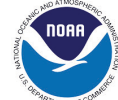




West Maui Wahikuli & Honokōwai Priority Watershed Area

REEF CONDITION REPORT

December 2014



Executive Summary

Background

- The State of Hawaii and partners established the West Maui Priority Watershed Area in year 2010 with the intent of making this a focal location for coral reef research and management initiatives. The USCRTF added a priority watershed partnership designation to Wahikuli and Honokōwai in 2011, and the [West Maui Ridge to Reef Initiative](#) (WMR2R) was formalized in 2012 creating layers of commitment to interagency and community partner collaboration in this area of West Maui. Ongoing and planned projects enacted to improve condition of reefs include the establishment of the Kahekili Herbivore Fisheries Management Area (KHFMA) in July 2009, and the initiation of several WMR2R projects intended to reduce extent and impact of land-based sources of pollution. Summarized below is what is known about current status and recent trends of local reefs in order to provide a baseline against which future condition can be assessed.

Coral Reef Habitats & Survey Data for Wahikuli and Honokōwai

- **There is considerable variability in both condition and characteristics of coral reef and hardbottom habitats within the Wahikuli and Honokōwai watersheds.** Much of the hardbottom habitat in this area consists of patchy or low coral cover habitat, but there are also sections of coastline with coral-rich and structurally complex reefs - in particular in the 'Canoe Beach' area and within the Kahekili Herbivore Fisheries Management Area (KHFMA).
- **There is considerable variability in the type and quantity of biological survey data available from different parts of priority watershed area.** Specifically, there is considerable and spatially comprehensive data from inside the Kahekili HFMA, which has been intensively monitored since 2008, and which also has consistent benthic data from a 'CRAMP' site in front of the Kahekili Beach Park since 1994. For all other parts of the watershed, available survey data is limited either spatially or temporally. One purpose of this report is to highlight those gaps.
- **Priority watershed areas have been divided into 4 'sections' to reflect the variability of habitat types and data-availability:** 'Canoe Beach'; 'Black Rock', 'Kahekili HFMA', and 'Mahinahina/North Honokōwai' (figure 1), and here we report on the status of coral reefs and associated fish assemblages at that scale. Where possible we report not only current conditions, but also longer-term trends, and attempt to place those values in context by comparing against similar data from elsewhere in Maui and beyond.

Coral Reef Status and Trends

Kahekili Herbivore Fisheries Management Area (KHFMA)

- The KHFMA section contains substantial areas of well developed reef, and across all hardbottom areas in that section, coral cover averaged 32.6% over last 5 years, considerably higher than the average for all hardbottom habitats in Maui of 10.1%. Over the same time period, mean biomass of fishes generally, including of 'key herbivores' (parrotfishes and surgeonfishes), was around twice the average from Maui hardbottom sites (comparison points for both derived from NOAA CRED surveys around Maui in 2010, 2012, and 2013).
- The DAR-CRED monitoring of the KHFMA provides clear evidence of positive change since the KHFMA was established, including increased biomass of parrotfish and surgeonfishes and increased cover of crustose coralline algae (CCA, that is considered to be beneficial for coral growth and recruitment). Following earlier declines in coral cover (between 2008 and 2010) coral cover stabilized within the KHFMA and then slightly ticked up in late 2013 and into 2014. Data from the CRAMP site at Kahekili Beach Park indicates that, for

that one area of shallow reef, coral cover has been relatively stable over around the last decade, having previously declined from the year we first have data from (1994).

Black Rock

- There is very little reef habitat in the 'Black Rock' section, and therefore it is not problematic that there is also very little survey data from there.

Canoe Beach

- The Canoe Beach section appears to contain a large area of well-developed reef. However, the only benthic data we are aware of come from a cluster of sites sampled towards the northern end of that stretch of high cover reef in 2008, and from the recently established 'Coral Health' sites at the southern edge of that reef tract. Those data indicate that coral cover is relatively high (e.g. mean of 39% at the northern cluster, and 49% at the 'Coral Health' sites), but it is not known how representative those sites are of the larger reef habitats in this section.
- Fish data for Canoe Beach comes from the 'DAR resource fish' surveys at a single 12m deep site near the southern edge of the main reef tract. Data from those surveys indicates that biomass of targeted fishes, including parrotfishes and surgeonfishes, is relatively low at that site: ~half the average from other Maui sites covered by that survey program.
- The 'Mahinahina/North Honokōwai' contains a lot of patchy reef habitat, but also some clusters of relatively high coral cover. The main longer-term data available from this section comes from a CRAMP site and a 'DAR resource fish' site located on what is probably some of the best quality reef habitat in the section. That data indicates relatively high coral cover at the CRAMP site (~30% overall, but ~40% at the deeper station and ~20% at the shallow station). Biomass of target fishes at the 'DAR resource fish' site was low compared to other sites in Maui surveyed by that program (generally ~1/3 or less of the Maui average for that program. As for the Canoe Beach section, in fact more so, it is difficult to know how representative available data are of wider reefs in this section.
- Two recently established 'Coral Health' sites adjacent to the Mahinahina and Honokōwai stream drainages indicate variable coral cover ranging between 5–43% and 38–40%, respectively.

Coral Reef Condition Status and Trends Schematic. Hatched lines indicate that there is insufficient data to draw conclusions about status or trends. Red= condition is poor compared to other reefs in Maui; Green indicates 'good' condition (i.e. high biomass, high coral cover, low macroalgal cover; orange means around average for Maui. Arrows are intended to give an indication of recent trends. NOTE that judgments are largely subjective. There will be scope for a more formal assessment as more data is gathered over longer timeframes. We strongly advise readers to examine the more detailed data provided below.

SECTION	Fish Biomass	Key Herbivore	Fish Richness	Coral Cover	Crustose Coralline Algae [CCA]	Macroalgal Cover
Canoe Beach	→	→				
Kahekili HFMA	→	↑	→	→	↑	↓
N. Honokōwai	→	→				

Survey Outlook

- As noted above there are significant data gaps for all sections of the watershed areas other than the KHFMA. In particular, what data there is comes from a small number of fixed sites that therefore do not give information on other reef habitats in the vicinity, and which tend to be limited to one or a small

number of habitats or depth ranges. Therefore, in addition to some issues of limited replication for some data sets, it is difficult to know how representative those data are of status or trends in the majority of reef habitats in the priority watershed area.

- Collaborative monitoring of the KHFMA has demonstrated substantial changes in reef assemblages since closure, but given the lifespans of the fishes protected (2 or more decades for many species) and the expected lag in response of slow growing corals, it will likely take several more years before the full effects of closure are known.
- The recently established 'Coral Health' sites were designed to generate high quality data on benthic cover and coral demographics at the 3 sites where survey transects are clustered – one in Canoe Beach, one close to Honokōwai Point, and one just north of the deeper Mahinahina CRAMP station. Continued monitoring of those sites will provide early indication of change in coral assemblages and health in reef areas adjacent to terrestrial drainage points. However, for the great majority of reef habitats in the priority watershed area, there are no implemented or planned coral health survey programs for the priority watershed area.
- As with nearly any such area in Hawaii and beyond, there are a variety of survey programs with different methods and designs. While there are frequently strong reasons for developing specific programs for particular locations and questions, the diversity of survey approaches does complicate larger scale and comparative assessments. To the extent it is possible and reasonable to do so, there would be great value in agencies concentrating on a small number of survey approaches and for there to be a concerted effort to develop calibration coefficients to facilitate data exchange and pooling.

Prepared by:
Ivor Williams
Bernardo Vargas
Darla White
Tova Callender

Background and Characterization of Near-shore Reef Habitats

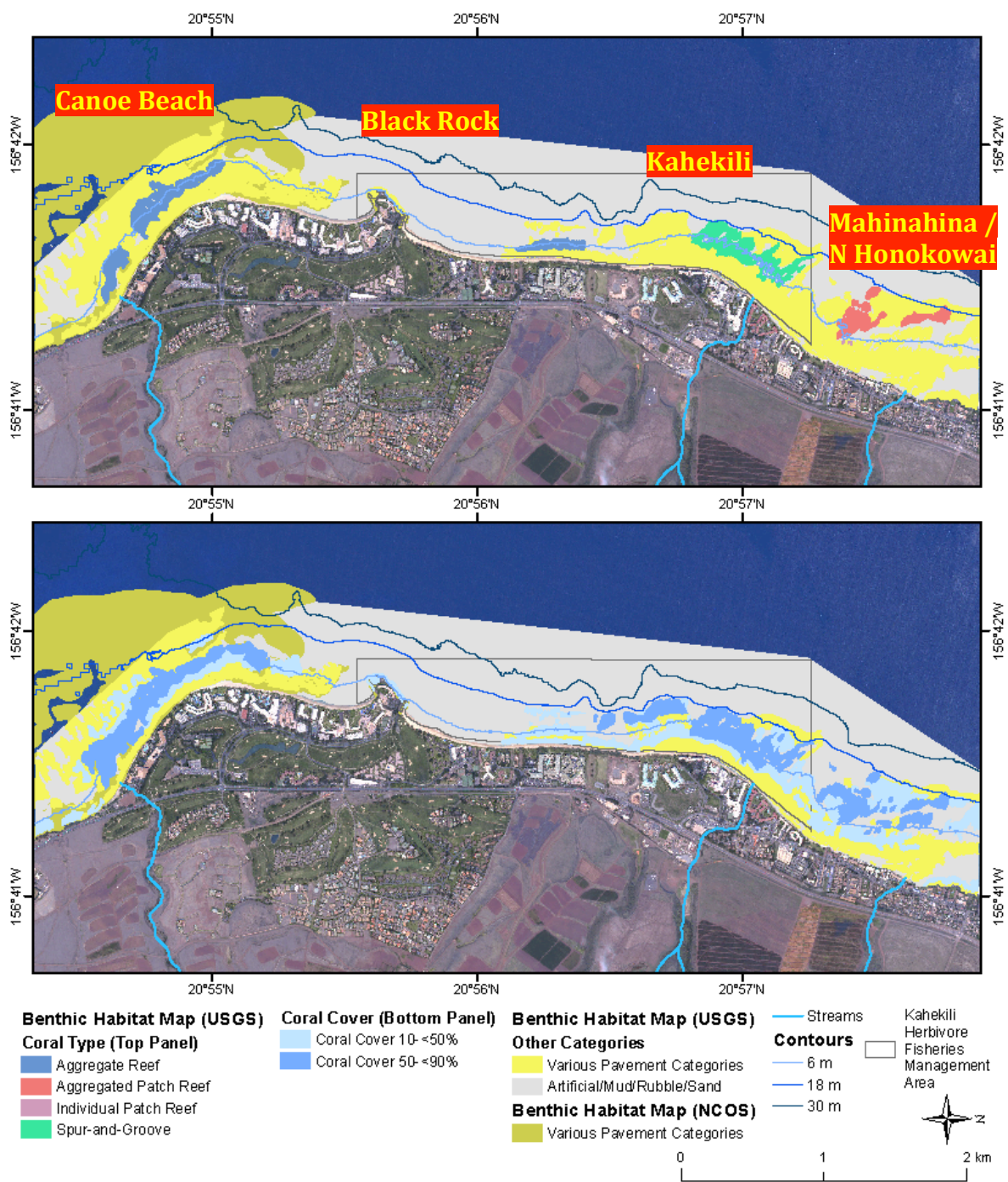


Figure 1. Maps of (a) reef type; and (b) coral cover categories at West Maui priority watershed. Data from USGS report.

The West Maui priority site contains 4.4 miles of coastline, which we have divided into 4 sections, based on reef structure and availability of data (fig 1): Hanaka'ō'ō Beach, commonly known as 'Canoe Beach' at the southern edge of the priority site has a large well developed nearshore reef and substantial hardbottom pavement areas with scattered coral extending into deeper water; the Pu'u Keka'a or 'Black Rock' section is largely sand-habitat with some coral habitat on Black Rock itself; 'Kahekili HFMA' contains extensive and varied reef habitats including

shallow fringing reef, offshore forereef, as well as complex spur and groove habitat around Honokōwai point; reef habitats in the furthest north section ('Mahinahina/North Honokōwai') consist largely of reef pavement and sandy zones, but with patches of richer coral habitat. Because of the size of the priority site and the diversity of habitat types, reef conditions are primarily reported at the level of these sub-sections.

Data Sources and Summary Metrics

Figure 2 shows the locations of sampling sites for all fish or benthic assemblage fish or benthic data gathered by DAR or CRED survey programs. We did not attempt to collate data from the several research efforts inside the Kahekili HFMA (KHFMA) in recent years, but those data could potentially be included in future or supplementary reports.

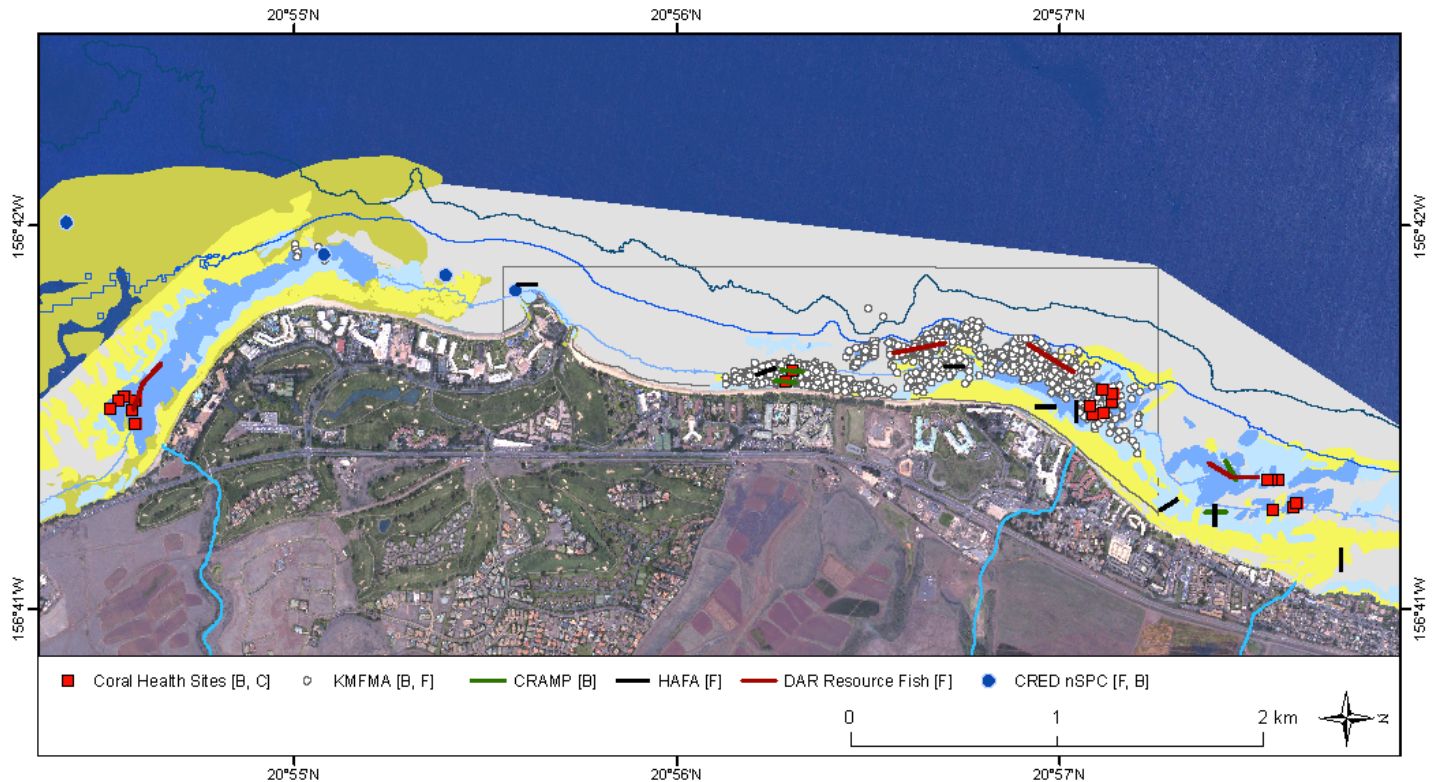


Figure 2. Coral reef surveys inside the priority watershed.

There are 4 main survey programs that we draw data from (see below). The locations of survey sites of each type are showing in figures 2-6.

- 'CRAMP' (Hawaii Coral Reef Assessment and Monitoring Program; <http://cramp.wcc.hawaii.edu>) sites involve photo-surveys of benthic cover in fixed permanent transects. Each survey location has two 'sites', generally at ~3m and ~7m; with each site consisting of 10 replicate transects. Within the watershed, there are 2 CRAMP locations: 'Kahekili' and 'Mahinahina' (figures 2, 5 & 6). The Kahekili CRAMP location was established in 1999 and Mahinahina in 2004.
- DAR 'Resource Fish' surveys are timed swims, in which divers focus on fishery target taxa and size ranges (for consistency only data on fishes > 15 cm are used for this report). 'Resource' fish surveys are conducted 1-3 times a year at each site, with each survey covering ~250m long stretch of reef starting from a fixed location. Within the watershed, there are 'resource' fish sites at Canoe Beach, Kahekili (2 sites), and Mahinahina (figures 2, 3, 5 & 6), all at ~10m deep. We use 'resource fish' surveys from 2008 onwards.

- ‘KHFMA’ surveys involve fish and benthic photo-transects of transects randomly located within hardbottom habitats inside the Kahekili HFMA (figures 2 & 5). KHFMA surveys were established to test the effectiveness of the Kahekili HFMA; they began in January 2008, and have involved 1 or 2 ‘rounds’ of intensive surveys every year since.
- ‘Coral Health’ sites are locations where there are co-located benthic cover, coral condition, and coral demographic surveys. Three clusters of those were established and first sampled in June & July 2014 - at Canoe Beach, Honokōwai (inside Kahekili HFMA), and Mahinahina (figures 2, 3, 5 & 6). These newly established sites will be surveyed once per year through 2016 and ideally beyond. In addition, comparable data has been gathered on one occasion at the location of the Kahekili CRAMP stations (figures 2 & 5).

As shown in figure 2, there are also CRED or DAR data from two other programs: ‘HAFA’ surveys, and ‘CRED SPC’. The HAFA surveys are timed swims conducted by snorkel in very shallow nearshore habitats (~2 m). Because of the very narrow focus of that program, and because there are relatively few data from the priority watershed we have not included that data beyond showing site locations in figure 2. ‘CRED SPC’ surveys are conducted by CRED during the MHI-wide randomized surveys conducted for the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). That program has been designed to assess island-scale and larger reef assemblages, and hence the 4 sites that randomly fell within the watershed (figure 2) are far insufficient to allow for their use.

Summary of Available Survey Data

As would be the case for almost any similarly sized section of coastline in Hawaii, there are data from a variety of survey programs, established with a range of different goals. The KHFMA program is the only of these programs that attempts to be representative of reef habitats at a scale comparable to or within the scale of this report – in that case, surveys are widely distributed across pavement and reef areas within the KHFMA, and have sufficient replication to draw strong conclusions about fish and benthic condition status and trends over time in the KHFMA.

There is considerable value in other programs, for example, the CRAMP sites provide very high quality information about status and trends in benthic cover at the location of the survey transects; similarly the coral health sites established in 2014 will provide scope for assessing changes in coral condition and benthic assemblages along gradients in proximity to stream mouths/drainage points at Canoe Beach, Honokōwai, and Mahinahina, i.e. reef areas that would likely most immediately respond to changes in upslope land based pollution management projects underway through the West Maui Ridge to Reef Initiative.

Other survey data come from larger-scale programs conducted by DAR or CRED that focus on particular habitats or depth ranges, i.e. those surveys are not intended to be representative of specific local reef as a whole, but are instead part of larger-scale assessments of trend or broad condition. Where those data are used below, it should be understood as representing best available data; status and trend information from those sites does not necessarily represent the totality of reefs in the priority watershed.

Reef Condition Metrics

Standard reef condition metrics are used to quantify reef condition in ways that are consistent with reporting at other NOAA coral program priority sites. By definition standardized metrics simplify complex ecological relationships and processes in ways that lose considerable amounts of information. Nevertheless, they provide information on aspects of condition that scientists and managers have deemed to be particularly meaningful, and which are widely used as coarse indicators of condition. For several of those target metrics, we do not currently have sufficient information to assess conditions. This summary document is partly intended to highlight current data gaps.

Table 1a. Condition metrics - Fish

Fishes	Metric	Purpose / Justification
	Total Fish Biomass	Total fish biomass represents what is typically an estimate of standing stock (weight) of reef fishes per unit area. Biomass is affected both by the number and the size distribution of local fishes, and is widely used as an indicator both of fishing impacts and of overall fish assemblage status.
	Key Herbivore Biomass (parrotfish & surgeonfish)	Large populations of herbivorous fishes will tend to maintain local algal communities in cropped states (e.g. CCA) that are considered most suitable for coral growth, recruitment and persistence. The KHFMA was in part set up to assess the scope for increased herbivory to promote conditions that allow corals to thrive on local reefs.
	Species richness	Species richness is a measure of the number of species observed in a standardized sample. High richness, i.e. high diversity of species – is generally considered desirable and may also indicate an environment that is suitable for a wide range of species. As noted above, all metrics should be interpreted with caution, but even more than other metrics used, richness is prone to large variability depending on methods used, observer experience, and aspects of reef condition that effect detectability.

Table 1b. Condition metrics -

Benthos	Metric	Purpose / Justification
		Benthic % Cover from Photo Transects – i.e. Upper Canopy Cover
	Hard Coral	Reefs with high coral cover are generally actively growing and structurally complex environments. Coral cover is an integrated measure of growth, recruitment, mortality, and partial mortality of corals. Thus, high or increasing coral cover is indicative of an environment suitable for a coral reef to thrive.
	Crustose Coralline Algae [CCA]	CCA appears as hard, typically pink, rock-like substrate. High cover of CCA is generally indicative of algal growth being well controlled by resident herbivores. Compared to other algae that can occupy reef substrate, CCA is relatively benign or positive to corals – including that coral larvae will preferentially settle on some forms of CCA.
	Macroalgae	Macroalgae are structurally complex, generally fleshy and upright algae. While healthy reefs can have considerable macroalgae, increases in macroalgae or transitions from coral to conspicuous macroalgal cover are likely indicative of declining environmental quality for coral.
		Coral Condition & Demographics
	Coral Recruitment	Juvenile colonies can be distinguished in the field by a distinct tissue and skeletal boundary (not a fragment of larger colony). This parameter measures the influx of new members into the population by sexual reproduction. The establishment of new coral recruits indicated good conditions for reef development and growth
	Coral Condition	Coral bleaching and disease are health impairments that interfere and limit a coral's ability to perform normal physiological functions (maintenance, growth, and reproduction). They are typically caused by a number of agents, including, environmental factors such as nutrients, toxicants, and climate; pathogens including bacteria and viruses (infectious agents); and inherent or congenital defects. Coral bleaching and disease have become central topics of discussion among coral reef managers, scientists, and the general public, largely because of the alarming rate at which these threats have increased in the last two decades.

Canoe Beach Section

Available Survey Data

Although the Canoe Beach section contains large expanses of well-developed coral reef as well as extensive pavement habitats, there is rather little available survey data from this section (Figures 1, 2 & 3). Benthic cover and coral condition data is given below for the ‘Coral health’ sites surveyed in July 2014. Annual average fish metrics are from the 1-3 surveys per year at the ‘Resource fish’ site since 2008.

The 8 KHfMA transects surveyed in 2009 are not sufficient to draw meaningful conclusions for this section, but results from those confirm that there was abundant coral there at and time of those surveys (mean coral cover 39%), and, as with the resource fish data discussed below, indicate relatively low biomass of parrotfish and surgeonfish.

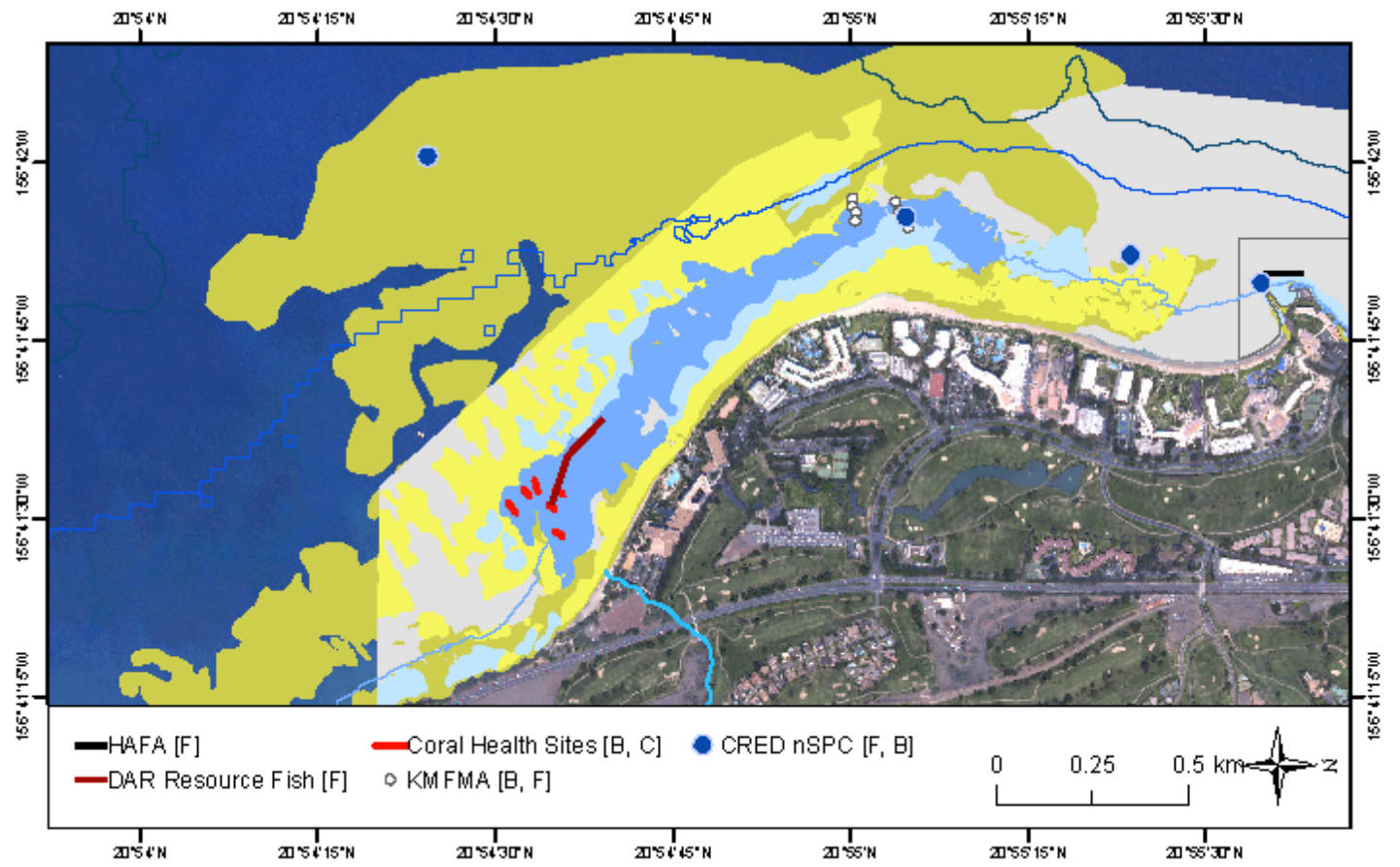


Figure 3. Available survey data from Canoe Beach Section

Benthic Condition Metrics

Table 2a. Mean ± SE benthic cover from coral health site surveys. Coral Health Site data are derived from 3 transects at <20f deep. CRED RAMP comparison come from the analysis of 2013 RAMP benthic images from all sites at comparable depth (<60ft)

	'Coral Health' site	CRED RAMP	
	Recent (2014)	Maui	All MHI
Hard Coral	47.3 ± 1.7	18.3 ± 2.7	12.2 ± 2.5

Macroalgae	0.0	2.8 ± 0.7	3.8 ± 0.9
CCA	0.67±0.33	1.7 ± 0.5	3.0±0.9

Table 2b. Demographics (Density colonies/m²) Data are Mean ± SE. CRED comparisons are for sites <60ft of water from 2013 surveys.

	'Coral Health' site	CRED RAMP	
	Recent (2014)	Maui	All MHI
Juvenile colonies	6.9 ± 2.9	5.1 ± 1.4	3.9 ± 0.4
Adult colonies	27.0 ± 4.9	11.2 ± 2.9	6.8 ± 1.2

Table 2c. Coral Health (%). Data are Mean ± SE. CRED comparisons are for sites <60ft of water from 2013. CRAMP and CRED data collected using slightly different methods, which means that estimates are not exactly comparable (different survey areas yield somewhat different estimates of disease prevalence). Surveys conducted in Oct 2014;

	Coral Health Site	CRED RAMP	
	Recent (2014)*	Maui	All MHI
Coral bleaching	5.5 ± 0.2	2.0 ± 0.5	2.0 ± 0.5
Disease -Growth anomalies -Recent tissue loss	0.4 ± 0.2 0.0	1.0 ± 0.7 0.5 ± 0.2	0.3 ± 0.1 0.1 ± 0.1

Fish Condition Metrics

Table 3. Mean ± SE fish biomass from Canoe Beach DAR Resource Fish site. Note that Maui average comes from all other resource fish sites at comparable depth in Maui.

BIOMASS (g /m ²)	Canoe Beach Resource Fish		DAR Resource Fish
	5-yr Ave	Recent (2014)	Maui (5 year average)
All Fishes	6.9 ± 1.8	4.9 ± 1.6	15.2 ± 0.8
Parrotfish	1.0 ± 0.2	1.1 ± 0.3	2.7 ± 0.2
Surgeonfish	4.7 ± 1.4	3.4 ± 1.7	7.7 ± 0.8

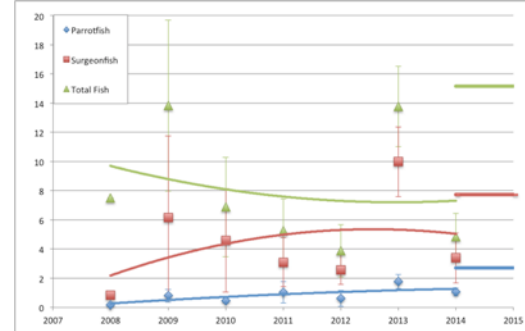


Figure 3A. Fish Assemblage Trends . Canoe Beach Resource Fish Surveys. Bars on right hand side represent Maui 5yr averages.

The number of species encountered per survey in Resource fish surveys over last five years was 10.5 ± 0.8 (mean ± SE), which is a little lower than the Maui average for these surveys of 12.4 ± 0.2 over the same time period.

Resource fish biomass (i.e. biomass of medium and large fishes of target families), and biomass of key herbivore families (parrotfishes and surgeonfishes) at the Canoe Beach site have been below the average of other DAR Maui resource fish sites in the same depth range (fig 3A). Not surprisingly given the small sample size, data are quite

variable from year to year, but there is no clear evidence of an overall upward or downward trend in fish conditions metrics at that site.

Summary

In spite of the relatively large amount of well-developed coral habitat in this section of the watershed, there is little available survey data, other than from the a small area of reef approximately offshore of the Hanaka'ō'ō Beach Park (i.e. Canoe Beach itself) and from the recently established 'coral health' transects. What fish data there is comes from DAR's 'resource fish' surveys, and indicates that in spite of the relatively high coral cover, biomass of target fishes, including of parrotfish and surgeonfish is below the averages for comparable sites around Maui surveyed by DAR for that program. There is no clear indication of an upward or downward trend in fish populations, but also insufficient data to be able to draw strong conclusions.

Black Rock Section

The Black Rock section contains very little coral habitat (figure 2). Available data are not sufficient for meaningful assessment.

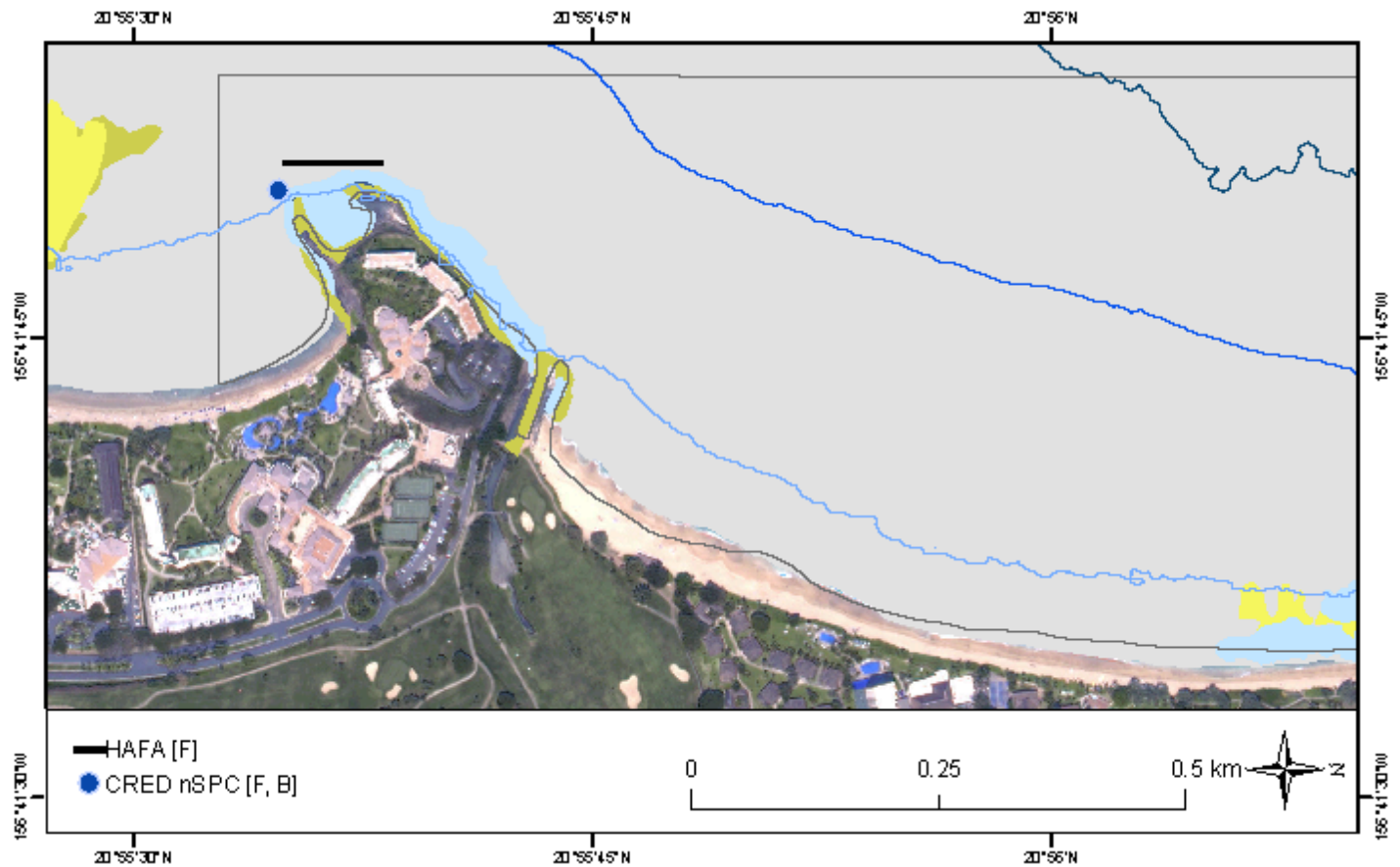


Figure 4. Black Rock Section.

Summary

This section of coastline has relatively little reef or hardbottom habitat, and is not a priority area for coral reef surveys.

Kahekili HFMA Section

Available Survey Data

There is abundant survey data from the Kahekili section, including the intensive 'KHFMA' surveys, for which CRED and DAR staff have gathered fish and benthic data at sites haphazardly located across hardbottom and reef habitats since January 2008. The sampled area encompasses nearly all nearshore reef habitat from just south of Kahekili Beach Park to the northern edge of the spur-and-groove reef at Honokōwai Point (figures 1 & 5). Much of the reef is well developed and somewhat structurally complex, starting from close to the shoreline and extending to depths of between 25ft in the southern portion and ~55ft in the middle and northern portions. In addition, there are CRAMP benthic transects on nearshore reefs in front of Kahekili beach park that have been surveyed nearly annually by CRAMP and DAR since 1999. There have been some additional survey efforts, but those not spatially or temporally extensive enough for us to include them here given the strength of other data sources available.

In June-July 2014, CRED and DAR established 6 coral health stations on spur-and-groove reef habitat just north of Honokōwai point (figure 5), with the intention of implementing long-term co-monitoring of coral health and demographics there.

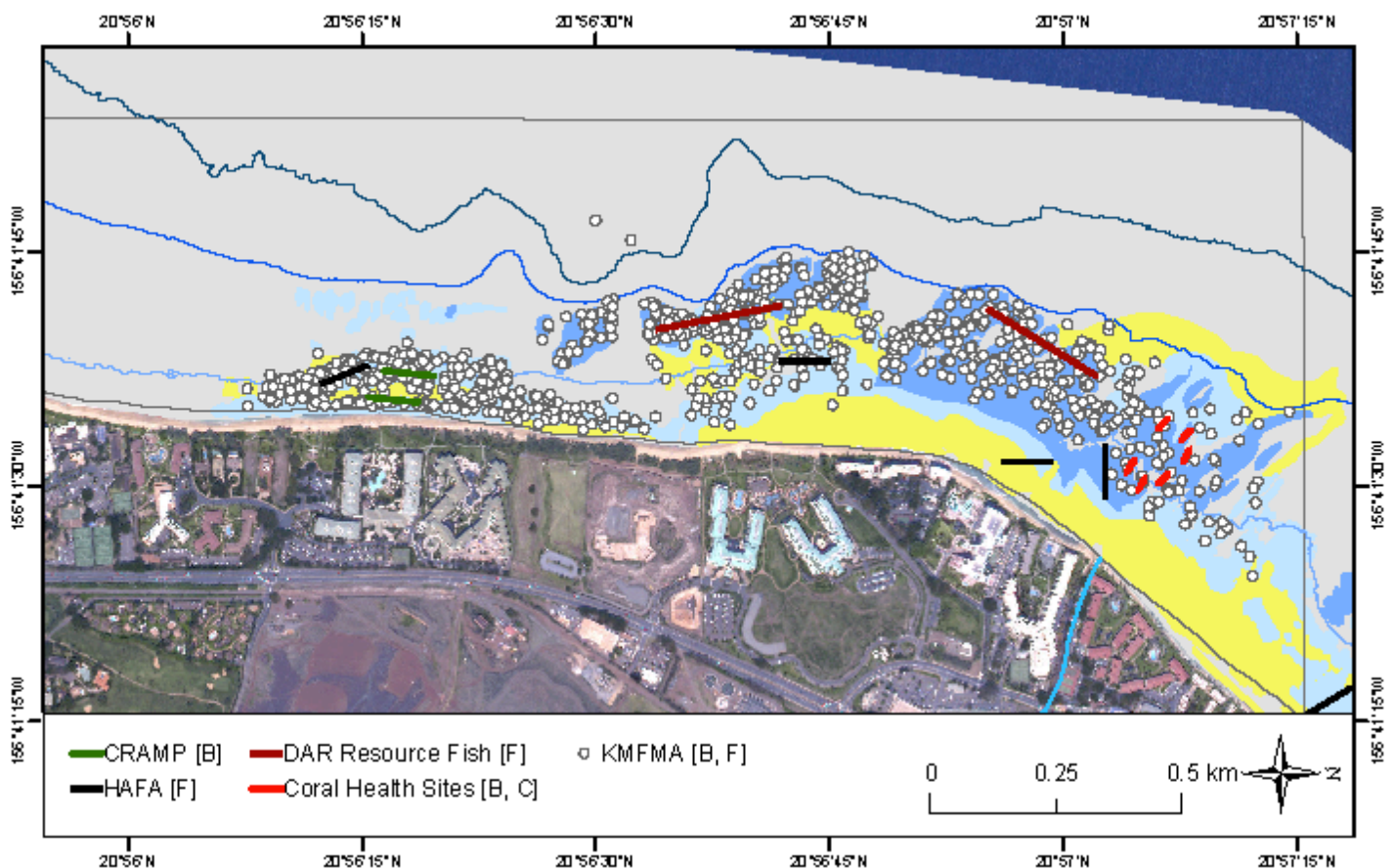


Figure 5 Kahekili Herbivore Fisheries Management Area Section.

Because the KHFMA monitoring is much more spatially extensive than CRAMP, we are using that as the primary data source for current condition and providing CRAMP data to show longer-term trends at that site. The location of the 2 DAR resource fish sites and 4 DAR 'HAFA' stations in this section of coastline are shown in figure 5, but those data are not utilized below, because of the availability of the other more comprehensive or longer-term datasets.

Benthic Condition Metrics

Table 4a. % Cover (Mean and SE). CRED RAMP Comparisons are for sites in <60ft of water from 2010 to 2013.

% COVER (Mean and SE)	KHFMA DAR-CRED		CRED RAMP	
	5-yr Ave (2010-14)	Recent (2014)	Maui	All MHI
Hard Coral	32.6 ± 0.5	34.6 ± 0.9	18.4 ± 1.6	14.4 ± 0.6
Macroalgae	0.9 ± 0.4	0.1 ± 0.02	10.1 ± 1.4	12.9 ± 0.8
CCA	7.5 ± 1.1	10.9 ± 1.0	5.0 ± 0.6	6.4 ± 0.3

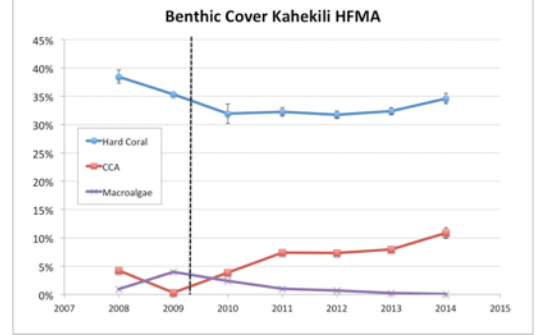


Figure 5A. Benthic Cover Trends KHFMA Monitoring

Table 4b. Demographics (Density colonies/m²) Data are Mean ± SE. CRED comparisons are for sites <60ft of water from 2013 surveys.

	Coral Health Site	CRAMP DAR-CRED	CRED RAMP	
	Recent (2014)	Recent (2010-2011)	Maui	All MHI
Juvenile colonies	3.3 ± 0.2	3.3 ± 0.5	5.1 ± 1.4	3.8 ± 0.4
Adult colonies	20.0 ± 0.9	20.5 ± 1.5	11.2 ± 2.9	6.8 ± 1.2

Table 4c. Coral Health (%). Data are Mean ± SE. CRED comparisons are for sites <60ft of water from 2013 surveys. CRAMP and CRED data collected using slightly different methods, which means that estimates are not exactly comparable (different survey areas yield somewhat different estimates of disease prevalence)

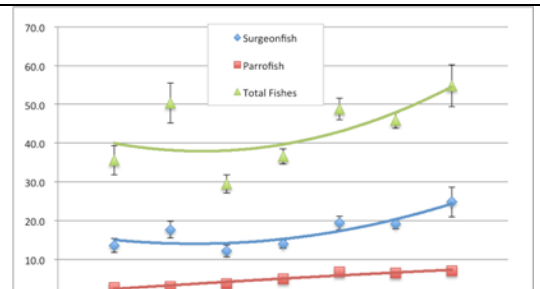
	Coral Health Site	CRAMP DAR-CRED	CRED RAMP	
	Recent (2014)	Recent (2010-2011)	Maui	All MHI
Coral bleaching	2.4 ± 0.3	0.3 ± 0.3	2.0 ± 0.5	2.0 ± 0.5
Disease				
-Growth anomalies	0.5 ± 0.1	1.1 ± 0.4	1.0 ± 0.7	0.3 ± 0.1
-Recent tissue loss	0.7 ± 0.7	0.5 ± 0.2	0.5 ± 0.2	0.1 ± 0.1

Fish Condition Metrics

Table 5. Biomass (g m⁻²). Data are Mean ± SE. CRED RAMP Comparisons are for sites in <60ft of water from 2010 to 2013.

Note that differences in survey methods mean that biomass estimates are not exactly comparable (i.e. different methods yield somewhat different biomass estimates).

BIOMASS (g /m ²)	KHFMA DAR-CRED		CRED RAMP	
	5-yr Ave (2010-14)	Recent (2014)	Maui	All MHI
All Fishes	43.1 ± 4.5	54.8 ± 5.4	23.3 ± 2.2	23.8 ± 1.5
Parrotfish	5.8 ± 0.6	7.1 ± 0.9	2.8 ± 0.7	2.3 ± 0.3



Surgeonfish	17.9 ± 2.2	24.8 ± 3.9	9.0 ± 1.0	7.9 ± 0.5	Figure 5B. Fish Assemblage Trends KHFMA Monitoring
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Richness. Number of species per transect in KHFMA surveys was 14.4 ± 0.5 (mean ± SE) in 2014; and the five year average is 13.9 ± 0.4 species. Because of methodological differences, it would not be meaningful to compare richness estimates between KHFMA and CRED RAMP surveys.

Long-Term Benthic Data - Kahekili CRAMP

This data comes from the CRAMP stations at 3 and 7m deep towards the southern end of the reef in front of Kahekili Beach Park. Note that data from before 1999 comes from the site established by the Pacific Whale Foundation in 1994. Although efforts were made to overlay the CRAMP site on the site of the Pacific Whale Foundation site, the exact location of sub-transects changed at that time.

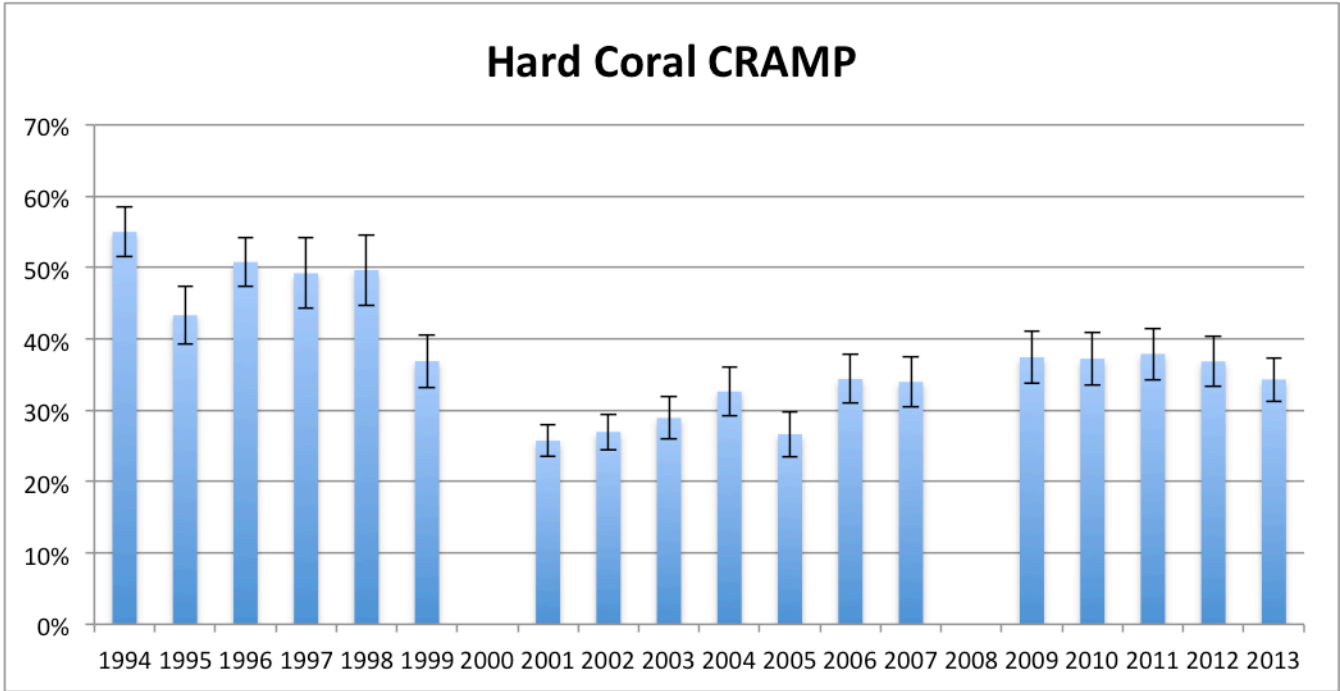


Figure 7. CRAMP coral cover from Kahekili

Summary

Nearshore hardbottom habitats in this section of coastline contain large areas of coral habitat, including coral rich shallow and medium depth habitats south of Honokōwai point, and some very well-developed spur-and-groove habitats close to Honokōwai Point. Long-term data from the CRAMP transects in front of Kahekili beach park suggest that there was considerable decline in coral cover between around 1994 and the early to mid-part of the 2000s; but coral cover at those stations has been relatively stable or partially increasing since then.

Overall, coral cover and fish populations, including herbivorous fishes, are in a relatively good states, compared to available and Maui Island and MHI comparisons.

The spatially and temporally comprehensive data from the KHFMA survey program provide clear evidence of recent change in fish and benthos, subsequent to establishment of the Kahekili HFMA in 2009, including clear upward trends in biomass of herbivorous fishes and in cover of crustose coralline algae (CCA). Most recent benthic cover data indicate a small upward tick in coral cover across this area as a whole, following decline between 2008-2010 and relatively stability through 2103. Given timelines of recovery evident from studies of coral reef marine reserves elsewhere in the world, there is almost certainly considerable scope for further and larger changes to reef condition in coming years if protection is maintained.

North Honokōwai /Mahinahina Section

Available Survey Data

Reef and hardbottom habitats in this section are highly variable, with only a few patches of well-developed complex reef. Available survey data includes the 'Mahinahina' CRAMP stations at 3m and 10m deep, where benthic cover have been surveyed since 2004, and the DAR 'resource fish' survey site, which is located over the deeper CRAMP station, and where fish assemblages have been surveyed 1 to 3 times annually in recent years. In addition, DAR and CRED established 6 coral health permanent monitoring stations in June 2014. The location of the 3 'shallow-water' HAFA sites in this section are shown in figure 8 below, but because of rather limited effort and because data are only representative of very shallow inshore habitats, they are not used for assessment of status or trends

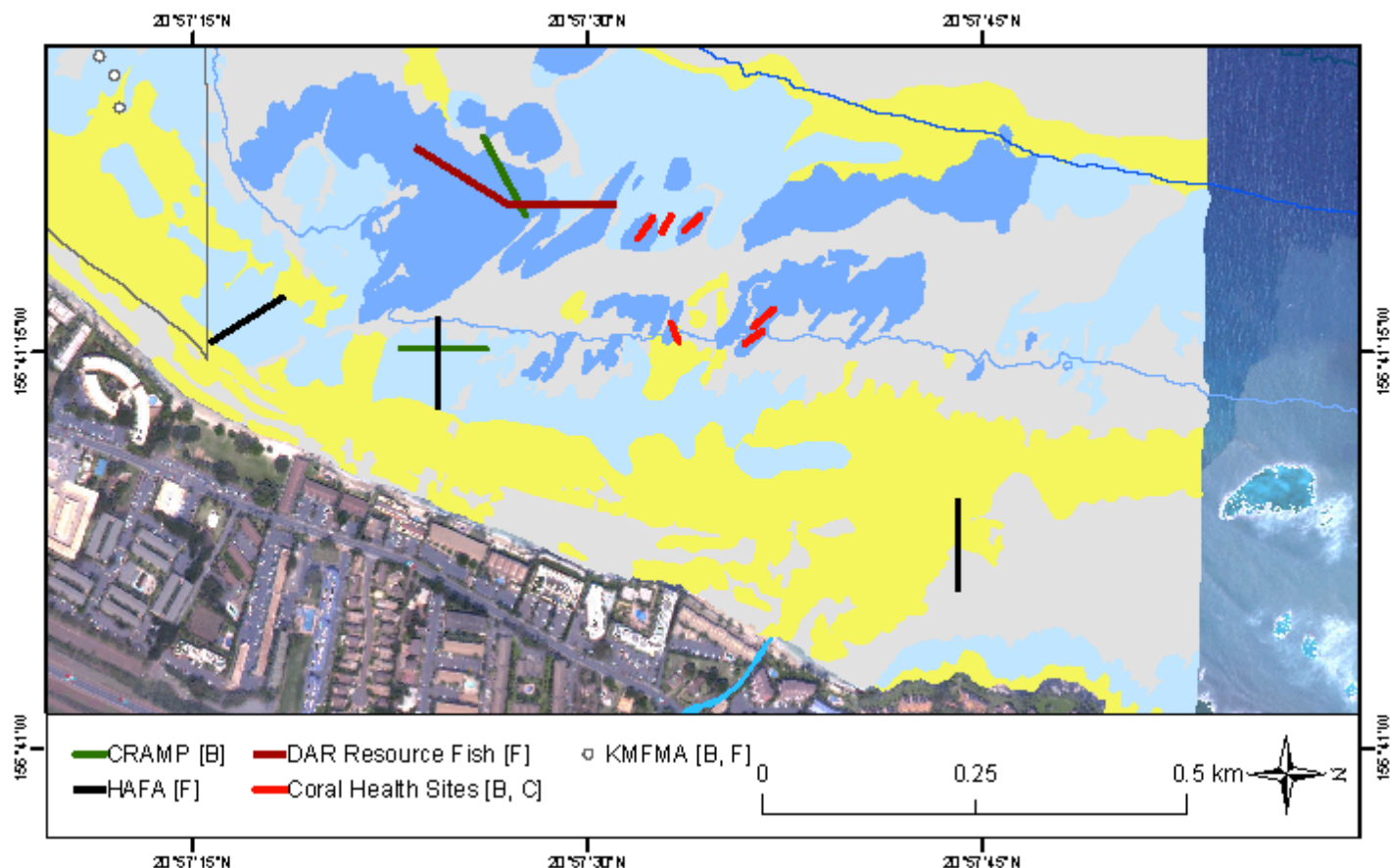


Figure 8. North Honokōwai/Mahinahina Section.

Benthic Condition Metrics

Table 6a. Mean $\pm$ SE benthic cover from coral health site surveys. CRED RAMP comparison come from the analysis of 2013 RAMP benthic images from all sites at comparable depth (<60ft).

	Coral Health Site	CRED RAMP	
	Recent (2014)	Maui	All MHI
Hard Coral	23.7 $\pm$ 8.8	18.3 $\pm$ 2.7	12.2 $\pm$ 2.5
Macroalgae	1.2 $\pm$ 0.7	2.8 $\pm$ 0.7	3.8 $\pm$ 0.9

CCA	0.0 ± 0.0	1.7 ± 0.5	3.0 ± 0.9
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Table 6b, Demographics (Density colonies/m²) Data are Mean ± SE. CRED comparisons are for sites <60ft of water from 2013 surveys.

	'Coral Health' site	CRED RAMP	
	Recent (2014)	Maui	All MHI
Juvenile colonies	7.0 ± 1.9	5.1 ± 1.4	3.85 ± 0.4
Adult colonies	9.9 ± 7.4	11.2 ± 2.9	6.8 ± 1.2

Table 6c. Coral Health (%). Data are Mean ± SE. CRED comparisons are for sites <60ft of water from 2013. CRAMP and CRED data collected using slightly different methods, which means that estimates are not exactly comparable (different survey areas yield somewhat different estimates of disease prevalence). *Coral condition surveys conducted in Oct 2014;

	"Coral Health" site	CRED RAMP	
	Recent (2014)	Maui	All MHI
Coral bleaching	0.2 ± 0.2	2.0 ± 0.5	2.0 ± 0.5
Disease			
-Growth anomalies	0.0	1.0 ± 0.7	0.3 ± 0.1
-Recent tissue loss	0.0	0.5 ± 0.2	0.1 ± 0.1

Fish Condition Metrics

Table 7. Mean ± SE fish biomass from Mahinahina DAR Resource Fish site. Note that Maui average comes from all other resource fish sites at comparable depth in Maui.

BIOMASS (g /m ²)	Mahinahina Resource Fish		DAR Resource Fish
	5-yr Ave	Recent (2014)	Maui (5 year average)
All Fishes	4.2 ± 0.9	1.8 ± 1.0	15.2 ± 0.8
Parrotfish	1.0 ± 0.4	0.4 ± 0.3	2.7 ± 0.2
Surgeonfish	2.2 ± 0.6	0.7 ± 0.6	7.7 ± 0.8

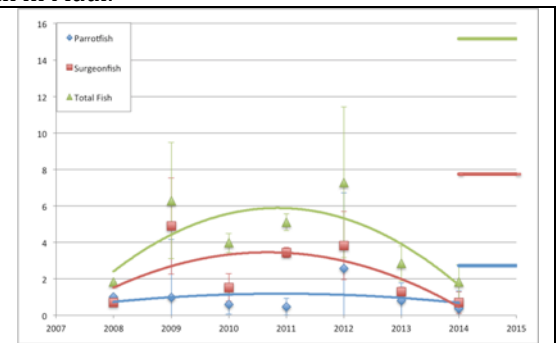


Figure 8A. Fish Assemblage Trends. Mahinahina Resource Fish Surveys. Bars on right hand side represent Maui 5yr averages.

The number of species encountered per survey in Resource fish surveys over last five years was 10.4 ± 0.4 (mean ± SE), which is a little lower than the Maui average for these surveys of 12.4 ± 0.2 over the same time period.

Resource fish biomass (i.e. biomass of medium and large fishes of target families), and biomass of key herbivore families (parrotfishes and surgeonfishes) at the Mahinahina site have been well below the average of other DAR Maui resource fish sites in the same depth range (fig 8A). Unsurprisingly given the small sample size, data are quite

variable from year to year and it is very difficult to draw firm conclusions about trends, however it is noticeable that biomass values have been particularly low in recent years.

Long-Term Benthic Data - Mahinahina CRAMP

This data comes from the CRAMP stations at 3 and 10m deep. Note that this is the average of the 3m and 10m stations. At the 3m station, coral cover was $18.5\% \pm 5.1\%$ in 2004 and, almost unchanged, at $18.6\% \pm 4.1\%$ in 2013. However, coral cover appears to have declined at the deeper station, from $43.5\% \pm 3.8\%$ to $35.8\% \pm 2.3\%$ in 2013.

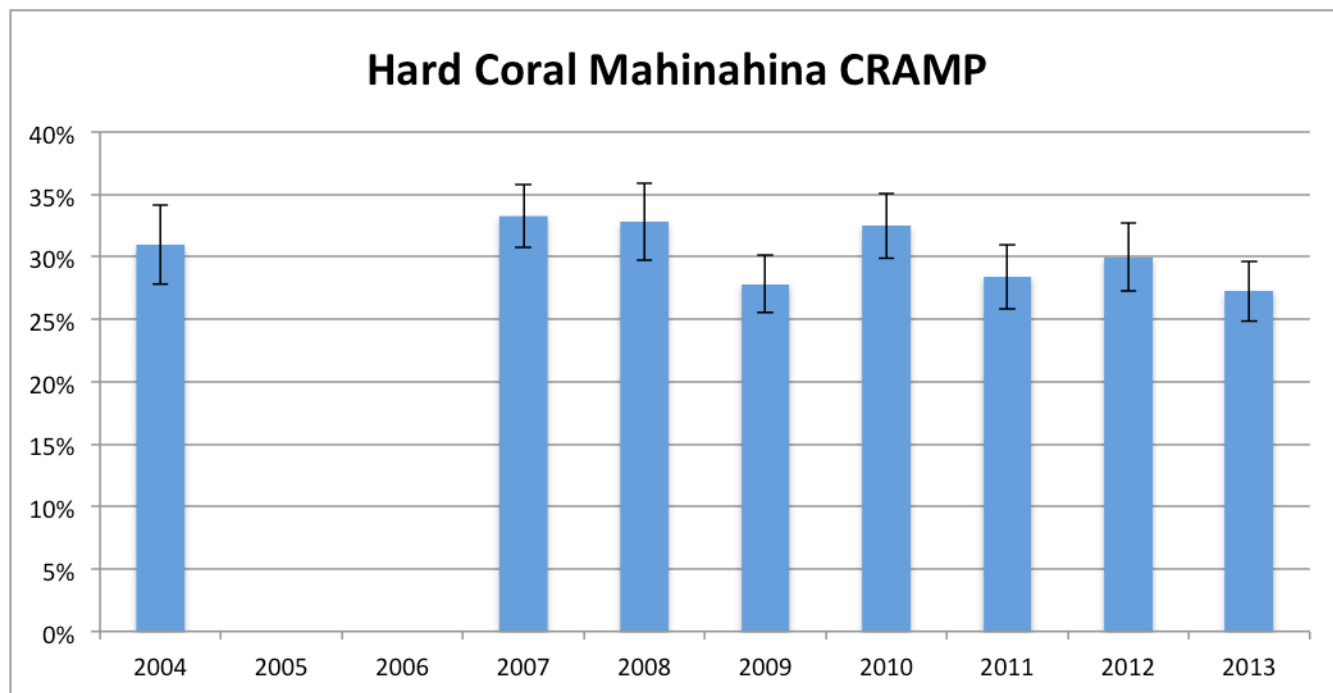


Figure 9. Placeholder - CRAMP coral cover from Honokōwai

Summary

Reef and hardbottom habitats in this section of coastline are highly variable, with a few patches of relatively high-quality coral-rich habitat. The Mahinahina CRAMP and 'DAR resource fish' sites were located within some of the better quality habitat in this section, and it is not entirely clear how representative those are of the wider area. However, data show stable coral cover at the 3 m station, but indicate that coral cover has declined at the 10 m station.

Target fish biomass appears to be very low at the DAR resource fish site in this coastline, with few parrotfish, surgeonfish, or other targeted fish species in survey size classes (i.e. 15cm and above). Likely, low fish biomass is partially reflective of generally poor and patchy coral habitat.