda | |
| *Hydroclathrus clathratus* | | |
| *Hypnea chordacea* | Stout Hypnea | |
| *Hypnea musciformis* | Hookweed | |
| *Laurencia mcdermidiae* | Mcdermind's Laurencia | |
| *Laurencia* spp. | | lipeʻepeʻe |
| *Liagora* spp. | | |
| *Martensia fragilis* | Fragile Martensia | |
| *Microdictyon setchellianum* | Coarse Mesh Seaweed | |
| *Neomeris* spp. | Finger Seaweed | |
| *Padina* spp. | | limu pepeiao |
| *Plocamium sandvicense* | Hawaiian Plocamium | |
| *Portieria hornemannii* | Hornemann's Seaweed | |

| | | |
|---|---|---|
| *Pterocladiella caerulescens* | Blue-green Pterocladia | |
| *Pterocladiella capillacea* | Red Pterocladia | limu loloa |
| *Reticulocaulis mucosissinus* | | |
| *Sargassum echinocarpum* | Prickly Sargassum | limu kala |
| *Sargassum obtusifolium* | Ribbon Sargassum | limu kala |
| *Sargassum polyphyllum* | Variable Sargassum | limu kala |
| *Stypopodium flabelliforme* | Blue Seaweed | |
| *Turbinaria ornata* | Ornate Seaweed | kāhili |
| *Ulva expansa* | Large Sea Lettuce | pakaiea |
| *Ulva fasciata* | Sea Lettuce | pālahalaha |
| *Wrangelia elegantissima* | Elegant Seaweed | |

* Endemic species are denoted in blue font. Invasive species are denoted in red font.

| Invertebrate Species Observed from 2020-2022 | | |
|---|---|---|
| **Scientific Name** | **Common Name** | **ʻŌlelo Hawaiʻi Name** |
| *Actinopyga obesa* | Plump Sea Cucumber | - |
| *Actinopyga varians* | White-spotted Sea Cucumber | loli |
| *Bohadschia argus* | Argus Sea Cucumber | - |
| *Callianassa* | Ghost Shrimp | - |
| *Carpilius convexus* | Marbled Stone Crab | - |
| *Carpilius maculatus* | 7/11 Crab | ʻalakuma |
| *Cellana exarata* | limpet | ʻopihi |
| Class Malacostraca | mantis shrimp | - |
| Class Polychaeta | polychaete worm | - |
| *Colobocentrotus atratus* | Shingle/Helmet Urchin | hāʻukeʻuke |
| *Conus* sp. | cone shell | - |
| *Cypraea* sp. | cowrie | - |
| *Dardanus gemmatus* | Jeweled Anemone Crab | - |
| *Diadema paucispinum* | Long-Spined Urchin | wana |
| *Dolabella auricularia* | Wedge Sea Hare | - |
| *Drupa* sp. | drupes | - |



| | | |
|---|---|---|
| *Echinometra mathaei* | Pale Rock-Boring Urchin | ʻina |
| *Echinostrephus aciculatus* | Needle-spined Urchin | - |
| *Echinothrix calamaris* | Banded Urchin | wana |
| *Enoplometopus occidentalis* | Red Reef Lobster | - |
| *Euapta tahitiensis* | Tahitian Sea Cucumber | - |
| Family Nephropidae | lobster | - |
| *Gonioinfradens paucidentatus* | Red Swimming Crab | - |
| *Grapsus tenuicrustatus* | Thin-Shelled Rock Crab | ʻaʻama |
| *Heterocentrorus mamillatus* | Red Slate Pencil Urchin | hāʻukeʻuke ʻulaʻula |
| *Holothuria arenicola* | Sand Sea Cucumber | - |
| *Holothuria atra* | Black Sea Cucumber | loli okuh kuhi |
| *Holothuria difficilis* | Difficult Sea Cucumber | - |
| *Holothuria hilla* | Light-Spotted Sea Cucumber | - |
| *Holothuria pervicax* | Stubborn Sea Cucumber | - |
| *Holothuria whitmaei* | Teated Sea Cucumber | - |
| Holothuroidea | unidentified sea cucumber | - |
| Infraorder Anomura | hermit crab | - |
| Infraorder Brachyura | unidentified black crabs | - |
| *Isognomen californicum* | Black Purse Shell | - |
| *Isognomen perna* | Brown Purse Shell | - |
| *Loimia medusa* | Spaghetti Worm | kaunaʻoa |
| *Mithrodia fisheri* | Fisher's Star | - |
| *Nerita picea* | common nerite | pipipi |
| *Octopus cyanea* | Day Octopus/ tako | heʻe |
| *Opheodesoma spectabilis* | Conspicuous Sea Cucumber | - |
| *Ophicoma erinaceus* | Black Brittle Star | - |
| *Pentaceraster cumingi* | Panamic Cushion Star | - |
| *Percnon planissimum* | Flat Rock Crab | - |
| Phylum Porifera | unidentified sponges | - |
| *Serpulorbis* sp. | vermetid tube snails | - |
| *Stenopus hispidus* | Banded Coral Shrimp | - |

| Hard Coral, Soft Coral, and Zoanthid Species Observed from 2020-2022 | | |
|---|---|---|
| **Scientific Name** | **Common Name** | **ʻŌlelo Hawaiʻi Name** |
| *Gardineroseris planulata* | Honeycomb Coral | koʻa |
| *Leptastrea bewickensis* | Bewick Coral | koʻa |
| *Leptastrea purpurea* | Crust Coral | koʻa |
| *Montipora capitata* | Rice Coral | koʻa |
| *Montipora flabellata* | Blue Rice Coral | koʻa |
| *Montipora patula* | Ringed Rice Coral | koʻa |
| *Palythoa caesia* | Pillow Zoanthid | - |
| *Palythoa tuberculosum* | Rubbery / Mat Zoanthid | - |
| *Pavona varians* | False Brain Coral | koʻa |
| *Pocillopora damicornis* | Lace Coral | akoʻakoʻa |
| *Pocillopora meandrina* | Cauliflower Coral | koʻa |
| *Porites evermanni* | Brown Lobe Coral | koʻa |
| *Porites lobata* | Lobe Coral | pohaku puna |
| *Porites solida* | Solid Coral | koʻa |
| *Sarcothelia edmondsoni* | Blue Octocoral | - |
| *Zoanthus* sp. | unidentified zoanthid | - |
| *Tripneustes gratilla* | Collector Urchin | hāwaʻe |

# Appendix 7: Brief from Mālama Pūpūkea Waimea Literature Review of Scientific Studies

**A brief of Reports and Publications related to the Pūpūkea MLCD from 1975 to 2023**

To gather a comprehensive set of scientific and community-based research that can support MPW's goals to partner with the State, the City and County of Honolulu, and others to better manage the MLCD, in 2021, MPW retained retained Ellie Jones, MPW's Marine Science Coordinator (2021-2022), to conduct an initial scientific literature review that can be continuously updated. Research summarized in the review includes information gathered in 25 reports and papers authored by MPW-retained scientists and students, MPW marine science coordinators, University of Hawai'i academics, government agencies, and others from 1975 to 2023.

Research was categorized into four chapters: (1) biological studies conducted in the Kapo'o Tidepools, (2) biological studies conducted within the larger area of the Pūpūkea MLCD, (3) biological studies that include data gathered in the Pūpūkea MLCD, and (4) non-biological studies conducted within the Pūpūkea MLCD (such as investigation of submarine groundwater discharge and environmental impact reports).

As a living document, the ongoing literature review is intended to serve as a comprehensive catalogue of research conducted in the Pūpūkea MLCD, and is a testament to the importance of combining "Western" science with community-based data collection in the collective effort to understand, monitor, and protect Hawai'i's nearshore marine environments.

Some of the key conclusions from the scientific research in this literature review include: fish, invertebrate, and limu in the MLCD tend to be rich in diversity and abundance; the Tidepools act as a "nursery" for the MLCD; the MLCD provides spillover to the outer unprotected areas; human use in the area has increased drastically over time; human presence changes fish behavior; visitors often come into destructive contact with the reef; the Tidepools receive substantial submarine groundwater discharge; and terrestrial mauka (upland) sources of pollution, from commercial development and the beach shower and wastewater, pose threats to the Tidepools.

Combining these studies with MPW's kilo (traditional observation methods) over the past thirty years provides a strong understanding of the current condition of the marine resources of the MLCD, gives MPW and partners a road map for future research, and can inform future management planning and decision-making.

| YEAR | AUTHOR(S) | STUDY | CHAPTER | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| 1975 | Kimmerer & Durbin | The Potential for Additional Marine Conservation Districts on O'ahu and Hawai'i | | ■ | | |
| 2003 | Antolini, Moffie & Paulson | Hawai'i Marine Protected Areas Governance Study | | | | ■ |
| 2007 | Friedlander, Brown & Monaco | Coupling ecology and GIS to evaluate efficacy of MPAs in Hawai'i | | | ■ | |
| 2008 | Needham, Tynon, Ceurvorst, Collins, Connor & Culnane | Recreation carrying capacity and management at Pūpūkea MLCD on O'ahu, HI | | | | ■ |
| 2009 | Meyer & Holland | Spatial dynamics and substrate impacts of recreational snorkelers and SCUBA divers in Hawaiian MPAs | | | | ■ |
| 2010 | Friedlander, Wedding, Brown & Monaco | Monitoring Hawai'i's MPAs: Examining Spatial and Temporal Trends Using a Seascape Approach | | ■ | | |
| 2012 | Rosinski | Creating comprehensive MPAs: The ecology of the Pūpūkea tide pools and their value to the Pūpūkea MLCD | ■ | | | |
| 2013 | Stamoulis & Friedlander | A seascape approach to investigating fish spillover across a marine protected area boundary in HI | | ■ | | |
| 2014 | Friedlander, Stamoulis, Kittinger, Drazen & Tissot | Understanding the scale of marine protection in Hawai'i: From community-based management to the remote NWHI | | | ■ | |
| 2015 | Townscape, Inc. | Pūpūkea Beach Park Master Plan | | | | ■ |
| 2015 | Zannino | Is that a sea cucumber or a rock? A biological inventory of Pūpūkea's Shark's Cove tide pools | ■ | | | |
| 2017 | Friedlander, Donovan, Stamoulis, Williams, Brown, Conklin, DeMartini, Rodgers, Sparks & Walsh | Human-induced gradients of reef fish declines in the Hawaiian Archipelago viewed through the lens of traditional management boundaries | | | ■ | |

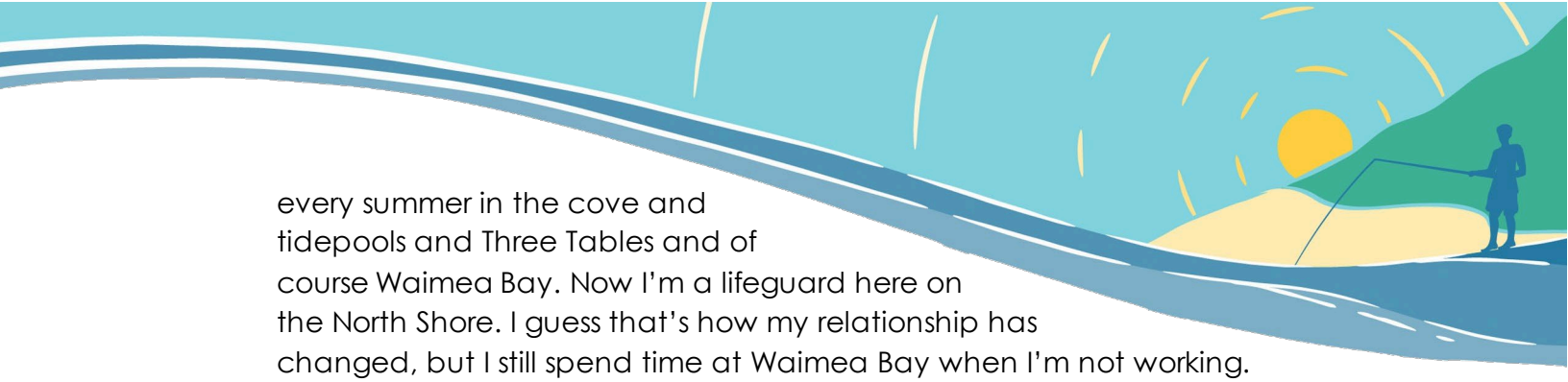
| | | | | | | |
|---|---|---|---|---|---|---|
| 2017 | Tom Nance Water Resource Engineering | Assessment of Potential Impacts on Water Resources of the Proposed Pūpūkea Rural Community Commercial Center | | | | ■ |
| 2017 | Marine Research Consultants | Assessment of Marine Water Chemistry and Community Structure in the Vicinity of the Proposed Pūpūkea Rural Community Commercial Center | | | | ■ |
| 2018 | Friedlander, Donovan, Koike, Murakawa & Goodell | Characteristics of effective MPAs in HI | | | ■ | |
| 2019 | Stamoulis & Delevaux | Pūpūkea-Waimea MLCD Coral and Fish Assessment: 2010-2019 | | ■ | | |
| 2020 | Stamoulis, Delevaux, Williams, Friedlander, Reichard, Kamikawa & Harvey | Incorporating reef fish avoidance behavior improves accuracy of species distribution models | | ■ | | |
| 2020 | Friedlander, Hunter & Goodell | Pūpūkea Kapoʻo Tidepool Ecological Assessment | ■ | | | |
| 2020 | Friedlander, Donovan, DeMartini & Bowen | Dominance of endemics in the reef fish assemblages of the Hawaiian Archipelago | | | ■ | |
| 2020 | Walker, Stamoulis & Duncan | Identification of Submarine Groundwater Discharge in the Pūpūkea MLCD | | | | ■ |
| 2020 | Barcina | An assessment of biodiversity and recreational human use during the COVID-19 pandemic beach closures at Kapoʻo Tidepool, Pūpūkea, Hawaiʻi | ■ | | | |
| 2021 | Ramos & Dulai | Submarine groundwater discharge and related contaminants in Shark's Cove Kapoʻo tide pools | | | | ■ |
| 2021 | Mislinski | Summer Marine Science Report: Mālama Pūpūkea-Waimea | ■ | | | |
| 2023 | Jones | Mālama Pūpūkea-Waimea Literature Review: Reports and Publications related to the Pūpūkea MLCD from 1975-2022. | ■ | | | |
| 2023 | Stamoulis, Jones, Yagodich & Antolini | Assessment of Biological Carrying Capacity at Kapoʻo in the Pūpūkea MLCD (Hawaiʻi Conservation Conference July 2023) (PPT) | ■ | | | |

# Appendix 8: Themes from Community Engagement Data

The bulleted items below are participant responses to questions asked in 26 interviews, 45 survey responses, and community meetings attended by 68 North Shore O'ahu residents. Editing of comments was done only to add clarification, and similar responses may be grouped or represented by one comment. Any facts stated by participants were not checked for accuracy.

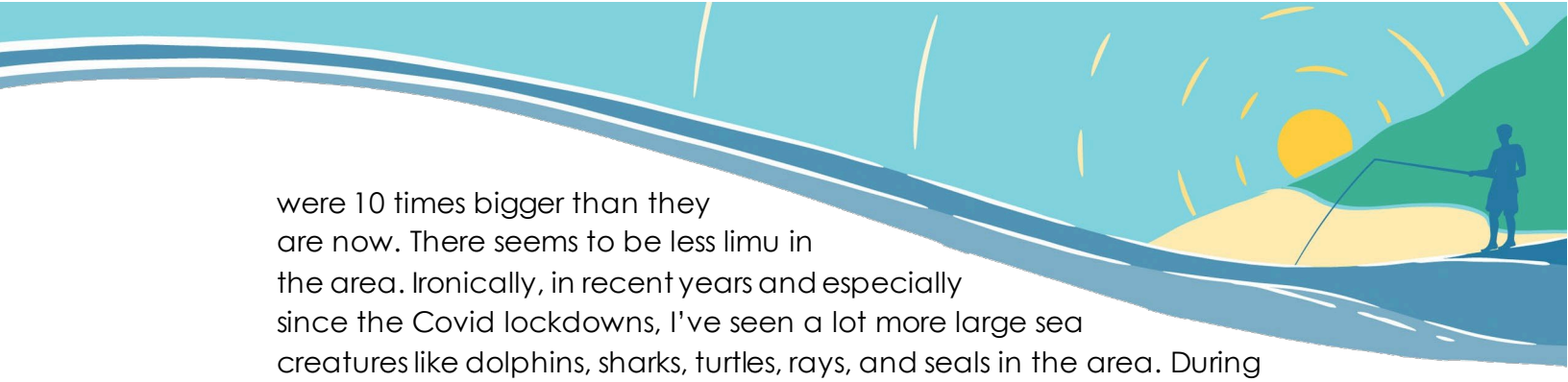
**What is your relationship to the Pūpūkea MLCD?**

- In the summer, I paddle through the area once or twice a week. It has remained somewhat intact due to the MLCD status.
- I grew up at Ke Iki beach nearby and spent a lot of time cave diving and snorkeling in the area. I enjoy the fact that the area is protected because I can see a variety of species, different fish and turtles. I don't think that's changed over time because it's still protected, and I still live here.
- I'm a volunteer of MPW.
- My great grandparents were from Kahuku.
- More people, less access, crowded parking—especially with the food trucks. I used to do snorkeling, but I don't go as often as I used to because it's so crowded.
- I moved here in 1968. In 2022, there are more fish at Sharks Cove and more healthy honu everywhere.
- I've been coming to this area since I was a kid, and I've raised my kids here. Our family has lived across from Three Tables and also next to Sharks Cove. We've spent countless hours in the water snorkeling and diving and exploring the reef. My children have participated with Ka Papa Kai from the beginning. My [family member] was a big wave surfer and surfed Waimea Bay regularly. We continue his legacy of love for the ocean. This area holds special meaning for us. It's been very crowded lately, so we haven't been as much, but I still love it.
- My relationship to the MLCD is one of loving it and raising my family in it. I've spent decades enjoying the ocean and marine life here, and so have my wife and six kids. I'd say my relationship with it just keeps growing.
- I swim there multiple times a week in the summer months. I'm aware of the area being protected.
- My great grandmother regularly walked from Hale'iwa to Kulaloa, and she talked about knowing 'ohana along the way and receiving food (salt and kalo) from them.
- My relationship with this place is both part of recreation and work. I've lived here my whole life and was raised learning how to swim and surf and dive all over here. As a grom, I learned to bodysurf the shore break at Waimea Bay and spent



every summer in the cove and tidepools and Three Tables and of course Waimea Bay. Now I'm a lifeguard here on the North Shore. I guess that's how my relationship has changed, but I still spend time at Waimea Bay when I'm not working.

- My parents moved us out to the North Shore when I was just born, and I grew up spending a lot of time at [a family friend's] house near Three Tables. My family experience emphasized the mana of the place.
- It has been a big part of our family since before becoming MLCD. Mom's Beach at Three Tables, jump rock, exploring tidepools, etc. Better now with more fish and protection.
- Volunteer with Waimea Valley, was connected with Eddie Aikau
- My relationship now is to protect the resource, but prior to that, I swam here and also became SCUBA certified.
- As a fifty-year North Shore resident, the level of my relationship has varied over the years. Early on, our usage of the beach and waters was almost daily—teaching kids to swim, snorkeling through schools of fish etc., etc. More recently, our usage has become much more occasional—maybe once or twice a month. SUPing from Three Tables up to Sharks Cove has been our most common excursion lately. Kids sometimes surf at Rubber Duckies. The MLCD has been/is a very special place for our family. Our lives would have been much different without it. I'll never forget coming down Pūpūkea Road, stopping at the stop sign at Kamehameha Highway, and looking out to see a whale less than 50 yards offshore. Where else on the planet does this happen?
- I used to snorkel there at least once a week, but because of COVID and lack of parking, I have not been to the area in almost three years.
- It's my childhood stomping grounds. It's overrun with tourists now.
- I used to swim and snorkel in the Pūpūkea MLCD on a regular basis, but now it is much too crowded with people to enjoy, so I only go a few times per year.
- I appreciate the commitment of the volunteers.
- 50 years of look-see. Lots is gone.
- Very supportive of it and hope that the combination of education and enforcement can lead to the replenishment of marine life in the area.
- More people using the area is the biggest change. Traffic and parking needs are an issue. Safe sunscreen education needs addressing. Increased military transport using the area. Including air traffic at all hours.
- My favorite place to go to escape from town.
- My mother's family is from Waialua and I was raised in Wahiawa, so I spent a lot of time in the area from Mokule'ia to 'Ehukai swimming, diving, surfing, and fishing as a youth. Of course, the ocean and the roads are a lot more crowded than they were in the 60s and 70s. I can remember halalu and 'oama runs that



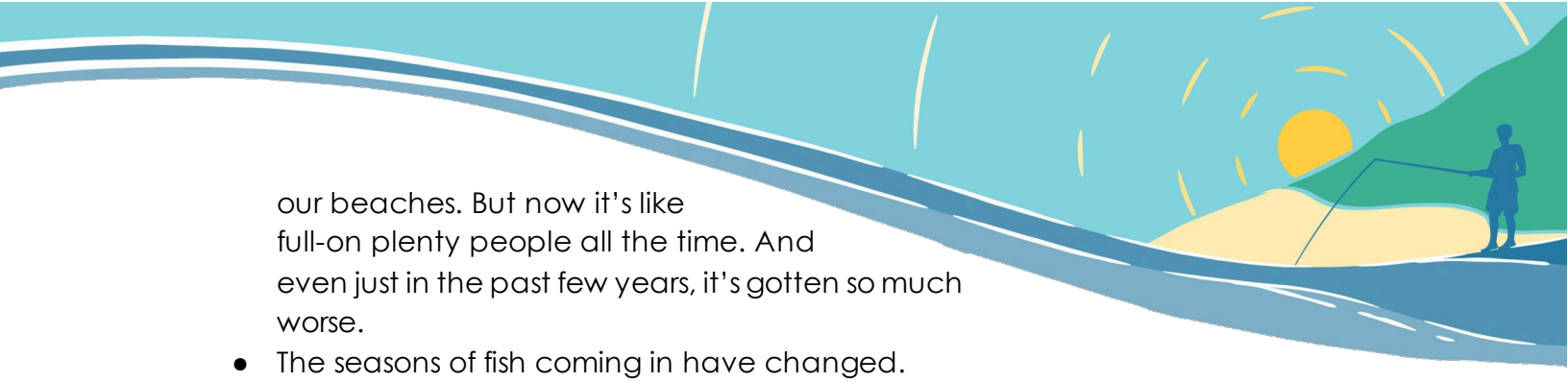
were 10 times bigger than they are now. There seems to be less limu in the area. Ironically, in recent years and especially since the Covid lockdowns, I've seen a lot more large sea creatures like dolphins, sharks, turtles, rays, and seals in the area. During the lockdown, I saw pāku'i and Kona crabs in Waimea Bay that I'd never seen before.

- I believe it preserves marine life and stabilizes the ocean ecosystem. Should be expanded and enforced better.
- Many more visitors, but much cleaner, organized, and informative since becoming managed by the community.
- I am so grateful to community members who have stepped up to be volunteers and stewards of Pūpūkea MLCD. Their preservation efforts have been so valuable in protecting this precious resource. I bicycle past and enjoy Sharks Cove many times a week. The Pūpūkea MLCD is landscaped beautifully in an effort to direct foot traffic and preserve the integrity of this landmark.
- During the summer, I snorkel in the area a few times a week. I have seen the coral on the shelf on east side of Three Tables get trampled by the tourists from the commercial boat that ties up there every day. It's such a bummer to encounter that tour with all the tourists walking around on the shelf and trampling the coral. Also, I clean up fishing gear from the east end of the MLCD every time I go. And I cringe at all the people walking around the tidepools all year. I would like to see the number of visitors limited and everyone be charged for access. The funds collected could go back into enforcement and restoration within the MLCD.
- I have enjoyed competitive swimming in the Waimea Bay area five times a year in the North Shore swim series since the early 1980s.
- I have lived just south of Waimea Bay for a year. I swim and snorkel in the Pūpūkea MLCD and surrounding areas multiple times a week from April-Nov. In the winter, I walk and spend time on the beach weekly and swim in Waimea Bay when the waves are smaller. I can clearly see that even the protections that have been in place increase the fish and marine life compared to the surrounding waters further north and south of the MLCD area.
- I love watching the whales from the shore. Watching spinner dolphins is also a joy. Parking is horrible, especially for locals.
- My relationship is one of love and joy. The MLCD is a wonderful, life-giving place that I cherish and spend much of my time. I respect the power of the MLCD, and it gives me a place to escape, exercise, and spend time in wilderness. Our relationship started as primarily a swimming, water-based relationship, but I have started to spend more time on beaches as well as in watercraft in the water.

- Shoreline fishing has increased and is dangerous to swimmers. Water pollution from cesspools and storm run offs. "No seeum" jellyfish cloud the ocean and sting swimmers. Fish have decreased! Traffic is terrible! Sharks Cove seems like a toilet with masses of tour groups urinating while snorkeling. Pilau!
- I enjoy swimming in the area in the summer and fall, and I see less sea life.
- I'm an ocean swimmer who spends a lot of time here in the summer. I've lived here for 28 years and can definitely see the reduction of sea life. Divers using underwater scooters zooming through dolphin pods is distressing, and the boat operators should be fined.
- Growing up thinking of the area as a "no fishing or diving zone." As I grew up I learned more about the importance of the area and the MLCD.
- Is a place that I call home even though I am not from here. It's a great place, great community, and one of the best coastlines with beautiful beaches.
- Born and raised Native Hawaiian and live in Pūpūkea. Notice daily more visitors and tourists than ever.
- Visit Sharks Cove which has become more and more crowded.
- My child has been a part of MPW for about four years learning about the area, its regulations, and conditions and conservation.
- I use the MLCD mostly in the summer for SCUBA diving.
- We are from Mānoa, but my daughter works shark tours in Haleʻiwa, and we come to Pūpūkea around once per week to snorkel, be on the beach, or eat at Pūpūkea or Haleʻiwa
- I have only lived in Pūpūkea for a couple of years, but I have always been very happy to live by a protected area. I would like to see more limits on fishing and on people walking in the tidepools, though.
- It has become much more crowded with tourists and commercial tours, especially Sharks Cove, tidepools, and Three Tables.
- I find myself snorkeling in the MLCD more often over the last several years.
- I grew up swimming in the area, and at various times helped with community engagement. Nowadays, I mostly report violators and take the kids there.

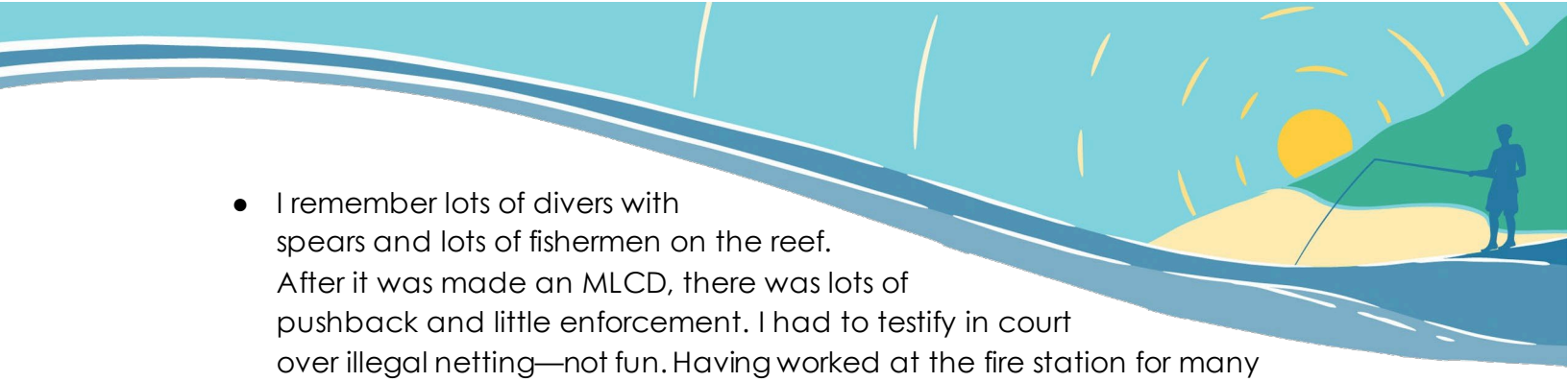
**How has the Pūpūkea MLCD and surrounding area changed?**

- I've been on the North Shore since 2004. The area has become much more trafficked, crowded, and overused, particularly since the eruption of the food truck circus across the road.
- Man. The area has changed so much. There's so many people now, not like it used to be. I mean before, during the surf season, we would see an increase in people, but that was mostly surfers staying for a few months. Then they would go, and the summer was kind of our break when we would get to relax and enjoy

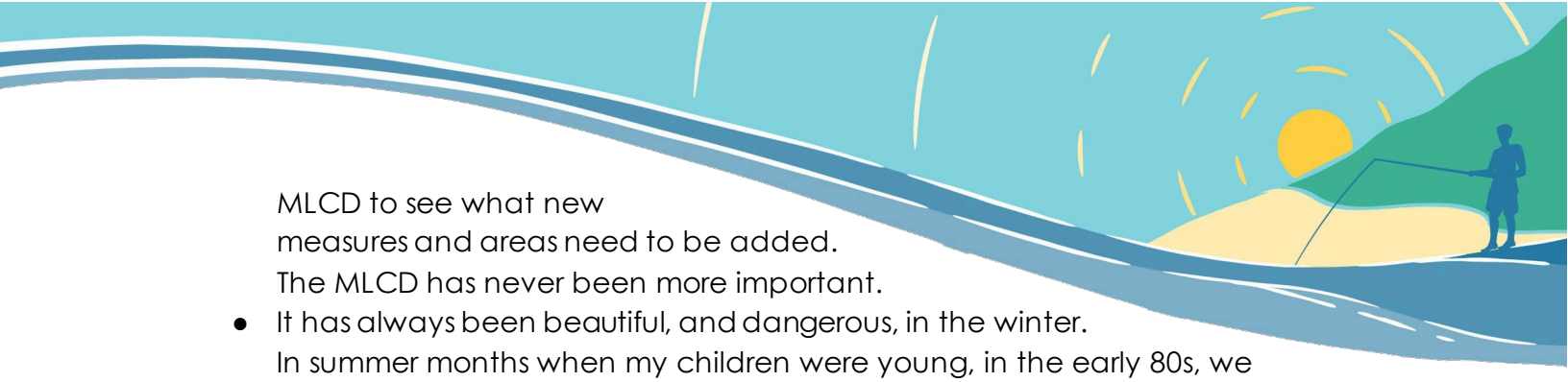


our beaches. But now it's like full-on plenty people all the time. And even just in the past few years, it's gotten so much worse.

- The seasons of fish coming in have changed.
- The difference between then and now is people—so many people in places there never were. We used to take our kids when they were little to Three Tables, where we would teach them to swim and snorkel, and there would be other families with kids doing the same. Now it's mostly tourists and military, and the beach looks like Waikīkī. We're pushed out. The community vibe that we once had is gone. It's sad. Even the military comes to Waimea and Three Tables early in the morning to work out, so we can't even go early to avoid the crowds.
- There's lots of limu, but I currently don't see the same patterns as before. The limu we used to pick is now burnt before May. The kūpeʻe and pipipi were more abundant. Resources overall are dwindling. I'm seeing more poachers. There's nighttime poaches on the rocks, picking and throwing net.
- I've seen an increase in fish diversity.
- There's less sediment in the Sharks Cove area.
- There has been a dramatic increase in foot traffic from when I was young, and I'm in my 40s now. There has been so much coastal erosion due to heavy foot traffic becoming an issue. Also, there weren't native plants to help with that like naupaka. Now, I see the planted areas MPW has done and how that's helped to decrease the eroded areas.
- There are a lot more tourists now. I think the food trucks contribute to excess traffic and overuse of the area.
- There's good and bad changes. Good would be there's more of a presence like MPW and DOCARE and the City guy that takes care of it is really good now. There's some bad changes like way more visitors and way more damage like erosion and trash. It wasn't like that before, even a decade ago.
- When I was younger, I saw more resources and less people. Then the resource got more used, and then MPW came along, and call volume [to DOCARE] went down. But now it's gone up, and there's more people than ever before. Way more tourists.
- People used to go fishing and diving for food. There's a lot more fish when you do go snorkeling, but there's less opportunity to snorkel because there's less parking available.
- Way more traffic and people!! But the ocean is very much the same to me.
- The coastal restoration at Sharks Cove is beautiful! Love all the naupaka and other natives. I remember it being mostly weeds before. Also love seeing more info for tourists and residents. And sometimes an actual person!



- I remember lots of divers with spears and lots of fishermen on the reef. After it was made an MLCD, there was lots of pushback and little enforcement. I had to testify in court over illegal netting—not fun. Having worked at the fire station for many years, I have seen all kinds of things that were not good for that area. Most of those have stopped, and it is better off environmentally.
- Always popular with residents but much more crowded with visitors in the last few years. The food truck cluster across the highway is a real bummer, and over-tourism is a major problem that must be addressed. Illegal short-term rentals contribute to the problem. The dive schools were/are a challenge also.
- The beach and waters are very crowded now. I think people come out for the day and stay as they can get lunch from the food trucks. The food trucks have also added to the parking problems and people crossing Kamehameha Hwy to use them. They also contributed to the added rubbish I can see from the road.
- There's been shoreline erosion. The crowds of tourists have grown exponentially. In the water, on the reef, and on the land. Brown water advisories have become more frequent. And storm runoff has become more toxic. These things have all been taking a toll on the marine life. Much of our limu in particular is something that has become scarce, which was once very abundant when I was a kid. Typically, the only time I notice local families there anymore is when they're volunteering with MPW. It used to be a spot for local families to spend the day with their families. That's a rarity now due to the overcrowding by tourists.
- I used to take my children, and later grandchildren, to Sharks Cove to snorkel on a regular basis. Now there are too many people, and often the water is not as clear. Also, the parking lot is chaotic.
- I am glad the Kapoʻo tidepools are now included.
- More people…fewer lobster and other sea life.
- Over 40 years ago, there were lots of fish. Then gradually, the populations decreased. With the establishment of the MLCD, there has been a visible increase in fish populations.
- Fewer people.
- More development, beaches eroding, crazy traffic
- Parking and traffic were never a problem in my youth. There are many more people in the water, especially at Three Tables and Sharks Cove. I'm sure the increase in the number of people has degraded the environment, but due to the fishing bans, the amount of reef fish seems to have increased, and I feel safer in the water with more people.
- Naturally things have degraded as tourism has expanded from 6 million per year to over 10 million. More people have come to the area, and it's time to revisit the



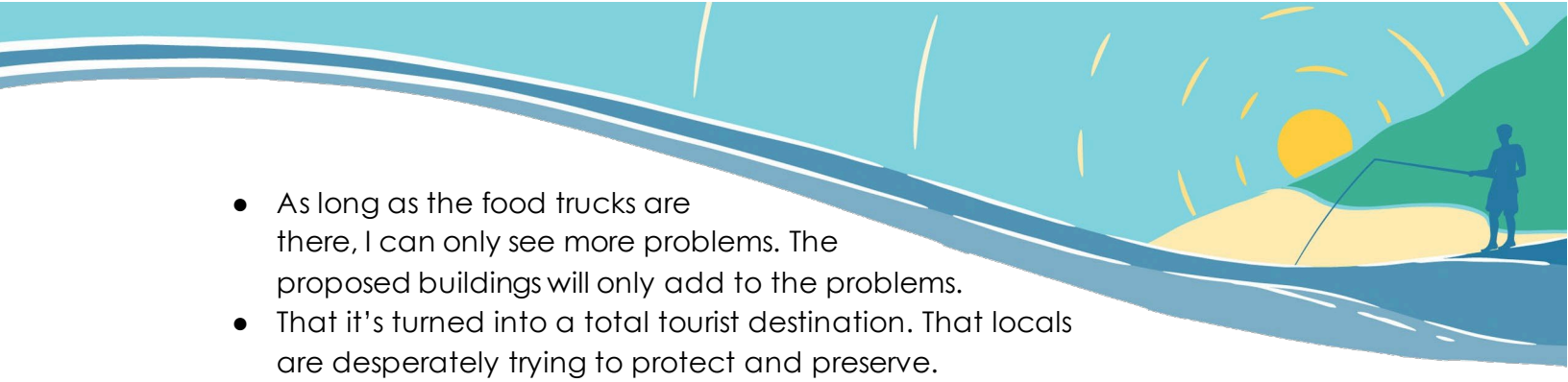
MLCD to see what new
measures and areas need to be added.
The MLCD has never been more important.

- It has always been beautiful, and dangerous, in the winter.
  In summer months when my children were young, in the early 80s, we would explore the cove during the calm summer months.
- It has been amazing to see the native plants restored to the area and see them thrive.
- In the early 1980s, there was more sand in Waimea Bay, especially in the Kahuku end of the bay. Also, there were no houses at the Hale'iwa side of the bay; today there is an entire neighborhood there.
- Since I have only spent time here for one year, I have noticed seasonal changes, but cannot attribute any changes over time. However, I can say with confidence that there is a large increase in fish and marine life in the MLCD compared to other areas along the North Shore. I spend time swimming on the North Shore from the Hale'iwa Harbor to Sunset Beach, and there is a noticeable increase in fish and marine life in the MLCD area. I don't know if that is due to prime habitat or the protections already in place, but it is beautiful to see how much life there is in the MLCD area.
- People used to clean up their own debris when they visited the area. Now it's like we are always cleaning up after someone—and not because we think it looks better, but because we know that whatever is left lying around eventually ends up in the ocean.
- It's more crowded, yes, but also there's way more pressure and people trying to put rules on the place. It feels sometimes like too many rules, especially when enforcing the rules isn't consistent.
- The ocean used to be pristine, clean without "no seeums" stinging jellyfish. There were many more fish. Sharks Cove was not crowded and didn't smell like a toilet.
- More sea life in the past
- There are a lot more tourists flocking to the area, and it seems the fish are more friendly due to people feeding them. Especially the nenue and mamo.
- Visitors and transplants outnumber natives and locals by vast majority
- Grew up on O'ahu and used to catch the bus to Sharks Cove to explore the tidepools. Now there are more people and less marine life.
- Increase of use, adjacent commercial use.
- Much more development
- The landscape is the same to us but a few more conveniences with the Pūpūkea food truck area.
- So many more people. I'm seeing their impact (trash, coastal erosion, etc.).

- Water is much less clear. It is more crowded with loud music and people standing on coral rocks with no regard for the environment. There is very little parking available, and most of it goes to tourists.
- The marine life has become much more abundant and diverse over the last several years.
- 1. Fishing concentrated at Waimea 2. More community understanding of the resources 3. More commercial SCUBA operations, more tours, more commercial activity across the street.

**What are your current perceptions of the Pūpūkea MLCD - what's going on, and how do you think it is going?**

- It is doing okay, but, the food truck activity needs to be curtailed.
- It's doing better.
- I think it's going good because it's constantly monitored and there are rules that protect it.
- It seems to be going well. Sometimes I talk with a volunteer when I'm at Sharks Cove, and I appreciate their efforts to educate the public.
- I think the MLCD needs control, and I think it also needs official paths. I see the really bad erosion getting worse every day. We need to regulate. The state needs to limit how many people can come. It's just getting abused, and little groups like MPW will never be able to keep up no matter how hard they try as long as it's a free-for-all.
- I think, thank God it's a MLCD because at least there's some regulation around here. With all the people, if everyone could take stuff, there would be nothing left. I wish you guys would stop the commercial fishing here at Waimea Bay. It's not fair, but the shore fishing is OK I think. And the boats in summer get pretty nuts. Might want to enforce that better because we lifeguards can't be the police. We try to help, but sometimes it's a challenge. The new dolphin rules are good, but hopefully they will be enforced.
- I feel like it would be better if there was more enforcement.
- I think there's people trying their best, but there's so many visitors that it's hard. The media promotes it and there's tourist traps nearby that benefit from it, so the ocean is just exploited.
- I'm not quite sure, but the more protected areas for fish, animals, and plants to grow and restore, the better.
- Things are good, but it sure does get hammered by the number of people using it. Like so many of our resources.
- I'm very encouraged by the work that MPW is doing. Please keep up the great work!

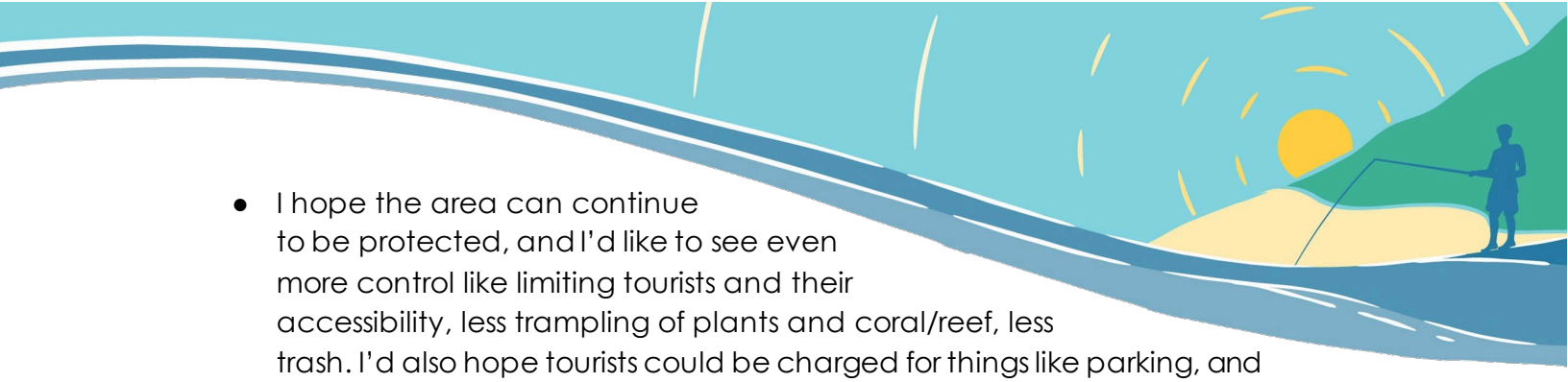


- As long as the food trucks are there, I can only see more problems. The proposed buildings will only add to the problems.
- That it's turned into a total tourist destination. That locals are desperately trying to protect and preserve.
- The commercial enterprises across the street have added to the congestion of traffic. That traffic is magnified by the number of tourists driving to swim in the Pūpūkea MLCD. The cars back up, and it is stop-and-go often in the MLCD area. Very inconvenient for residents, and unhealthy for pedestrians and cyclists.
- Good
- Too many people. Pollution.
- Enforcement is an ongoing issue, as there aren't enough DLNR officers. Mālama Pūpūkea-Waimea has been very instrumental in education for shoreline and ocean users.
- In general, there needs to be more respect and thankfulness for the ʻāina.
- DLNR needs to crack down harder on homeowners who are building their own erosion barriers that damage the beaches
- I think the MLCD has helped to stem the deterioration of the marine environment in the area. However, I think the dolphins need to be better protected from human pestering and the amount of halalū, ʻōpelu and ʻoama caught should be restricted more.
- More DOCARE officers are needed to enforce existing rules. I see people poaching all the time!
- Preservation is always a challenge in Hawai'i, especially on the North Shore of O'ahu. So many developers want a "piece of the action" and disregard the desires of the community. The volunteers at the Pūpūkea MLCD have stood their ground and, even under the threat of serious lawsuits, have held their ground and fought for preservation. Bravo!
- The MLCD is being overused by tourists. There are way too many people visiting the area and having negative impacts on the marine life.
- Difficult parking and traffic
- I regularly see folks spearfishing and sometimes fishing from shore (north of Waimea Bay) in the MLCD area, which is disappointing. I don't know what to do or who to contact when I do see this happening. The overuse of especially Sharks Cove and the tidepools area during the height of summer is worrisome. I'm not sure how the MLCD can balance recreation and enjoyment of this beautiful resource with conservation and protection, but this seems to be a major issue. You can often see the sunscreen slick on top of the water in these areas, which is very sad. I don't think there's enough outreach and information about the MLCD or the work being done there, so many folks don't understand how fragile and precious this area is.

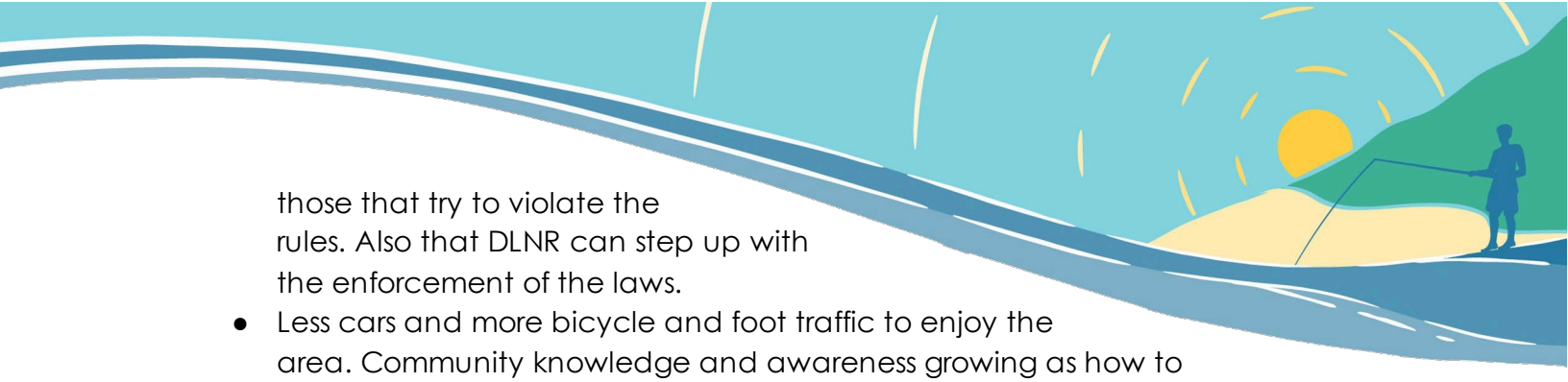
- Love the protection that the designation provides. It seems to be going well, but I'm not sure how much rules are clearly communicated and enforced. No one owns this place. People need to share and love it together
- I think a lot of good is happening, although I am worried about the impacts of so many tourists with unsafe sunscreen and lack of respect and how this might reverse some of the efforts of the MLCD.
- Natives should have more gathering rights.
- A good start, but much more is needed to restore the area.
- Overuse, unsafe use and trampling of vegetation. Parking is overfull and unsafe.
- I think the biggest thing to worry about is the amount of freshwater input and the amount of nutrients coming into the MLCD through those sources.
- I think it's perfect now and would not want any further development. When I hear of the food truck area turning into more of a mall, that feels out of character and a poor idea.
- Need better parking options/management for Waimea. Sharks Cove can be quite crowded for parking at times, too. Have observed spearfishers at Sharks Cove a few times, so I don't think the signs are blatant enough. The baby pools at Sharks Cove could be a great place to provide more info to tourists about harmful sunscreens and not tossing cigarette butts or plastic on the ground, before it gets into the ocean.
- I think it's wonderful that the area has some protection, and I love to see people in the community contributing to these efforts.
- I appreciate that there is a dedicated organization protecting and restoring it, but I fear that more and more people will outpace recovery and preservation efforts.
- It's definitely headed in the right direction through conservation and protection.
- 1. Too many commercial SCUBA operators/tours 2. Good community education and outreach 3. Need more regular presence of conservation officers

**What are your hopes for the Pūpūkea MLCD?**

- My hope is that the Pūpūkea MLCD becomes incorporated into a broader and more specific plan to regulate or limit access to it as a way of protecting this public trust resource from overuse and promoting its preservation in a truly sustainable way.
- That the boundary expands.
- Stop the commercial fishing and enforce the rules better.
- My hope is that it can return to a place for families who live here. I hope the marine life can get a break from all the tourists. Does the state even see what's happening?



- I hope the area can continue to be protected, and I'd like to see even more control like limiting tourists and their accessibility, less trampling of plants and coral/reef, less trash. I'd also hope tourists could be charged for things like parking, and that money could go towards education and upkeep efforts.
- I hope the state steps up and takes on the responsibility of protecting it. It's one thing to call it "protected" and another to actually protect it.
- I hope it stays protected and enforcement improves. Maybe adapt some rules, but only if those who protect the place are listened to, if their recommendations are taken into account. Also adapt rules to make enforcement easier. And less people—I'd like to see less people.
- Perhaps a docent that's paid and more education for the general public. Somehow limit the divers with tanks. Some kind of privilege for residents so that we could use it, too—like a sticker on your car . Let some of the divers and others make reservations for the parking and pay a little something for upkeep.
- Expand it.
- I always recall the day I went to Shark's Cove during the summer of 2020, and I only saw one other person. I thought how happy the fish and reefs were that summer! It would be nice to see a day a week or month where people actually couldn't even enter the water. Just to give nature a break.
- Hope to see more fish and wild things and less people.
- More protections, restrictions. Restrict access several days a week. Similar to what's happening at Hanauma Bay. No commercial activity in or near the MLCD. It's a global treasure.
- I know that it is impossible to go back in time, but we need for the local people to enjoy all our beaches. During the first waves of Covid when tourism was down, it was nice to see mostly locals using our beaches.
- Restoration and preservation. I would love to see the amount of tourists replaced with locals. I would love to see MPW get a very large grant to continue the work that they are doing with restoration, preservation, and education. I would love to see the MLCD close to the public for certain days of the week or even certain times of the year for nature replenishment.
- I hope that access is closed to Sharks Cove on a regular basis to allow the tidepools and ocean environment to rest and heal.
- Continued presence and care by the volunteers, better DOCARE enforcement, improved coastal vegetation throughout the MLCD.
- Control of numbers of people. Less poaching. Less pollution.
- That through publicity and education, it becomes something the entire community supports and can be proud of, in hopes that would put pressure on



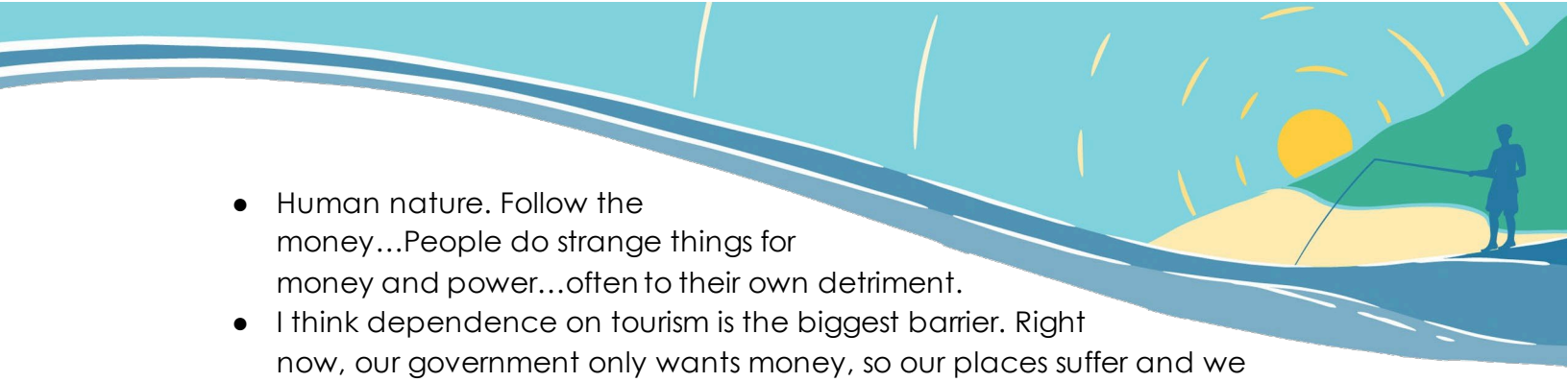
those that try to violate the rules. Also that DLNR can step up with the enforcement of the laws.

- Less cars and more bicycle and foot traffic to enjoy the area. Community knowledge and awareness growing as how to protect and nurture the native endemic environment.
- Improve the traffic jam to get there by actually finishing the parking lot at Laniakea.
- Perhaps profit-making operations like dive companies should be regulated better and limited. In the long term, parking should be moved from makai of Kamehameha to mauka to lessen the impact of petroleum pollution in the water.
- Expansion and more funding for public education such as interpretive signage and enforcement staffing.
- Expansion and community and state support of its mālama practices.
- Continue to preserve and protect this natural resource.
- I would like to see a fee-for-use, more enforcement, limiting numbers of people each day, and more restoration efforts.
- No more development.
- I would like to see clear information about who and how to contact when I see an infraction of the restrictions in this area. I would like to see more information about what the MLCD entails and how individuals can learn, help, and enjoy the resources safely. I would like to see the fish and marine species even more abundant and growing in the area!
- That the water is cleaned up, and that shoreline fishing is stopped.
- Sustainable sea life and coastline
- Monitor, enforce
- For it to eventually lead to more resources in the entire moku and help feed our communities sustainably.
- Sustainability
- It would help a lot to save the marine life before is too late.
- I would like to be able to spearfish responsibly in area.
- To restore and preserve the area for generations to enjoy.
- Less human traffic, ban of sunscreen/plastic waste, limit on parking and max people. Designated path/observation area for tourists with permanent educational information.
- I would love to see more research conducted in the area that would contribute to a holistic understanding of the environment.
- Help restore Hawai'i fishing
- Sustain the natural environment and resources.

- While I don't think brick and mortar local restaurants would be much different than the food trucks, I don't want to see fast food or other national chains in that area. The actual highway cannot handle more cars, or even what we already have. I think we should limit driving for non-residents on the stretch from Hale'iwa to Sunset, and charge a high toll for those that still choose to drive it. At the same time, this toll could subsidize (1) a free shuttle from Hale'iwa to the beaches, and (2) a bike path from Hale'iwa to the beaches. This would be more pleasant for everyone and could help start some bike rental businesses to generate income for locals.
- My hopes are that it continues to be protected and that those protections extend further to prevent fishing and other harm to the marine environment.
- That human impact doesn't slowly degrade the MLCD and that nature can run its course naturally.
- Would like to see the commercial tours banned and parking reserved for residents over tourists.
- I would like to see more education of residents and tourists through informational signs.
- 1. More resources 2. More community involvement 3. Less commercial activity 4. More young people leading the community 5. Permanent community and education facility

**What do you think are the barriers or challenges to those hopes?**

- Unfettered tourism and development and weak and/or ineffective government oversight, regulation, and enforcement regimes
- Commercial interests and fishermen
- There needs to be more funding for more officers. This MLCD needs one just for here. There's so many rules being broken all the time.
- Legalities involved, infrastructure, logistics (residents shouldn't be limited). Tourists might say it's not fair, but it's not fair we can never go and find parking or spend time there without hundreds of tourists trampling it.
- Political will
- Current funding and positions for DOCARE is a barrier to enforcement. For rules, there's a disconnect between what's best for a place and the rules themselves—like, for instance, the commercial use by SCUBA companies.
- People want their freedom to do as they please. And regulating it would require volunteers or paid positions, in addition to enforcement.
- Too many people. Social media. But to be fair, people and media are what have turned the tide on this area becoming a preserve.

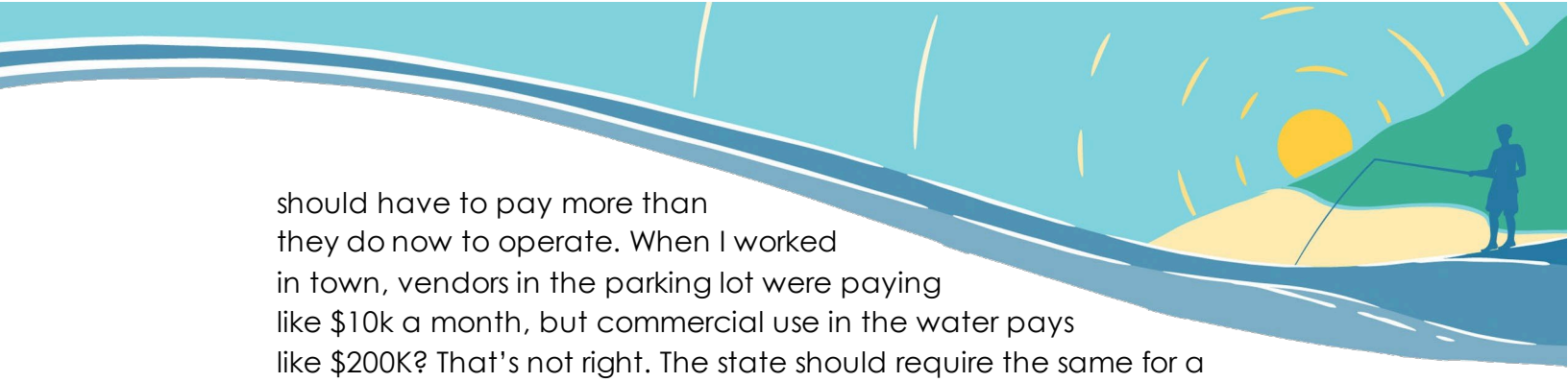


- Human nature. Follow the money…People do strange things for money and power…often to their own detriment.
- I think dependence on tourism is the biggest barrier. Right now, our government only wants money, so our places suffer and we suffer.
- I see tourism overwhelming us on the North Shore. Parking, traffic, and restrooms are all overused, and support from City and County is never enough to keep up with the problems.
- Money and political bureaucracy
- Lack of support by the City and State agencies that are tasked with managing this area.
- Funding for the planting of native vegetation
- Government regulations and enforcement plus education
- Funding, and the fact that the people who promote it (mostly through Mālama Pūpūkea-Waimea) are all volunteers, so it's vital that the organization remain strong.
- One vision at the state level, working across and in synchronicity with state and county departments.
- Politics, money, lack of will by the state to be creative.
- Economic imperatives, individual and libertarian selfishness.
- Funding and political will. Too much bending to the small but vocal minority. For instance, it's ridiculous that they allow netting at Waimea for akule. The shoreline fishermen HATE this. It's also ridiculous that people chase the poor dolphins out of the bay when they come within 300 yards of shore to rest and nurse. Ocean safety officers have no power to cite people for violations of protection laws.
- Uncontrolled tourism and lack of financial support needed.
- Funding and inertia.
- Rich developers, contractors, and home buyers can buy influence.
- Overuse
- Tourism is a challenge. Educating visitors is a challenge. Sometimes it's a challenge to gain support of local folks who have used this resource historically and want to continue to do so as they have for food and recreation without restrictions. Getting Hawai'i government on board to actually implement consequences is a challenge. I'm thinking specifically of the sunscreen ban, which does not have any clear consequences or anyone who is willing to implement them for companies that make/sell sunscreens with reef-harming ingredients. The same can be said for consequences for folks touching marine wildlife, spear fishing in protected areas, etc.
- Both visitors/tourists not respecting it and locals trying to not let people enjoy our shared resources.

- TOO MANY TOURISTS TOO
  MANY PEOPLE DISRESPECT FOR LAND.
  Not keeping it clean.
- Too many people, unclear rules
- Staffing
- Some people may not be open to the idea of regulated harvest within the MLCD, which could be frustrating for people wanting to provide for the families in the future.
- Politicians and their agenda
- Overfishing by non-natives
- Educating the public and limiting the damage, allowing time to heal.
- Tourism, restrictions are hard to enforce when people feel entitled.
- Funding
- People don't care.
- Disrespect of the land and sea. Developers wanting to increase income. Community vs government interests.
- There is always pressure by developers, tourism, and people who want to take (fish, etc.) from the ocean.
- Population growth
- Industry will push back
- General ignorance by some visitors to the MLCD.
- 1. Scuba operators 2. Sharks Cove Mall owners 3. Government funding and support

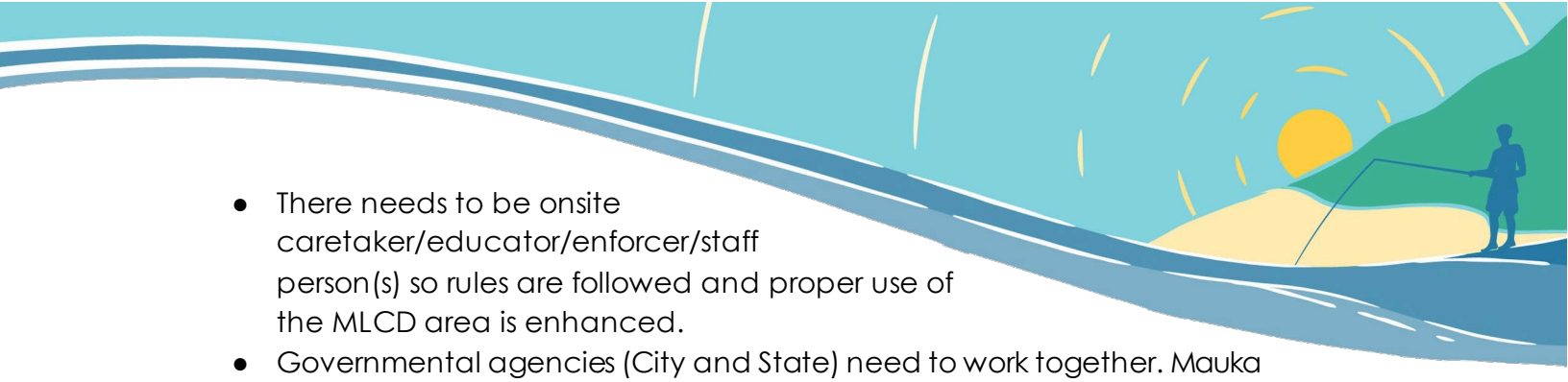
**Do you have any ideas about what could be done to solve those challenges or remove those barriers? Are there opportunities to achieve your hopes for the MLCD?**

- More education about what a wonderful resource it is and how we need to take care of it
- Maybe try one day off per year and see how that goes.
- Support from community, leaders, government—the bottom up.
- Perhaps designating rest days for the area during the heavily used months of summer. I think winter takes care of itself.
- Yeah, the state needs to grow a pair and set standards and actually support the entities tasked with the actual protection!
- However you guys change the rules so you can take away the commercial fishing if you want to really protect the place. And more funding would probably get more enforcement.
- Our state needs to refocus their values and priorities. We can't do anything on our own without them.
- The state needs to listen to the people who care for the places. There should be a cap on how many commercial SCUBA operators can be there, and they



should have to pay more than they do now to operate. When I worked in town, vendors in the parking lot were paying like $10k a month, but commercial use in the water pays like $200K? That's not right. The state should require the same for a commercial permit, and then some of the money should go back help manage the area. Also, they should close certain days to give the MLCD a break. Or even close it Sharks Cove and the tidepools all winter. The surf is big and dangerous anyway, and it would help with rescues. We just need better management of use, and we need to mitigate overuse. And boundary markers would help us so much—something because not everyone uses GPS. And for the commercial fishing in the Waimea Bay, that should require a permit, not just any commercial marine license. The permit requirement should include proving traditional practice—not just take for money. Also, there should be an easily enforceable limit on fish. Or a limit to a day or couple days—not two months of unregulated take.

- I think many people are unaware of the rules inside the boundaries.
- Education. Paradigm shift away from materialism toward environmentalism, spirituality.
- We need more support from the Governor and Mayor to help us out here.
- Everyone from voters to politicians must prioritize environmental concerns. We must have a better balance between the tourism economy and tourism degradation of our resources and environment. I'm sure there are many opportunities. Groups like MPW have been dreaming and creating them.
- Devise a way to limit numbers using the MLCD at any one time and allowing time for the area to rest. Find a way to enhance residents' access to the area; there are too many tourists using this resource on any given day.
- More education. More fines that are meaningful.
- A vision that addresses preservation and nurturing of our unique environment. Then we can move forward more smoothly with state resources available and ways for the community to address their specific concerns and access those resources.
- We need to control the North Shore traffic and access to our beaches in a reasonable way. Perhaps the idea of having local people only on weekends would help.
- Set some limits to avoid overuse if the people doing the monitoring are seeing negative impacts and can make some suggestions for the community and DLNR to think about.
- We can only keep trying to improve the beauty of Hawai'i and support also the communities that are working in the same direction.
- Environmentally significant places such as this should have rest periods.

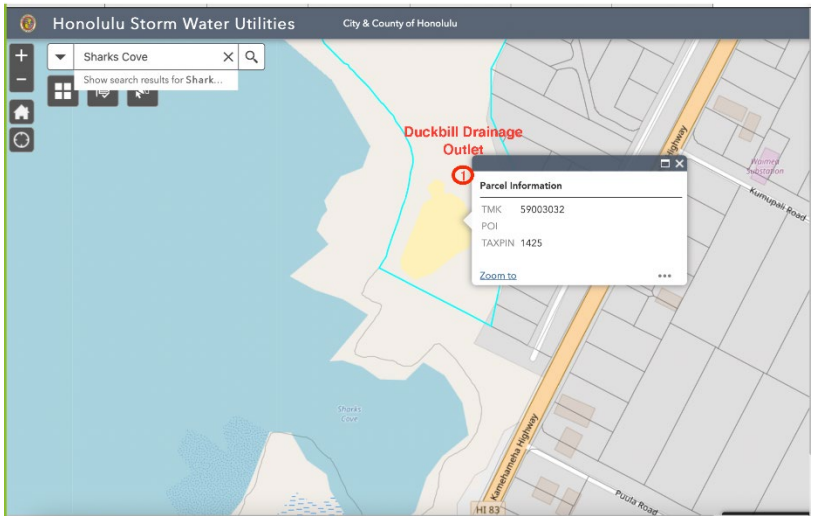


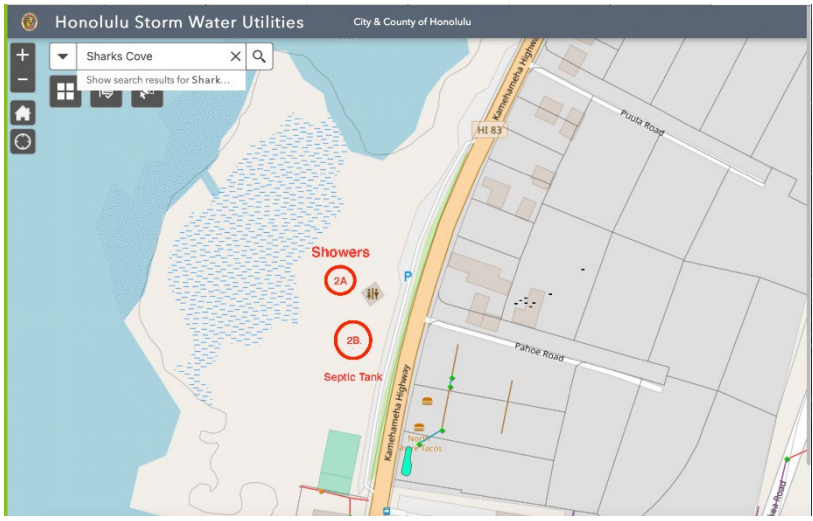
- There needs to be onsite caretaker/educator/enforcer/staff person(s) so rules are followed and proper use of the MLCD area is enhanced.
- Governmental agencies (City and State) need to work together. Mauka and makai.
- I believe the carbon footprint of the military use of the island needs to be addressed NOW. A reassessment of the military presence factored into our state level planning for the future.
- Start charging parking at beaches like Waimea for nonresidents and use funding to shore up DLNR.
- Realigning Kamehameha Highway mauka, adding more parking mauka, tighter control of commercial activity, moratorium of home construction makai of Kamehameha Highway.
- Empower lifeguards or HPD to cite people for ocean-based infractions. Hire more DOCARE officers. Inform the public on how to report violations. Make it easier to prosecute violators.
- Pro-environment legislation
- Educate and inform the public, bringing awareness to the fragility of precious natural resources.
- Charge a fee for use, and use the revenue to fund enforcement officers for Pūpūkea only. Also use funds for restoration.
- Native Hawaiian community activism should target conservation, and if worse comes to worse, Waimea Bay may need to be transformed into another Hanauma Bay, so tourists have to pay to get in.
- If the state government was willing to spend the time and resources to implement consequences (fines, bans, etc.), especially at the corporate level, to prevent breaking regulations, I think that would go a long way to helping these issues. I would support a small tax to use for conservation and education, but I'm not sure if there are many folks who agree with that perspective.
- Sustainable development. Understanding that people are different and should be respected.
- Regulate the area like Hanauma Bay.
- Hire more DLNR, educate fishermen, spearfishermen.
- I believe more education should be given to tourists about how fragile our marine ecosystems are, and perhaps limit the amount of people allowed in the waters per day, especially in the Three Tables and Sharks Cove area. I believe this could help limu and coral populations. I believe it would also be helpful to have very regulated harvest of certain animals.
- Make the hard decisions that don't just Band-Aid imminent problems.

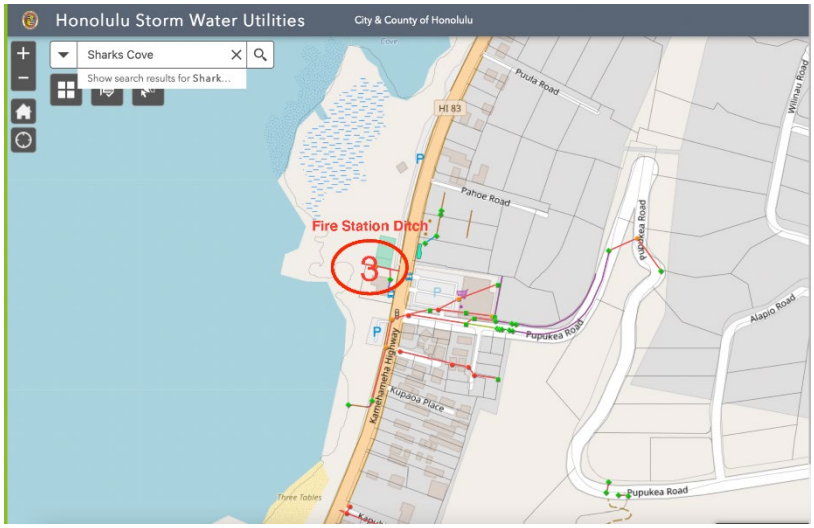
- People are willing to help and may volunteer to collect good data. Subtidal data is harder to gather though.
- Continued community education
- Continued community strength and advocacy.
- Strong community leadership to keep residents and tourists informed about the MLCD and any threats to it. I think the majority of people want to support the MLCD and fight against anything threat would harm it.
- I don't see the area experiencing less visitors and traffic, so my hope would be that preservation and restoration efforts can overwhelmingly outpace negative impacts. Has the Hanauma Bay education effort proven to be successful? Make Waimea Bay a toll road?
- Park rangers monitoring access and reminding folks to stay off the coral rocks, parking reserved for residents over tourists, and banning commercial tours.
- Make it easy for people to learn. Informational signs with graphics make it easier for people to learn.
- If we figure this out, we need to share with other community efforts facing similar challenges.
- I hope this group pushes back against Pūpūkea being the proposed site for the new dump, or the marine zone will be terribly contaminated by runoff.
- There needs to be more funding, the MLCD needs to be expanded, and there needs to be a more effective enforcement mechanism.
- My hope would be for all the coastline beaches and areas to be overseen by groups like MPW that will solve problems, educate and mālama ʻāina. Decisions that will keep the water, marine life and land clean, safe, and thriving.
- Please let the community around Oʻahu know how we can help. Even though we love "in town," we value Pūpūkea and want to support your efforts.

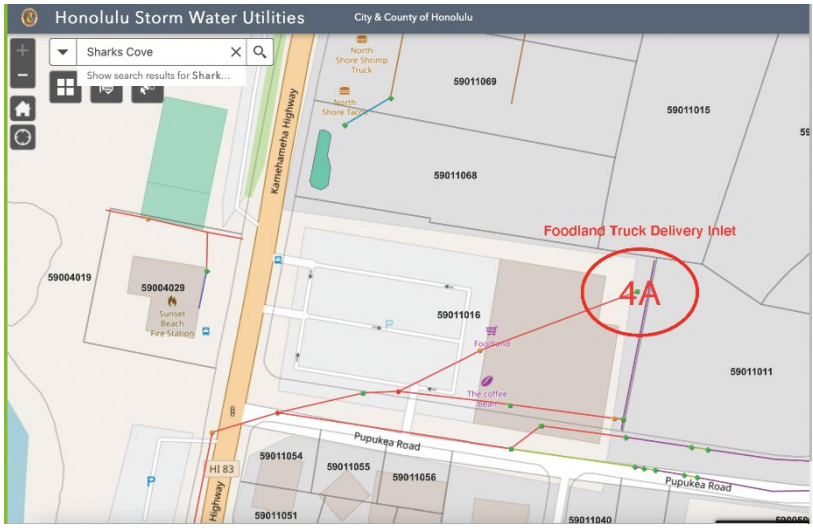
# Appendix 9: Detailed Maps of Stormwater Drainage Discharge Locations and Sources

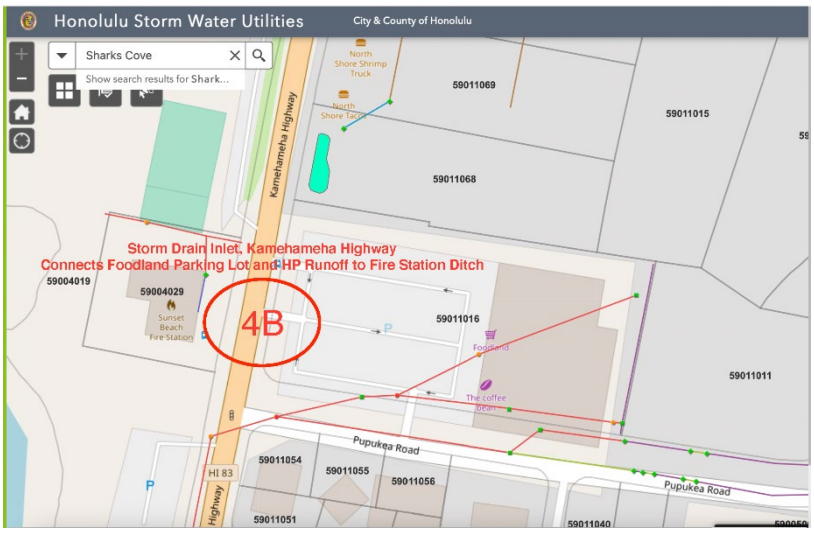
Stormwater drainage and water run-off from other land-based sources, such as showers and restrooms (comfort stations) affect MLCD ecosystem health. Several storm drains empty into the MLCD nearshore waters off Pūpūkea Beach Park. The maps below show the detailed locations of key drainage points that connect land-based sources of discharge into the nearshore environment. Maps are presented in numbered order from north-east to south-west adjacent to the MLCD.

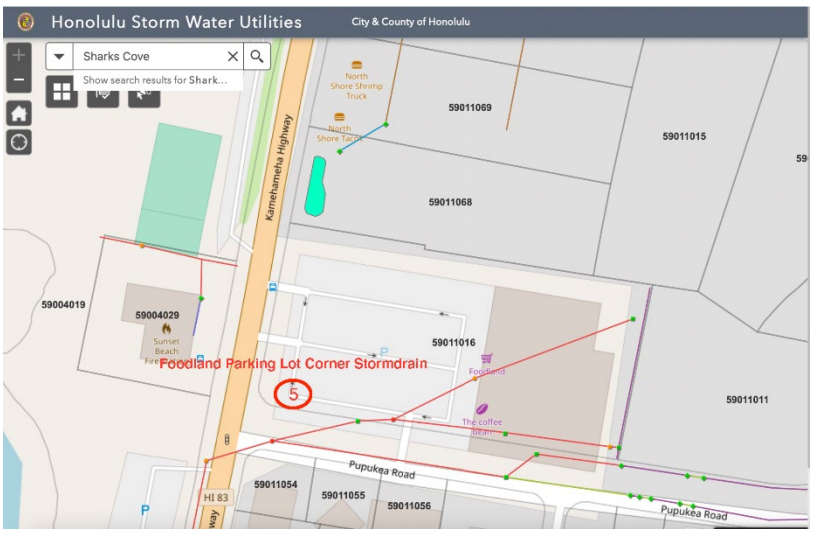



Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Storm Drain Inlet, Kamehameha Highway
Connects Foodland Parking Lot and HP Runoff to Fire Station Ditch
4B
Kamehameha Highway
Pupukea Road
59011069
59011015
59011068
59011016
59011011
59011054
59011055
59011056
59011051
59004019
59004029


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Foodland Parking Lot Corner Stormdrain
5
Kamehameha Highway
Pupukea Road
59011069
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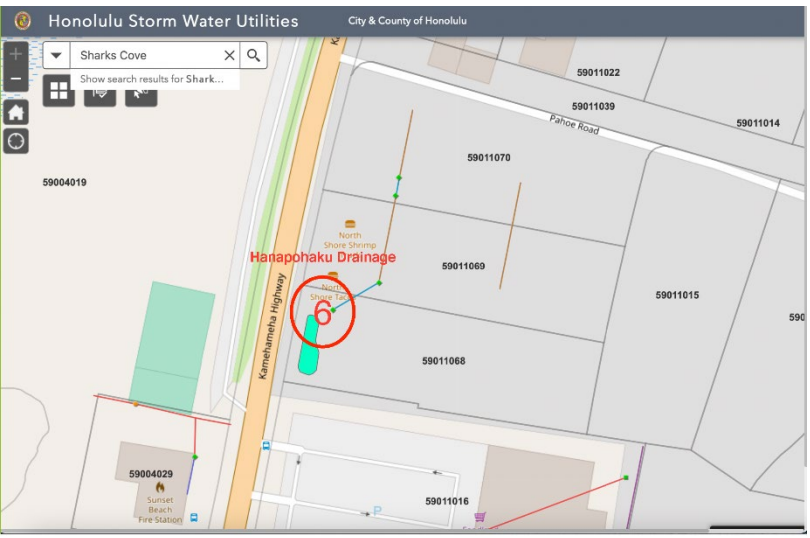
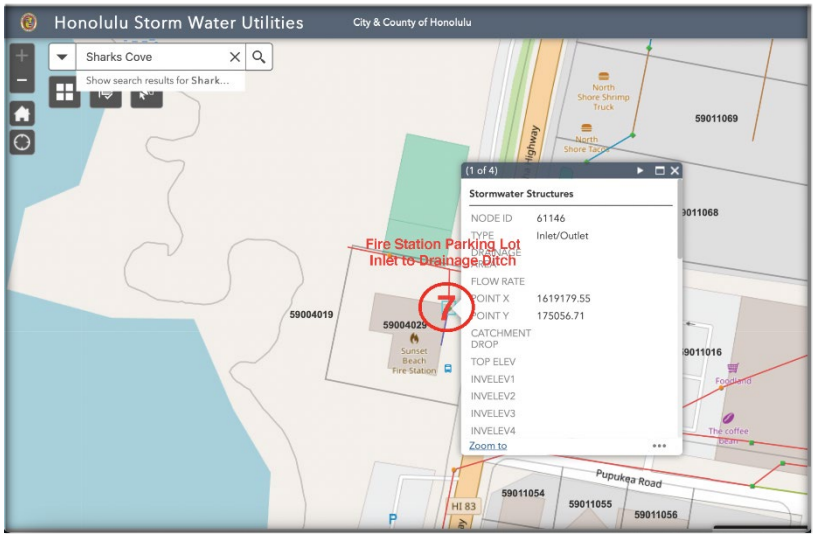
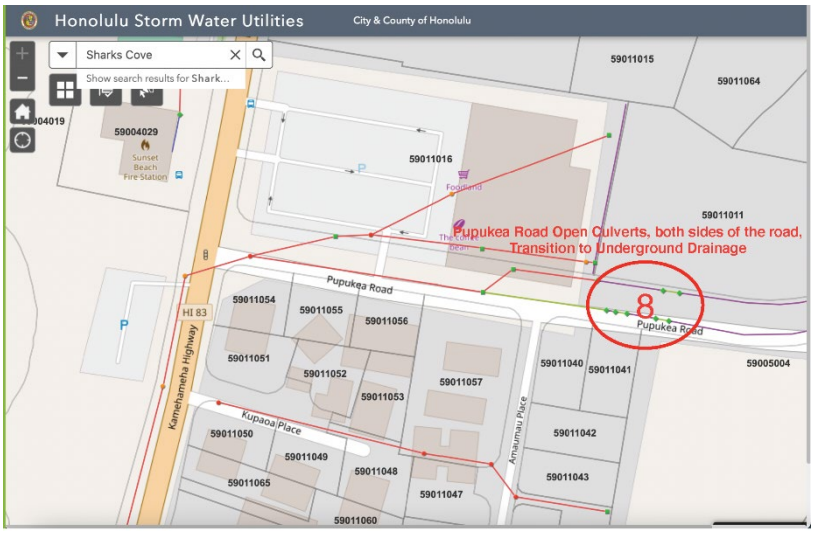
59011068
59011016
59011011
59011054
59011055
59011056
59004019
59004029


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Hanapohaku Drainage
6
Kamehameha Highway
Pahoe Road
59011022
59011039
59011014
59011070
59011069
59011015
59011068
59011016
59004019
59004029


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Fire Station Parking Lot
Inlet to Drainage Ditch
7
(1 of 4)
Stormwater Structures
NODE ID 61146
TYPE Inlet/Outlet
FLOW RATE
POINT X 1619179.55
POINT Y 175056.71
CATCHMENT DROP
TOP ELEV
INVELEV1
INVELEV2
INVELEV3
INVELEV4
Zoom to
Pupukea Road
59011069
59011068
59011016
59011054
59011055
59011056
59004019
59004029


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Show search results for Shark...
Pupukea Road Open Culverts, both sides of the road, Transition to Underground Drainage
8
Pupukea Road
Kamehameha Highway
HI 83
Kupaoa Place
Amaumau Place
59011015
59011064
59011016
59011011
59011054
59011055
59011056
59011051
59011052
59011053
59011057
59011040
59011041
59005004
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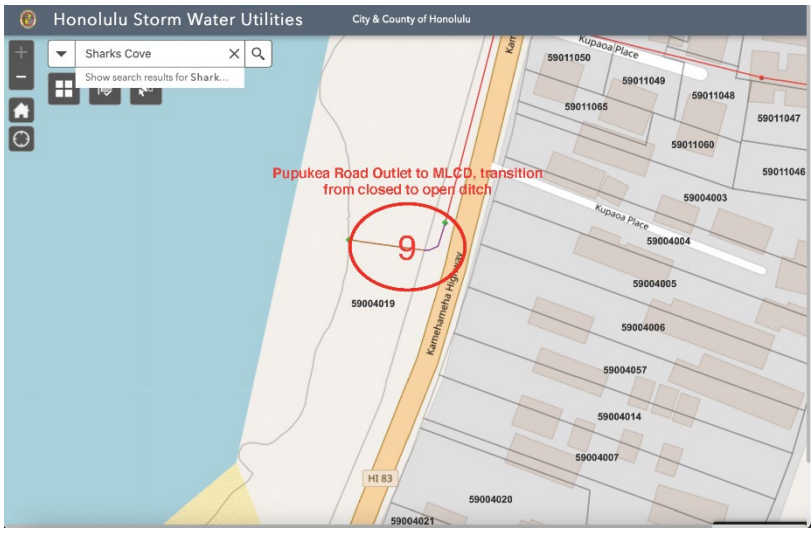
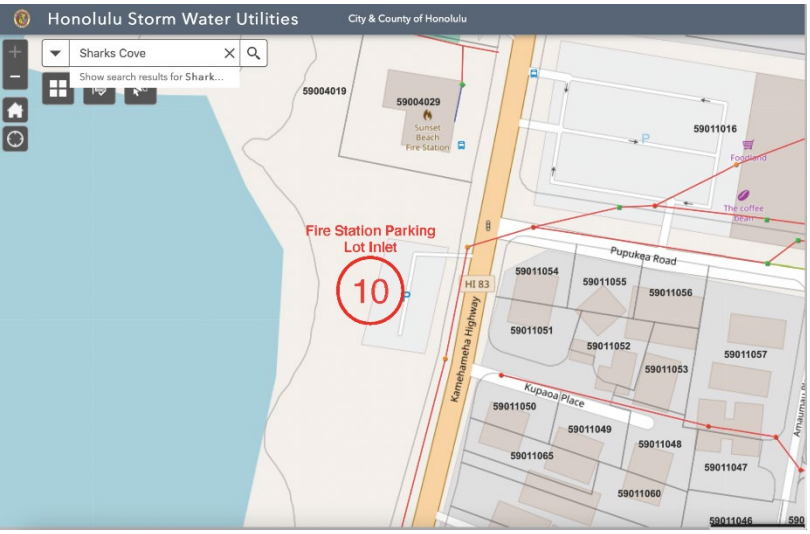
59011060
59004029
59004019


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Show search results for Shark...
Pupukea Road Outlet to MLCD, transition from closed to open ditch
9
Kamehameha Highway
HI 83
Kupaoa Place
59011050
59011049
59011048
59011065
59011047
59011060
59011046
59004003
59004004
59004005
59004006
59004057
59004014
59004007
59004020
59004021
59004019


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Show search results for Shark...
Fire Station Parking Lot Inlet
10
Pupukea Road
Kamehameha Highway
HI 83
Kupaoa Place
59004019
59004029
59011016
59011054
59011055
59011056
59011051
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59011065
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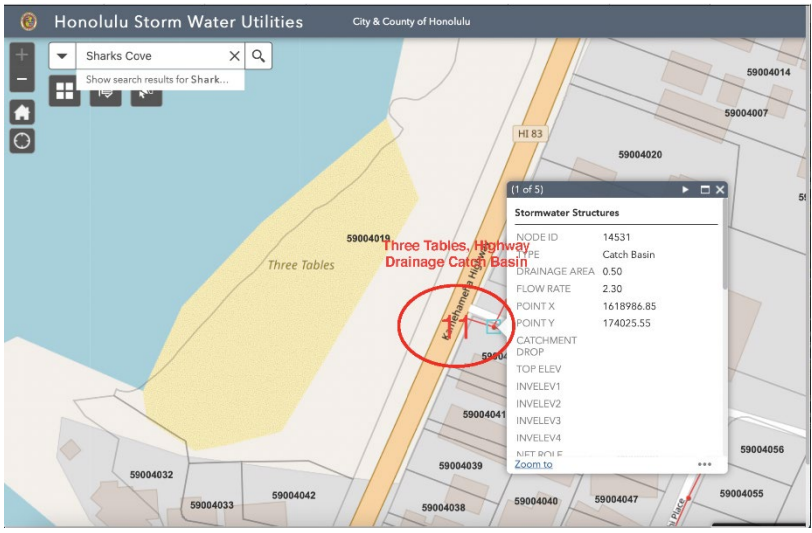
59011060
59011046


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Show search results for Shark...
Three Tables, Highway Drainage Catch Basin
11
Three Tables
Kamehameha Highway
HI 83
(1 of 5)
Stormwater Structures
NODE ID 14531
TYPE Catch Basin
DRAINAGE AREA 0.50
FLOW RATE 2.30
POINT X 1618986.85
POINT Y 174025.55
CATCHMENT DROP
TOP ELEV
INVELEV1
INVELEV2
INVELEV3
INVELEV4
Zoom to
59004014
59004007
59004020
59004019
59004041
59004039
59004056
59004032
59004033
59004042
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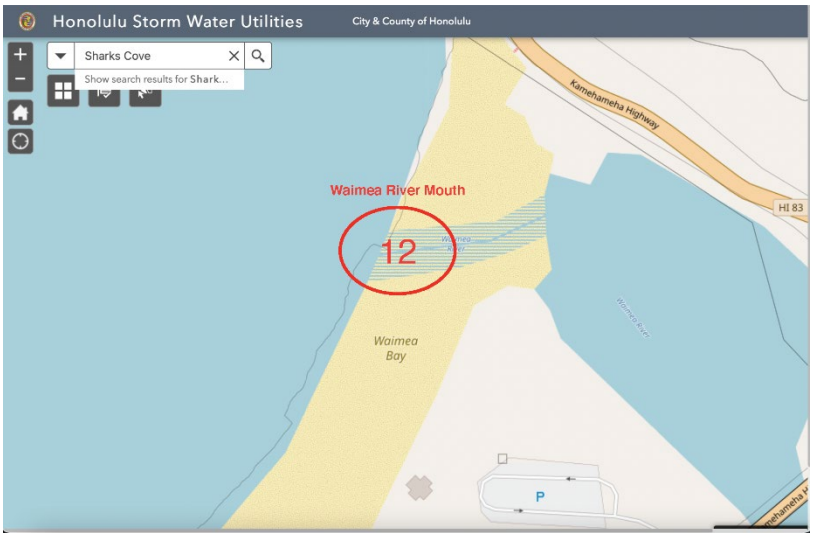
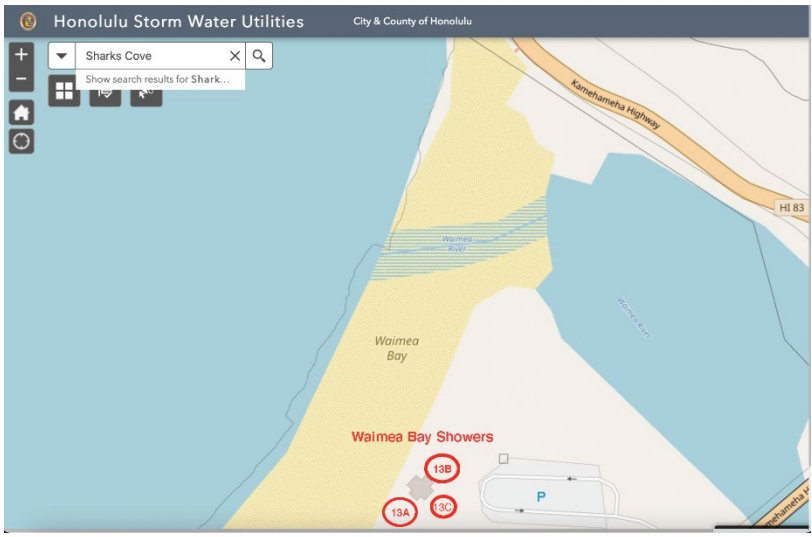
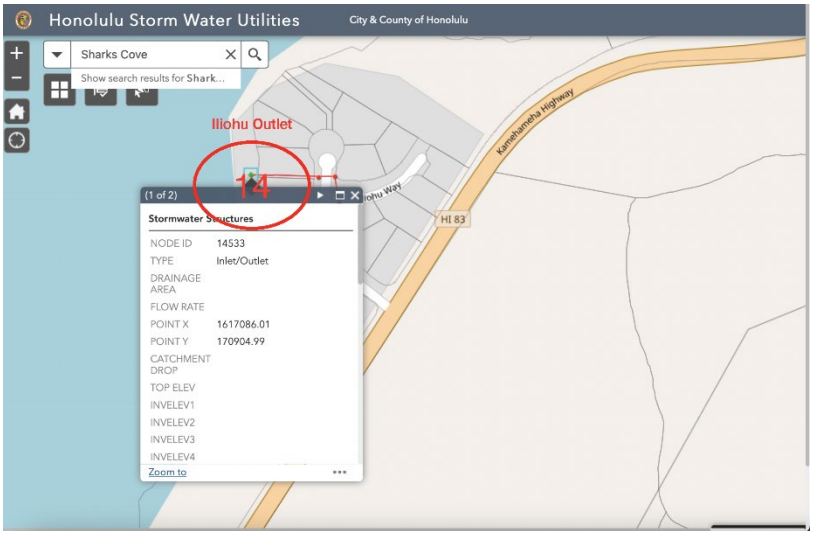

Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Show search results for Shark...
Kamehameha Highway
HI 83
Waimea River Mouth
12
Waimea Bay
P


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Show search results for Shark...
Kamehameha Highway
HI 83
Waimea Bay
Waimea Bay Showers
13B
13A
13C
P


Honolulu Storm Water Utilities
City & County of Honolulu
Sharks Cove
Show search results for Shark...
Iliohu Outlet
14
(1 of 2)
Stormwater Structures
NODE ID 14533
TYPE Inlet/Outlet
DRAINAGE AREA
FLOW RATE
POINT X 1617086.01
POINT Y 170904.99
CATCHMENT DROP
TOP ELEV
INVELEV1
INVELEV2
INVELEV3
INVELEV4
Zoom to
Kamehameha Highway
HI 83