



**UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE**

Office of Response and Restoration
Silver Spring, Maryland 20910

CRUISE REPORT¹

VESSEL: *Hi'ialakai*, Cruise 05-05 (Fig. 1)

CRUISE PERIOD: 14 July–25 July, 31 July–7 August 2005

AREA OF OPERATION: Main Hawaiian Islands

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Division, Pacific Island Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), NOAA, conducted reef assessment/monitoring and mapping studies in waters surrounding the Main Hawaiian Islands.

ITINERARY:
14 July Start of cruise. Embarked Craig Musburger (fish), Darla White (fish), Jeff Eble (fish), Greta Aeby (coral), Jean Kenyon (coral), Scott Godwin (invertebrates), Ranya Henson (invertebrates), Peter Vroom (algae), Emily Krause (algae), Joe Laughlin (towboard/fish), Benjamin Richards (towboard/fish), Jamison Gove (towboard/habitat), Casey Wilkinson (towboard/habitat), Amy Hall (moorings), Kyle Hogrefe (moorings), Ronald Hoeke (moorings), Charles Young (moorings), Parker Mason (moorings), John Rooney (QTC/TOAD/CTD), Susanna Holst (QTC/TOAD/CTD), and Haiying Wang (data management). Departed Snug Harbor at 0900. Arrived off Kaena Point, Oahu at 1300 for small boat drills, followed by rapid ecological assessments (REA), towboard, and oceanographic surveys. The fish and benthic REA teams completed assessments at one site south of the point. The towboard team completed one tow directly off the point, and the mooring team finished six conductivity-temperature-depth (CTD) casts.



¹ PIFSC *Hi'ialakai* Cruise Report CRHI-05-003
Issued 7 November 2005

Three towed optical assessment device (TOAD) operations were completed around Kaena Point. We departed Oahu en route to the windward side of Kauai at 2330.

- 5 July Began work on the northeast side of Kauai. The tow team completed six benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 25 shallow water CTDS, and conducted water sampling profiles at two sites. An STR was deployed at REA site KAU2. Night operations around the northeast side of Kauai included four TOAD drops and one deepwater CTD. A safety meeting was held by night operations personnel before night operations began.
- 16 July Continued working around Kauai, focusing on the east/southeast sides. The tow team completed six benthic and fish tows. The first REA dive at KAU4 was in strong current, and no video transects or quantitative algal data were collected. Full REA protocols were conducted at sites KAU5 and KAU6. The mooring team completed 35 CTDS (9 being points on a transect Hanapepe Bay); 8 water sample profiles were also collected along the transect. One subsurface temperature recorder (STR) was deployed at REA site KAU5. Night operations consisted of four TOAD deployments around Kauai, followed by an ADCP line with three accompanying deepwater CTDS across the narrowest part of the channel between Kauai and Niihau.
- 17 July Began work on the east side of Niihau. The tow team completed six benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 25 shallow water CTDS, and conducted a water sampling profile at 1 site. An STR was deployed at REA site NII2. Night operations consisted of four TOAD deployments, one deepwater CTD, one water sample profile, and multibeam operations around the northwest corner of Niihau.
- 18 July Worked around Lehua Rock on the northern tip of Niihau. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished eight shallow water CTDS, and conducted a water sampling profile at one site. The STR deployed on 7/17 at NII2 was relocated to NII1 on the northeast side of the island, and one additional STR was deployed. Night operations consisted of three TOAD deployments, one deep water CTD, one water sample profile, and multibeam operations around the northwest side of Niihau.
- 19 July Worked on the west side of Niihau. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished nine shallow water CTDS and conducted a water sampling profile at one site using the new 4-bottle sampler. Night operations consisted of five TOAD surveys. Transited to Kauai.

- 20 July Worked on the northwest side of Kauai (Na Pali coast). The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 25 shallow water CTDS, conducted 6 water sampling profiles in a linear series in Hanalei Bay, and scouted out a site for a WTR deployment. Night operations consisted of five TOAD surveys and some “sloppy” multibeam surveys.
- 21 July Worked on the southwest side of Kauai. The tow team completed six benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 18 shallow water CTDS, conducted 5 water sampling profiles in a linear transect in Waimea Bay, and deployed a WTR on Mana reef. While on Mana reef, the mooring team also spent ~30 minutes searching for species of the scleractinian coral *Acropora*, but were unable to locate any colonies (although coral cover of other genera was fairly high). One short TOAD camera survey was conducted around the southwest shore of Kauai before we departed for Oahu.
- 22 July Worked around Kaena Point on Oahu. The tow team completed six benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 17 shallow water CTDS, conducted 1 water sampling profile, and deployed 4 STRs (3 in a linear array approximately 1 mile from OAH3, and one at site OAH5). Night operations consisted of one TOAD tow (followed by cable problems with the TOAD) and multibeam mapping.
- 23 July Worked on the north side of Oahu between Kualoa and Waimea Bay. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 31 shallow water CTDS, conducted 6 water sampling profiles on a linear transect in Kahana Bay, and deployed 1 STR off Punaluu. Night operations consisted of multibeam mapping.
- 24 July Worked on the north side of Oahu between Turtle Bay and Mokuleia. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 12 shallow water CTDS, and conducted 6 water sampling profiles (five of them on a linear transect in Haleiwa Bay).
- 25 July Returned to Honolulu because of a medical concern with one of the ship’s crew. Disembarked Musburger, White, Eble, Aeby, Kenyon, Godwin, Henson, Vroom, Krause, Laughlin, Richards, Gove, Wilkinson, Hall, Hogrefe, Hoeke, Young, Mason, Rooney, Holst, and Wang.
- 26-30 July In port.
- 31 July Continuation of cruise. Embarked Craig Musburger (fish), Todd Wass (fish), Jeff Eble (fish), Dan Bashis (coral), Jean Kenyon (coral), Scott Godwin (invertebrates), Ranya Henson (invertebrates), Ryan Okano (algae), Emily Krause

(algae), Joe Laughlin (towboard/fish), Benjamin Richards (towboard/fish), Elizabeth Keenan (towboard/habitat), Casey Wilkinson (towboard/habitat), Jamison Gove (moorings), Peter Vroom (moorings), Delisse Ortiz (moorings/night ops), John Rooney (QTC/TOAD/CTD), Jeremy Jones (moorings/night ops), and Haiying Wang (data management). Departed Snug Harbor at 0900 and conducted safety drills. Arrived off west side of Molokai at 1330 and began REA, towboard, and oceanographic surveys. The fish and benthic REA teams completed assessments at one site. The towboard team completed two tows, and the mooring team finished five CTD casts, three water samples taken in a linear transect, and deployed one STR at REA site MOL1. Night operations consisted of multibeam sonar around the south side of the island

- 1 August Worked on the southwest side of Molokai. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 25 shallow water CTDS, collected 11 water samples (3 transects, 2 4-sample depth profiles and 1 3-sample depth profile), and deployed 1 STR at REA site MOL3. Night ops consisted of a little bit of multibeam work that was hampered by boat traffic, and one deepwater CTD.
- 2 August Worked on the west side of Lanai. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 20 shallow water CTDS, and conducted 10 water sampling profiles (2 4-sample depth profiles and 1 2-sample depth profile). One deep-water CTD was taken during daylight hours.
- 3 August Worked on the east and south side of Lanai. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys (minus one invertebrate diver on the last dive of the day). The mooring team finished 20 shallow water CTDS, collected 8 water profiles (2 4-sample depth profiles), and deployed 2 STRs. One deep-water CTD was taken during daylight hours. Night ops consisted of multibeam mapping of the northern part of Lanai.
- 4 August Worked on the southwest corner of Maui. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys (minus one invertebrate diver on the middle dive of the day). The mooring team completed 28 shallow water CTDS. Night operations consisted of multibeam mapping in Maalaea Bay.
- 5 August Worked on the northwest side of Maui around Lahaina. The tow team completed five benthic and fish tows, and the REA team conducted three fish and benthic surveys. The mooring team finished 33 CTDS and deployed 1 STR at site MAI9. Night operations consisted of multibeam mapping in Maalaea Bay.
- 6 August Worked around southwest Maui (Kihei area) and Molokini. The tow team completed three benthic and fish tows, and the REA team conducted three fish and benthic surveys. Because of a sick diver, fish REAs were restricted to belt

transects. No Stationary Point Count observations were made. The mooring team finished 11 CTD casts and deployed 2 STRs. Night operations consisted of multibeam mapping in Maalaea Bay.

Table 1: Cruise statistics for the Main Hawaiian Islands, summer cruise 2005.

CRUISE STATISTICS:

	Kauai	Niihau/Lehua Rock	Oahu	Molokai	Maui/Molokini	Lanai	Totals
Towed Diver Habitat/Fish Surveys	23	16	17	7	13	10	86
Linear kilometers of tow track	53.16	39.69	48.38	18.89	30.95	23.58	214.65
Fish Rapid Ecological Assessments	12	9	10	4	9	6	50
Benthic Rapid Ecological Assessments	12	9	10	4	9	6	50
Shallow water samples	21	3	13	14	0	18	69
Deep water sample profile	0	2	0	2	0	0	4
STR deployed	2	2	5	0	3	2	14
WTR deployed	1	0	0	0	0	0	1
TOAD drop camera surveys	13	12	4	0	0	0	29
ADCP	1	0	0	0	0	0	1
Nautical miles of ADCP track	14	0	0	0	0	0	14
Deep water CTDs	4	2	0	2	0	3	11
Shallow water CTDs	103	42	63	30	72	40	350
SCUBA dives	173	129	143	44	117	81	687

MISSIONS AND RESULTS:

- A. Established quantitative methods were used to estimate numerical abundance of fishes and fish species richness. Sites were selected to add spatial coverage to previous monitoring efforts by state and other agencies. Sampling was focused primarily in the 10-15-m depth range in coral reef habitat. See Appendix A for individual island descriptions.

1. A total of 49 new and 1 previously surveyed stations (by DAR) throughout the MHI were surveyed for fishes by the 3-diver fish REA team. The repeated station was on the protected western coast of Lanai. Ocean conditions precluded the surveying of windward sites on many of the islands, so most stations surveyed were on the southern and western facing shores. Fish assemblages were numerically dominated by large numbers of small-bodied planktivores (primarily pomacentrids), small-bodied wrasses (labrids), and medium-bodied herbivores (primarily acanthurids). Predators and highly prized food fish were rare or absent at most sites. Sharks were rarely encountered, and they were not encountered on transects at any station surveyed.
- B. Conducted surveys to document the species composition, relative abundance, percent cover, size distribution, and general condition of the shallow water anthozoans at Kauai, Niihau, Lehua, Oahu, Molokai, Lanai, and Molokini (Appendix B).
1. REA surveys were conducted at 50 sites at Kauai (12), Niihau (6), Lehua (3), Oahu (10), Molokai (4), Lanai (6), Maui (6) and Molokini (3). Twenty-seven anthozoan species were enumerated within belt transects; an additional seven anthozoan species were observed outside belt transects. *Porites lobata* is typically the numerically most abundant coral at these islands, with *Pocillopora meandrina*, *Montipora capitata*, or *Montipora patula* the next most abundant taxon. Average percent cover of live coral, as determined by the line-intercept method, varied from 0% at Lehua to 40.9% at Molokini. Size class distributions at Molokai, Maui, and Molokini show a majority of colonies measuring >10 cm maximum diameter, whereas smaller colonies constitute the majority of the population at other islands visited. The majority (65.4%) of coral colonies from all 50 sites combined have a maximum diameter smaller than 10 cm.
 2. Six different coral diseases were encountered during leg 1 surveys (Kauai, Niihau, Lehua, Oahu). The most commonly encountered diseases were with *Porites* trematodiasis (frequency of occurrence =60% of the sites) and *Porites* growth anomalies (50% of the sites). Bleached colonies of *Montipora capitata* were frequently found (83.3% of the sites) and may reflect a normal level of summer bleaching for this coral species. Evidence of *Acanthaster planci* (crown-of-thorns starfish) (animal or feeding scars present) was found at 10 of the 30 sites surveyed (33.3%). An outbreak of COTs was reported by the tow-boarding team at one site (OAH-9) and was subsequently surveyed by the REA team. At this site, 45 animals were counted within a 25 x 4 m belt transect (i.e., density = 4.5 COT/m²), with more than 100 animals noted elsewhere on the reef.
- C. Used quantitative photoquadrat sampling method to collect species composition and baseline abundance data of reef algae at eight islands in the Main Hawaiian Island Archipelago to compare with previously collected qualitative samples (Appendix C).
1. A total of 50 sites were visited (10 @ Oahu, 12 @ Kauai, 6 @ Niihau, 3 @ Lehua, 4 @ Molokai, 6 @ Lanai, 6 @ Maui, 3 @ Molokini). Quantitative analyses were successfully completed at 48 of these sites, producing 576 algal photoquadrats with accompanying field-ranked species lists and voucher specimens. Qualitative analyses occurred at two sites. At least 29 species of green, 47 species of red, and 10 species of brown macroalgae were observed at the eight islands.

D. The non-coral marine invertebrate fauna of coral reefs represents a group of animals that are numerically dominant in their habitat and, in some cases, represent taxonomic groups that are only represented in the marine environment. This group of organisms is surveyed and monitored for the purpose of identifying changes to reef communities. This is accomplished through procedures that quantify a set of target organisms and which also gradually builds an inventory of species to document biodiversity. Macroinvertebrate surveys were conducted to record species composition and abundance at eight islands and atolls in the Main Hawaiian Islands in order to establish baseline data to monitor non-coral invertebrate fauna of each reef system (Appendix D).

1. A total of 50 sites were visited between Maui and Niihau. Species data is preliminary at this point and involves non-coral species quantified from field observations, which represented nine phyla. Despite the surveys being conducted in multiple habitats *Echinostrephus* was the dominant macroinvertebrate found at all islands.

E. Used benthic and fish towed-diver survey methods at NWHI to provide a general description of reef habitat, invertebrates, and reef fishes over a large spatial scale. The methods provided assessments and the foundation for monitoring large-scale disturbances and general distribution and abundance patterns of macroinvertebrates and reef fishes over 50 cm total length (Appendix E).

1. A total of 86 towed-diver surveys were conducted totaling approximately 206.3 km of habitat.

Fish Observations:

The Redlip parrotfish (*Scarus rubroviolaceus*) was the most commonly observed fish larger than 50 cm Total Length (TL) at all islands/reefs. Surveys were conducted along multiple habitats yielding relatively low numbers of fishes over 50 cm TL, yet for most islands surveyed *S. rubroviolaceus* was the most commonly observed large fish regardless of habitat. Preliminary quantitative results yielded low shark densities at all reef/island locations during the survey period. Most notable observations included a dead 8-ft Sandbar shark (*Carcharhinus plumbeus*) stuck in a piece of derelict fishing gear off west shore Kauai, a large aggregation of giant trevally (*Caranx Ignobilis*) in a cave off east side Oahu, and a very large (10 ft) galapagos shark (*Carcharhinus galapagensis*) off the south side of Lehua Rock.

Benthic Observations:

Large areas of sand and macroalgae were the dominant habitat. *Pocillopora* and *Porites sp.* dominated the coral communities. A total of 80 crown-of-thorns starfish (COTS), *Acanthaster planci*, were recorded during this cruise. However, in addition to these sightings, a large concentration of over 1000 COTS were detected in one small area off the north shore of Oahu.

F. The Main Hawaiian Islands Reef Assessment and Monitoring Program (MHIRAMP) cruise, HI0505, presented an opportunity for the Coral Reef Ecosystem Division (CRED) to study the general nearshore oceanographic structure around Ni'ihau, Kauai, Oahu, Lanai, Maui, Molokai, and Molokini. Knowledge of oceanographic processes at these islands is

fundamental in understanding the structure and function of coral reef ecosystem dynamics such as reef morphology, larvae distribution, productivity, species richness and diversity, growth rates, and overall ecosystem health. Variability in the local hydrographic conditions directly affects water properties such as temperature, salinity, water clarity, and nutrient availability, all of which heavily influence local biological conditions on a reef ecosystem. In order to assess the oceanographic environment of the Hawaiian Islands, CRED employed a variety of data collection methods during the MHIRAMP cruise including Acoustic Doppler Current Profiler (ADCP) data, which provides detailed ocean current structure with depth, was collected around and in between each island. Conductivity, temperature and depth (CTD) casts with an attached Transmissometer (for water clarity) were conducted, and at select locations, concurrent water samples were collected for chlorophyll-a concentrations in nearshore environs. CTD casts, in concert with water samples, provided both a vertical and horizontal spatial picture of water characteristics at each island. In addition, subsurface oceanographic instrumentation was incorporated and included numerous temperature sensors and one wave and tide recorder. Although these instruments will not be retrieved for 2 years, they will eventually provide a continuous time series of data that will help improve our understanding of the various physical oceanographic stresses coral reef ecosystems are exposed to in the main Hawaiian Islands (Appendix F).

- G. Night operations during HI0505 included physical oceanographic measurements and benthic habitat mapping activities. The former included shallow (about 100 m maximum depth) and deep (about 500 m maximum depth) CTD casts and water sampling for nutrient analysis. ADCP data were collected during the entire cruise. A total of 21 CTD casts were conducted during the cruise, with 6 of those being deepwater casts. Deep casts were also accompanied by water sampling using Niskin bottles at depths between 3 m and 150 m to better characterize the mixed layer (Appendix G).

Shallow water CTD casts also supported multibeam mapping operations. A total of 246 square kilometers of shallow water seafloor were acoustically mapped around portions of all the main Hawaiian Islands except Hawaii. The TOAD underwater camera sled was deployed a total of 29 times on the cruise, off the islands of Ni'ihau, Kauai, and Oahu. Two tows from the island of Ni'ihau identified the coral genus *Acropora* at a depth of 64 m. This is a new record for this genus at Ni'ihau.

- H. A report from our Dive Master is included in Appendix H.

**SCIENTIFIC
PERSONNEL:**

Peter Vroom, PhD, Chief Scientist, Benthic Team–Algae, Joint Institute for Marine and Atmospheric Research (JIMAR), University of Hawaii (UH), Pacific Islands Fisheries Science Center (PIFSC), Coral Reef Ecosystem Division (CRED)

Emily Krause, Benthic Team – Algae, UH Manoa

Ryan Okano, Benthic Team – Algae, UH Manoa

Scott Godwin, Benthic Team – Invertebrates, Bishop Museum

Ranya Henson, Benthic Team – Invertebrates, Bishop Museum

Jean Kenyon, PhD, Benthic Team – Corals, JIMAR-UH, PIFSC-CRED

Greta Aeby, PhD, Benthic Team – Corals, Hawaii Department of Land and Natural Resources, Division of Aquatic Resources

Dan Bashis, Benthic Team – Corals, UH Manoa

Craig Musburger, Fish Team, UH Manoa

Darla White, Fish Team, UH Hilo

Jeff Eble, Fish Team, UH Manoa

Todd Wass, Fish Team, JIMAR-UH, PIFSC-CRED

Benjamin Richards, Towboard Team – Fish, JIMAR-UH, PIFSC-CRED

Jamison Gove, Towboard Team – Habitat, JIMAR-UH, PIFSC-CRED

Joseph Laughlin, Towboard Team – Fish, JIMAR-UH, PIFSC-CRED

Casey Wilkinson, Towboard Team – Habitat, JIMAR-UH, PIFSC-CRED

Elizabeth Keenan, Team – Habitat, JIMAR-UH, PIFSC-CRED

Kyle Hogrefe, Mooring Team, JIMAR-UH, PIFSC-CRED

Amy Hall, Mooring Team, JIMAR-UH, PIFSC-CRED

Charles Young, Mooring Team, JIMAR-UH, PIFSC-CRED

Ronald Hoeke, Mooring Team, JIMAR-UH, PIFSC-CRED

Parker Mason, Mooring Team, UH Manoa

Delisse Ortiz, Mooring Team, Washington State University

Jeremy Jones, Mooring, JIMAR-UH, PIFSC-CRED

John Rooney, PhD, Towed Camera/Deep water CTDs, JIMAR-UH, PIFSC-CRED

Susanna Holst, Towed Camera/Deep water CTDs, JIMAR-UH, PIFSC-CRED

Haiying Wang, Data Manager, JIMAR-UH, PIFSC-CRED

DATA COLLECTED:

Fish species lists for each site based on roving diver surveys including (a) in situ observations recorded by the diver, and (b) videotapes recorded from the fish towboard

Quantitative surveys of all reef fishes from belt-transects

Quantitative surveys of all reef fishes over 20 cm TL from stationary point-counts

Percent cover of benthic substrate using in-situ line-intercept method

Videotapes at each site showing general nature of each site (360 degree views) and substrate along 2, 25-m transect lines

Digital images at each site showing site overviews, selected coral species, and coral condition

Coral population parameters at each site including number and size class of coral colonies, by species; relative abundance (DACOR); transect depth; maximum depth; water temperature

Samples of *Pocillopora meandrina* for genetic analyses of species connectivity throughout Hawaiian Archipelago
 GPS coordinates of all REA sites and plotted locations; common place names of nearby shoreline area
 REA site metadata
 Digital images of diseased coral
 Field notes on signs of coral bleaching or disease
 Samples of diseased coral for histopathological analysis
 Digital images from algal photoquadrats
 Algal voucher specimens
 Algal field notes of species diversity and relative abundance
 Digital images of the benthic habitat from towboard surveys
 Macroinvertebrate counts from towboard surveys
 Quantitative surveys of reef fishes (larger than 50 cm TL) to species level from towboards
 GPS tracks from towed-diver surveys
 Benthic composition estimations from towboard surveys
 SBE39 (Seabird Electronics) depth/temperature data from each of fish and benthic towboard
 Videos of the seafloor from TOAD operations
 QTC (benthic acoustic signature) data
 Acoustic doppler current profiler (ADCP) transects
 Conductivity, temperature and depth (CTD) profiles to 500 m
 Conductivity, temperature and depth (CTD) profiles with attached transmissometer (for water clarity) to 30 m
 Water samples for chlorophyll measurements

(/s/Peter S. Vroom)

Submitted by: _____
 Peter S. Vroom, Ph.D.
 Chief Scientist

(/s/David Kennedy)

Approved by: _____
 David Kennedy
 Program Manager
 Coral Reef Conservation Program

Attachments

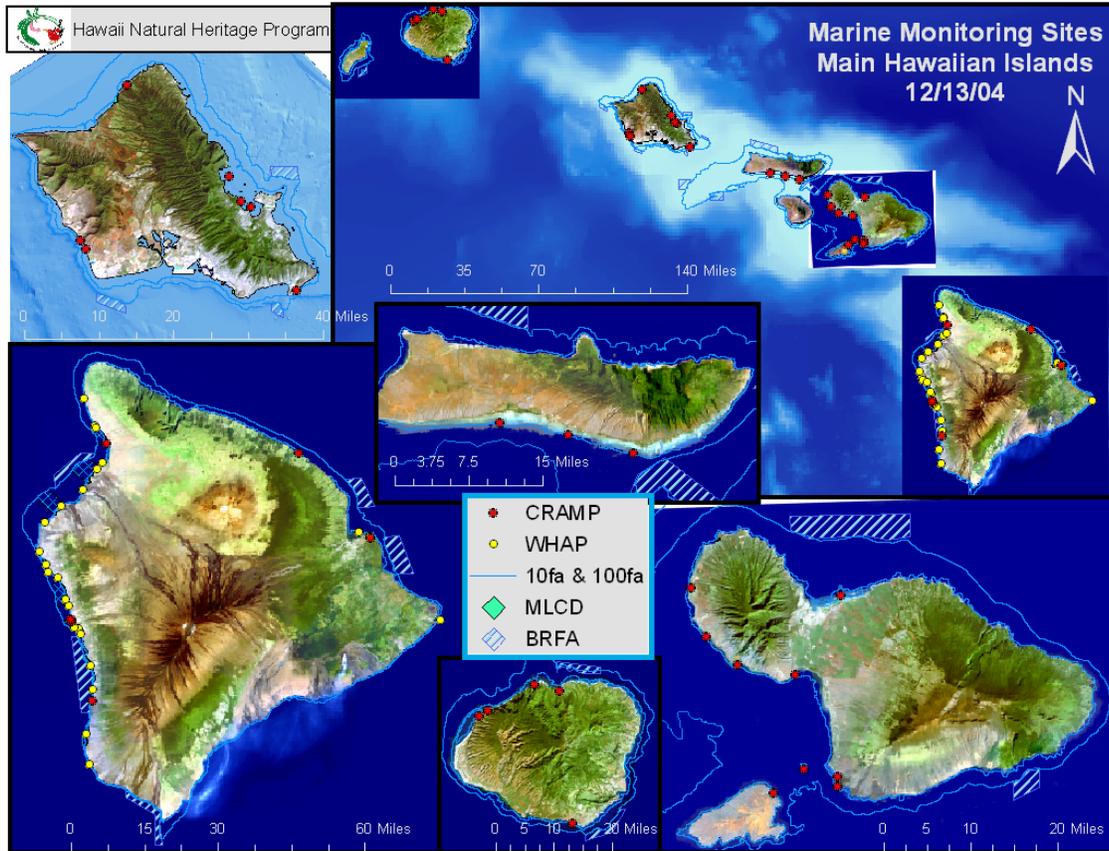


Fig.1. Maps of existing survey sites in the Main Hawaiian Islands. Proposed surveys for HI-05-05 will be the islands of Oahu, Kauai, Niihau, Molokai, Lanai, Maui, and possibly Kahoolawe.

Appendix A: **Fish Rapid Ecological Assessments (REAs) Team Activity Summary** (*Craig Musburger, Darla White, and Jeff Eble, Leg I; Craig Musburger, Todd Wass, and Jeff Eble, Leg II*)

From July 14 to July 24, 2005, the fish REA team surveyed 31 stations— 10 at Oahu, 12 at Kauai, 6 at Ni’ihau, and 3 at Lehua Rock. Then, from July 31 to August 6, 2005, the fish REA team surveyed 19 stations – 6 at Lanai, 6 at Maui, 4 at Molokai, and 3 at Molokini Crater. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys for species presence were conducted at each of these sites, using the same methodology as in previous RAMP cruises and summarized below. SPCs were not performed at Molokini Crater as a sickness of one team member limited the fish team to two divers. The fish team also collected specimens at each site for collaborative studies relating to genetic connectivity and ciguatera. The benthic team (corals, algae, invertebrates) followed the fish team at all sites.

Fish transect stations consisted of three consecutive 25-m lines set along a single depth contour at 10–15 m. As each line was set, the observers swam about 5 m apart along either side along each side of the line, counting and recording size classes for all fishes >20-cm total length (TL) within an area 4 m wide and 4 m high. At the end of each 25-m line, the divers turned around and, while remaining on either side of the line, began counting and recording size classes of all fishes within 2 m of their side of the line and 4 m off the bottom. Four stationary point counts were made at each transect station, generally ~15 m from the transect line. SPCs consist of the diver counting and recording the size classes for all fishes >25 cm total length observed in a cylindrical volume 10-m in radius during a 5-minute period. In addition, the divers recorded the species of fishes seen outside the transect area and outside the SPC counts, on an opportunistic basis. During REA surveys, the divers recorded all species observed during the dive. These observations of the diversity were combined with fish observed by other divers (benthic team, tow team, or mooring team) to develop an island-wide listing of all fishes observed.

All of the sites surveyed by the REA team were new sites. Sites were selected to increase spatial coverage of previous resource assessments conducted by other state and federal projects.

Overview of Fishes

Generally, fish stocks appeared to be heavily depleted at all of the islands surveyed. Large fish, predators, and other commonly fished species were rare or absent at almost all sites. When present, predators and fishery species were often small. Preliminary analysis of fish density without statistical analysis suggests that the density of all fishes was highest at Lehua Rock and followed in decreasing order from Ni’ihau to Lanai, Kauai, Oahu, Molokini, Molokai, and finally Maui.

The total number of coral reef fish species CRED documented for each of the islands was (in decreasing order) 143 for Kauai, 131 for Lanai, 127 for Oahu, 114 for Ni’ihau, 108 for Maui, 107 for Molokini, and 96 for Lehua. The number of species observed at each reef corresponds closely with the number of stations surveyed at each reef. It is expected that equivalent sampling effort would yield more similar species lists for each reef. However, the mean number of species observed per site was highest at Molokini ($m=69.0$, $s.d.=12.1$) and descended to Lehua ($m=61.0$, $s.d.=6.2$), Lanai ($m=60.7$, $s.d.=8.5$), Oahu ($m=54.4$, $s.d.=9.2$), Molokai ($m=51.5$, $s.d.=15.6$), Maui ($m=50.8$, $s.d.=12.3$), Kauai ($m=46.9$, $s.d.=11.8$) and Ni’ihau ($m=46.0$, $s.d.=28.4$).

At all reefs, the most specious family was the wrasse family (Labridae), followed by surgeonfishes (Acanthuridae), butterflyfishes (Chaetodontidae), and damselfishes (Pomacentridae) except at Molokini where more species of butterflyfishes were observed than surgeonfishes.

Reef Summaries

Kauai

The fish fauna at Kauai was dominated by planktivores and small predators. Numerically, the most abundant fish observed at Kauai were Blackfin Chromis (*Chromis vanderbilti*), Opelu (*Decapterus macarellus*), Saddle Wrasse (*Thalassoma duperrey*), Arc-eye Hawkfish (*Paracirrhites arcatus*), and Elegant Coris, (*Coris venusta*). The most common fishes at Kauai were *C. vanderbilti*, *C. venusta*, and *T. duperrey* which were observed at every REA site. Seven other fish species were observed at 11 of the 12 REA sites. The high numerical abundance of *D. macarellus* was the result of a single sighting of a school of 500 individuals. Sightings of large fish were infrequent, and no sharks were observed by the fish REA team during any dive at Kauai. Among fish larger than 20 cm Total Length, the most abundant fishes at Kauai were Orangeband Surgeonfish (*Acanthurus olivaceus*), Bluestriped Snapper (*Lutjanus kasmira*) which is an introduced species, and Bridled Triggerfish (*Sufflamen fraenatus*). Ulua were seen at Kauai, but they were never encountered on transects.

Lanai

Numerically, the most abundant fish at Lanai were Blackfin Chromis (*Chromis vanderbilti*), Agile Chromis (*Chromis agilis*), Arc-eye Hawkfish (*Paracirrhites arcatus*), Brown Surgeonfish (*Acanthurus nigrofuscus*) and Kole (*Ctenochaetus strigosus*). The sites at Lanai were all extremely similar in terms of the fish species composition. There were 21 fish species observed at every Lanai site, and another 16 species observed at 5 of the 6 Lanai sites. One notable encounter at Lanai was the presence along transects of a pod of approximately 150 spinner dolphins.

Lehua Rock

Only three REA sites were surveyed at Lehua Rock. Numerically, the most abundant fish at Lehua Rock were Blackfin Chromis (*Chromis vanderbilti*), Brighteye Damsel (*Plectroglyphidodon imparipennis*), Manybar Goatfish (*Parupeneus multifasciatus*), Arc-eye Hawkfish (*Paracirrhites arcatus*), Saddle Wrasse (*Thalassoma duperrey*), and Sleek Unicornfish (*Naso hexacanthus*). There were 28 fish species which were observed at all 3 of the Lehua sites and another 31 which were observed at 2 of the 3 Lehua sites. Grey Reef Sharks (*Carcharhinus amblyrhynchos*), Whitetip Reef Sharks (*Triaenodon obesus*) and Ulua (*Caranx ignobilis*) were observed by the fish REA team at Lehua, but they were never encountered on a transect.

Maui

Numerically, the most abundant fish at Maui were Blackfin Chromis (*Chromis vanderbilti*), Brown Surgeonfish (*Acanthurus nigrofuscus*), Kole (*Ctenochaetus strigosus*), Saddle Wrasse (*Thalassoma duperrey*), and Yellow Tang (*Zebrasoma flavescens*).

Molokai

Numerically, the most abundant fish at Molokai were Blackfin Chromis (*Chromis vanderbilti*), Saddle Wrasse (*Thalassoma duperrey*), Brown Surgeonfish (*Acanthurus nigrofuscus*), Kole (*Ctenochaetus strigosus*), and Johnston's Damsel (*Plectroglyphidodon johnstonianus*).

Molokini

Molokini offered several interesting fish sightings for the REA team. Fisher's Angelfish (*Centropyge fisheri*) were exceptionally abundant in depths below 25 feet. Gilded Triggerfish (*Xanthychthys auromarginatus*) were also exceptionally abundant. Numerically, the most abundant fish at Molokini were Blackfin Chromis (*Chromis vanderbilti*), Gilded Triggerfish (*Xanthychthys auromarginatus*), Saddle Wrasse (*Thalassoma duperrey*), Arc-eye Hawkfish (*Paracirrhites arcatus*), and Disappearing Wrasse (*Pseudocheilinus evanidus*). Whitetip Reef Sharks (*Triaenodon obesus*) were observed at Molokini, but they were not encountered along transects.

Niihau

Numerically, the most abundant fish at Niihau were Blackfin Chromis (*Chromis vanderbilti*), Bluestriped Snapper (*Lutjanus kasmira*), Elegant Coris (*Coris venusta*), Orangeband Surgeonfish (*Acanthurus olivaceus*), Saddle Wrasse (*Thalassoma duperrey*), and Kole (*Ctenochaetus strigosus*). Galapagos Sharks (*Carcharhinus galapagensis*), including one individual estimated to be over 7 ½ feet long were seen off transects at Niihau. Grey Reef Sharks (*Carcharhinus amblyrhynchos*) and Ulua (*Caranx ignobilis*) were also observed, but not on transects.

Oahu

The fish fauna of Oahu appeared severely depleted. Large predators and sharks were not observed by the fish REA team. While the tow team did report an unusually large aggregation of Ulua (*Caranx ignobilis*), the fish REA team did not observe any Ulua. Numerically, the most abundant fish at Oahu were Blackfin Chromis (*Chromis vanderbilti*), Saddle Wrasse (*Thalassoma duperrey*), Arc-eye Hawkfish (*Paracirrhites arcatus*), Sleek Unicornfish (*Naso hexacanthus*), and Manybar Goatfish (*Parupeneus multifasciatus*).

Notes on Large Fish/Species of InterestSharks

Grey reef sharks (*Carcharhinus amblyrhynchos*) were observed at Lehua and Niihau, Galapagos sharks (*C. galapagensis*) at Niihau, and whitetip reef sharks (*Triaenodon obesus*) at Molokini and Lehua. All sharks were encountered out of the boundaries of the belt transects but were noted as present for REA counts.

Jacks

Ulua (*Caranx ignobilis*) were observed at Niihau, Lehua, Kauai, and Molokini but were not seen along transects. Bluefin Trevally (*Caranx melampygus*) were observed at all reefs except Oahu and Maui.

Other Species of Interest: Roi, or Peacock Grouper, (*Cephalopholis argus*), an introduced species, was abundant on all islands and was observed along transects on every island. Ta'ape, or Bluestriped Snapper, (*Lutjanus kasmira*) were observed at every island except Maui. Bigeye Emperor (*Monotaxis grandoculis*) was observed at all islands. Finally, the Spectacled Parrotfish (*Chlorurus perspicillatus*) was only observed at Ni'ihau and Kauai.

Notes on Rare Observations

While the Main Hawaiian Islands are well studied and the fish fauna is well known, there were species that were observed infrequently. The following is a list of species only observed at one island by the fish REA team:

- Kauai:* *Acanthurus guttatus*
Acanthurus xanthopterus
Dendrochirus barberi
Gymnothorax eurostus
Hazeus nephodes
Nemateleotris magnifica
Platybelone argalus
Seriola dumerili
- Lanai:* *Aetobatis narinari*
Carangoides ferdau
Chaetodon ephippium
Hemitaenichthys thompsoni
Manta birostris
Pterois sphex
- Lehua:* *Kyphosus cinerascens*
- Maui:* *Antennarius commersoni*
Centropyge loriculus
Chanos chanos
Ostracion cubicus
- Molokini:* *Aluterus scriptus*
Chaetodon reticulatus
Sargocentron ensiferum
Sphyraena barracuda
- Niihau:* *Cheilio inermis*
Kuhlia sandvicensis
Rhinecanthus aculeatus
- Oahu:* *Diodon holocanthus*
Echidna nebulosa
Enneapterygius atriceps
Gymnomuraena zebra
Pseudanthias hawaiiensis

Appendix B: **Coral Rapid Ecological Assessment (REA) Team Activity Summary** (*Jean Kenyon and Greta Aeby, Leg I; Jean Kenyon and Dan Bashis, Leg II*)

Methods

Throughout the first leg of HI-05-05 (Kauai, Niihau, Lehua, Oahu) Aeby used the line-intersect method at 50-cm intervals along the first two of three, 25 m transects deployed by the fish team to calculate substrate composition. These two 25-m transect lines were also videotaped by Kenyon as a permanent record of the condition of the benthos and for later use in independently calculating percent coral cover. Kenyon surveyed coral colonies along both transect lines, and colonies were tallied by species, number, and maximum diameter. All corals whose colony center fell within 0.5 meter on either side of each transect line were enumerated and assigned to one of 7 size classes: <5 cm, 6-10, 10-20, 20-40, 40-80, 80-160, and >160 cm. These transect tallies are used to determine species abundance and size class distributions. Following quantitative surveys, qualitative surveys were conducted in a larger area around the first two transect lines to document additional species of corals that did not occur within the transect belts. The relative abundance of all coral species was assessed over this broader area using the DACOR system (D=Dominant; A= Abundant; C=Common; O=Occasional; R=Rare), and the overall percent coral cover was visually estimated. While Kenyon conducted the coral census working along the transect lines, Aeby surveyed a 6-m-wide belt along both transect lines for prevalence of coral disease.

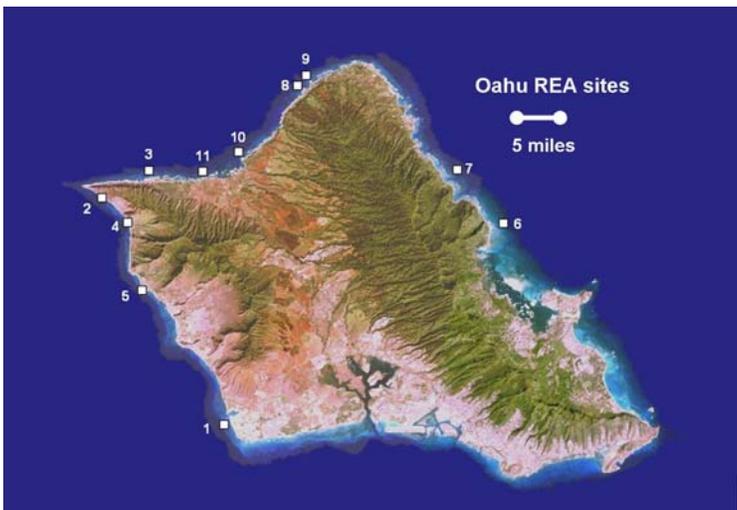
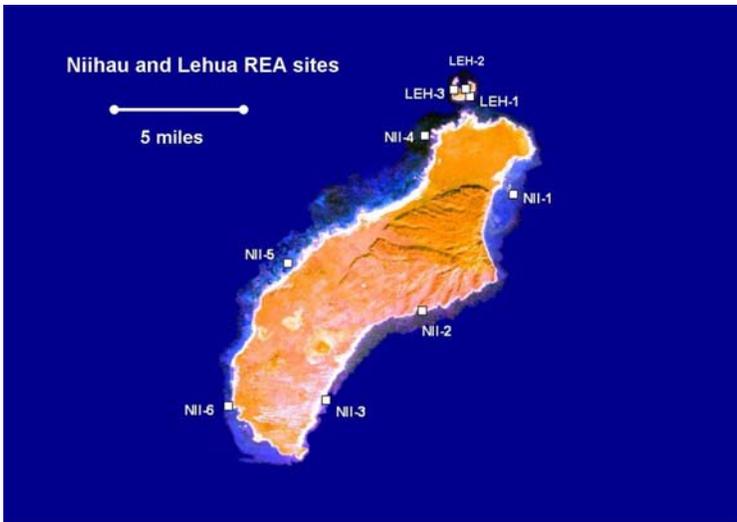
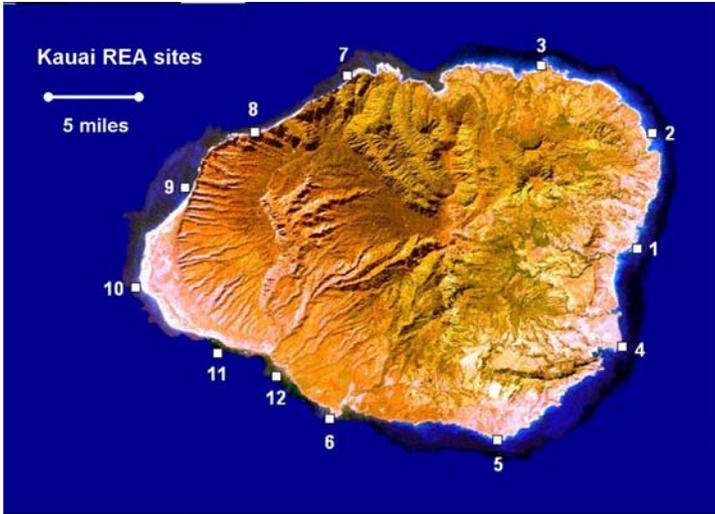
Last-minute personnel changes enacted for the second leg of HI-05-05 (Molokai, Lanai, Maui, Molokini) required a shift in survey strategy. Kenyon used the line intercept method at 50-cm intervals along the first two of three, 25 m transects deployed by the fish team to calculate substrate composition. These two 25-m transect lines were also videotaped by Barshis as a permanent record of the condition of the benthos and for later use in independently calculating coral percent cover. Then, Kenyon and Barshis both independently surveyed coral colonies along both transect lines and in the larger area around the transect lines according to the protocols described in the preceding paragraph. Surveys for coral disease were not conducted due to lack of specific expertise. Coral population survey data included in this report are those collected by Kenyon, the more experienced observer of Kenyon/Barshis.

During the first leg of HI-05-05, Aeby collected samples of diseased and healthy corals for microscopic and histological examination. During both legs of the cruise, Kenyon collected samples of healthy corals for a study of genetic connectivity of *Pocillopora meandrina* throughout the Hawaiian Archipelago that is headed by Dr. Evelyn Cox, Hawaii Institute of Marine Biology, University of Hawaii.

Results

REA surveys were conducted at 50 sites at Kauai (12), Niihau (6), Lehua (3), Oahu (10), Molokai (4), Lanai (6), Maui (6), and Molokini (3). Site numbers, locations, and other site descriptive parameters are presented in Table B-1. Survey locations are shown in Figure B-1.

Table B-1. Sites surveyed by REA team, MHI-RAMP, July/August 2005. Depths and temperatures are from Kenyon dive gauges.										
Site #	Date	Latitude (N)	Longitude (W)	General location	Transect depth (ft)	% coral cover	Max. depth (ft)	Temp, °F		
Kauai										
KAU-1	07/15/05	22	3.232	-159	18.801 Waipouli	42	2.9	44	79	
KAU-2	07/15/05	22	9.919	-159	17.943 Anahola	49	4.9	52	77	
KAU-3	07/15/05	22	13.836	-159	24.320 Kilauea Pt.	35	7.8	37	77	
KAU-4	07/16/05	21	57.564	-159	19.700 Nawiliwili	36	9.8	43	78	
KAU-5	07/16/05	21	52.136	-159	26.833 Hanapepe	20	8.8	27	78	
KAU-6	07/16/05	21	53.380	-159	36.529 Port Allen	44	17.6	51	78	
KAU-7	07/20/05	22	13.266	-159	35.502 Haena	36	12.7	46	78	
KAU-8	07/20/05	22	10.011	-159	40.810 S of Kalalau Valley	42	4.9	46	78	
KAU-9	07/20/05	22	6.752	-159	44.812 Inshore from Mana Reef	60	0	62	78	
KAU-10	07/21/05	22	0.992	-159	47.641 Missile Range	38	0	46	79	
KAU-11	07/21/05	21	57.158	-159	42.910 Kekaha	52	2	54	79	
KAU-12	07/21/05	21	55.821	-159	39.569 Pahala	37	18.6	42	79	
Niihau										
NII-1	07/17/05	21	57.125	-160	3.761 Poleho	33-40	2.9	46	79	
NII-2	07/17/05	21	52.519	-160	7.342 Kalalau Valley	33	0	37	79	
NII-3	07/17/05	21	49.010	-160	11.130 Kowahi	51	0	54	79	
NII-4	07/19/05	21	59.439	-160	7.235 Puuokoae	38	0	40	79	
NII-5	07/19/05	21	54.415	-160	12.647 Puuwai	38	0	46	79	
NII-6	07/19/05	21	48.777	-160	15.017 Pahau Point	50	0	54	79	
Lehua										
LEH-1	07/18/05	22	0.987	-160	5.480 South side	50	0	53	79	
LEH-2	07/18/05	22	1.302	-160	5.644 Inside caldera	58	0	68	79	
LEH-3	07/18/05	22	1.274	-160	6.093 West side	48	0	64	79	
Oahu										
OAH-2	07/14/05	21	33.682	-158	15.695 Kaena Point	33-38	3.9	44	82	
OAH-3	07/22/05	21	35.470	-158	12.571 Dillingham	60	28.4	64	79	
OAH-4	07/22/05	21	32.024	-158	13.997 Makua	39	3.9	45	80	
OAH-5	07/22/05	21	27.593	-158	13.070 Makaha	45	2	47	80	
OAH-6	07/23/05	21	31.987	-157	49.230 Kualoa	45	5.9	47	78	
OAH-7	07/23/05	21	35.552	-157	52.268 Punaluu	45	13.7	53	78	
OAH-8	07/23/05	21	41.111	-158	2.805 Waialeale	44	1	48	79	
OAH-9	07/24/05	21	41.787	-158	2.256 COT outbreak	42	29.4	72	78	
OAH-10	07/24/05	21	36.725	-158	6.676 Haleiwa	40	22.5	46	78	
OAH-11	07/24/05	21	35.424	-158	9.074 Mokuleia	42	33.3	55	78	
Molokai										
MOL-1	07/31/05	21	12.192	-157	15.168 Kawakiunui	35	2.9	36	81	
MOL-2	08/01/05	21	7.496	-157	18.193 Kaunala Bay	35	32.4	35	79	
MOL-3	08/01/05	21	4.980	-157	16.027 Kanalukaha	42	63.7	51	80	
MOL-4	08/01/05	21	4.827	-157	12.936 Halena	42	77.2	48	80	
Lanai										
LAN-1	08/02/05	20	54.814	-157	3.281 Kaea	46	1.0	51	80	
LAN-2	08/02/05	20	52.011	-157	2.608	33-41	48.0	43	80	
LAN-3	08/02/05	20	46.520	-156	59.394 Kaunamalapai	44	19.6	52	80	
LAN-4	08/03/05	20	46.772	-156	49.247	50	66.7	56	80	
LAN-5	08/03/05	20	44.462	-156	52.541	51	46.1	53	80	
LAN-6	08/03/05	20	44.019	-156	55.299	48	23.5	53	80	
Maui										
MAI-04	08/04/05	20	34.748	-156	24.253 Kamanamana	44	1.0	46	80	
MAI-05	08/04/05	20	43.486	-156	27.387 Kaluahakoko	36	78.4	46	80	
MAI-06	08/04/05	20	39.312	-156	26.739 Nahuna	31	18.8	33	80	
MAI-07	08/05/05	21	0.471	-156	40.089 NW side W Maui	50	13.7	56	79	
MAI-08	08/05/05	20	49.922	-156	38.888 Launiupoko Pt.	31	31.4	37	80	
MAI-09	08/05/05	20	47.441	-156	35.025 Ukumehame	42	41.2	46	80	
Molokini										
MOK-01	08/06/05	20	37.815	-156	29.797 S side Molokini	48	65.7	57	80	
MOK-02	08/06/05	20	38.014	-156	29.930 W point Molokini	50	24.5	60	80	
MOK-03	08/06/05	20	37.930	-156	29.815 Inside caldera Molokini	45	32.4	51	80	



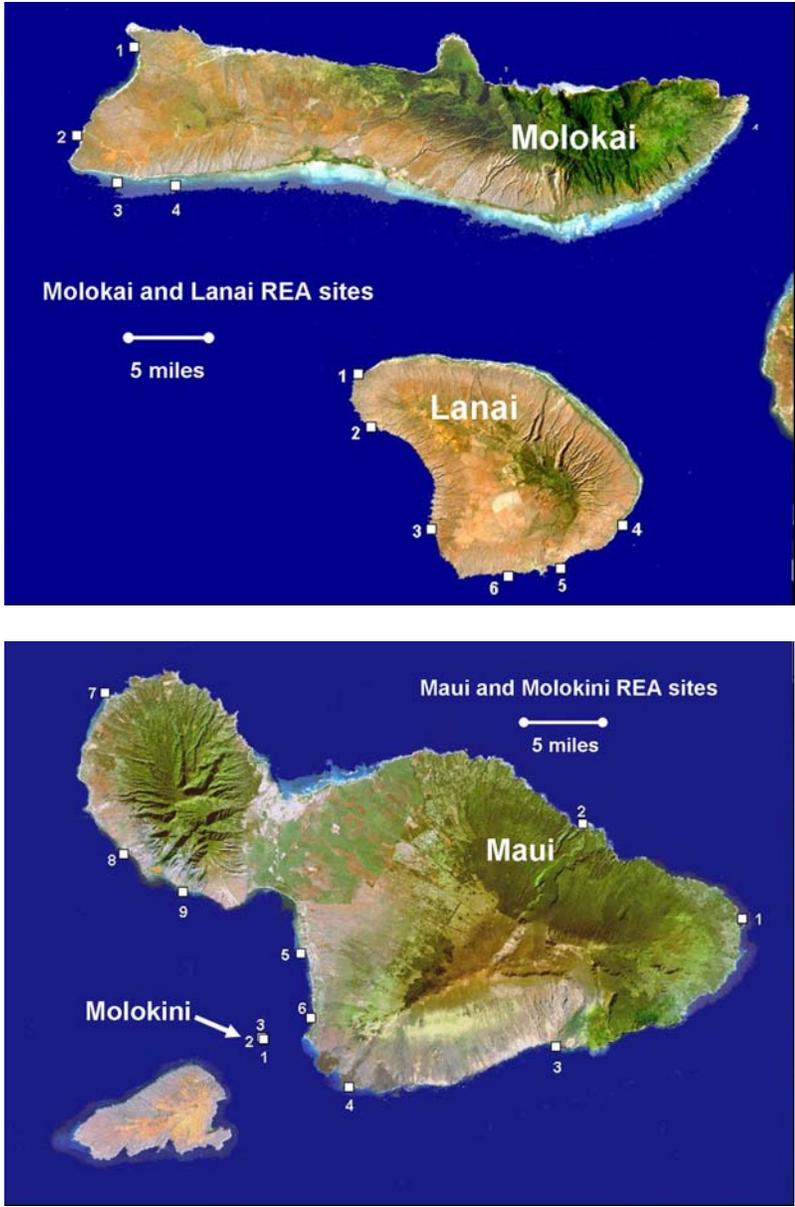


Figure B-1. Location of REA survey sites

Population Parameters

For each island, the area surveyed by Kenyon, number of colonies enumerated, and percentage of coral colonies represented by each taxon are shown in Tables B-2A and B-2B.

Table B-2A. Number of anthozoans surveyed at MHI REA sites by Kenyon during 2005, Leg 1 surveys. Taxa contributing more than 10% of the total number of coral colonies are in bold.								
Taxon	Kauai		Niihau		Lehua		Oahu	
	# of colonies	Percent of total						
<i>Montipora capitata</i>	1743	41.9	109	10.5	76	9.4	1446	31.2
<i>Montipora dilatata</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora flabellata</i>	0	0.0	0	0.0	0	0.0	4	0.1
<i>Montipora incrassata</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora patula</i>	392	9.4	35	3.4	63	7.8	562	12.1
<i>Pavona duerdeni</i>	0	0.0	4	0.4	9	1.1	2	0.0
<i>Pavona varians</i>	5	0.1	0	0.0	0	0.0	2	0.0
<i>Cyphastrea ocellina</i>	0	0.0	11	1.1	1	0.1	2	0.0
<i>Leptastrea bewickensis</i>	0	0.0	0	0.0	0	0.0	19	0.4
<i>Leptastrea purpurea</i>	3	0.1	2	0.2	0	0.0	70	1.5
<i>Fungia scutaria</i>	2	0.0	0	0.0	2	0.2	4	0.1
<i>Cycloseris vaughani</i>	46	1.1	0	0.0	1	0.1	28	0.6
<i>Leptoseris incrustans</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Pocillopora damicornis</i>	0	0.0	3	0.3	0	0.0	0	0.0
<i>Pocillopora eydouxi</i>	10	0.2	1	0.1	3	0.4	0	0.0
<i>Pocillopora ligulata</i>	0	0.0	1	0.1	0	0.0	2	0.0
<i>Pocillopora meandrina</i>	483	11.6	270	26.0	174	21.5	504	10.9
<i>Porites brighami</i>	18	0.4	13	1.3	1	0.1	7	0.2
<i>Porites compressa</i>	55	1.3	0	0.0	0	0.0	4	0.1
<i>Porites evermanni</i>	3	0.1	0	0.0	0	0.0	7	0.2
<i>Porites lobata</i>	1316	31.6	560	54.0	476	58.7	1908	41.2
<i>Porites monticulosa</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Psammacora nierstraszi</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Psammacora stellata</i>	7	0.2	26	2.5	4	0.5	50	1.1
<i>Palythoa sp.</i>	79	1.9	1	0.1	0	0.0	6	0.1
<i>Zoanthus pacifica</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Sinularia sp.</i>	1	0.0	1	0.1	1	0.1	4	0.1
<i>Tubastraea coccinea</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Cirripathes anguina</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Antipathes sp.</i>	0	0.0	0	0.0	0	0.0	0	0.0
Total # colonies	4163	100	1037	100	811	100	4631	100
Area surveyed, m2	595		300		150		483	

Table B-2B. Number of anthozoans surveyed at MHI REA sites by Kenyon during 2005, Leg 2 surveys. Taxa contributing more than 10% of the total number of coral colonies are in bold.

Taxon	Molokai		Lanai		Maui		Molokini	
	# of colonies	Percent of total						
<i>Montipora capitata</i>	83	9.0	119	5.0	300	14.4	181	10.1
<i>Montipora dilatata</i>	0	0.0	0	0.0	0	0.0	(1)*	0.1
<i>Montipora flabellata</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora incrassata</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora patula</i>	119	13.0	262	11.1	249	12.0	355	19.8
<i>Pavona duerdeni</i>	2	0.2	1	0.0	2	0.1	3	0.2
<i>Pavona varians</i>	0	0.0	17	0.7	91	4.4	3	0.2
<i>Cyphastrea ocellina</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Leptastrea bewickensis</i>	0	0.0	0	0.0	1	0.0	1	0.1
<i>Leptastrea purpurea</i>	1	0.1	4	0.2	2	0.1	5	0.3
<i>Fungia scutaria</i>	0	0.0	2	0.1	4	0.2	1	0.1
<i>Cycloseris vaughani</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Leptoseris incrustans</i>	0	0.0	0	0.0	2	0.1	8	0.4
<i>Pocillopora damicornis</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Pocillopora eydouxi</i>	3	0.3	5	0.2	1	0.0	3	0.2
<i>Pocillopora ligulata</i>	1	0.1	0	0.0	0	0.0	0	0.0
<i>Pocillopora meandrina</i>	382	41.6	259	11.0	307	14.8	526	29.4
<i>Porites brighami</i>	0	0.0	0	0.0	0	0.0	1	0.1
<i>Porites compressa</i>	44	4.8	123	5.2	163	7.8	36	2.0
<i>Porites evermanni</i>	0	0.0	3	0.1	4	0.2	3	0.2
<i>Porites lobata</i>	282	30.7	1545	65.5	945	45.5	501	28.0
<i>Porites monticulosa</i>	0	0.0	0	0.0	1	0.0	0	0.0
<i>Psammacora nierstraszi</i>	0	0.0	11	0.5	1	0.0	0	0.0
<i>Psammacora stellata</i>	1	0.1	3	0.1	1	0.0	0	0.0
<i>Palythoa sp.</i>	0	0.0	2	0.1	3	0.1	0	0.0
<i>Zoanthus pacifica</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Sinularia sp.</i>	0	0.0	1	0.0	0	0.0	0	0.0
<i>Tubastraea coccinea</i>	0	0.0	0	0.0	0	0.0	150	8.4
<i>Cirrhpathes anguina</i>	0	0.0	0	0.0	0	0.0	12	0.7
<i>Antipathes sp.</i>	0	0.0	0	0.0	0	0.0	1	0.1
Total # colonies	918	100	2357	100	2077	100	1791	100
Area surveyed, m ²	175		300		300		150	

* tentative identification awaits confirmation

Twenty-seven species of anthozoans, which included 22 scleractinian species were enumerated within belt transects. The tentative identification at Molokini of a colony of *Montipora dilitata*, a rare species that may be proposed for endangered status under the Endangered Species Act, awaits further confirmation. An additional seven anthozoan species (*Balanophyllia* sp., *Diaseris* sp., *Leptastrea transversa*, *Leptoseris mycetoseroides*, *Montipora incrassata*, *Pocillopora molokensis*, *Sarcothelia edmondsoni*) were observed in the larger area qualitatively surveyed around the transect lines. In terms of the number of colonies represented within transect belts, *Porites lobata* is a dominant coral at all islands visited except Molokai, with *Pocillopora meandrina*, *Montipora capitata*, or *Montipora patula* the next most abundant taxa.

Figure B-2 shows the average percent coral cover from the REA sites, calculated from the point-intercept method applied by Aeby and Kenyon.

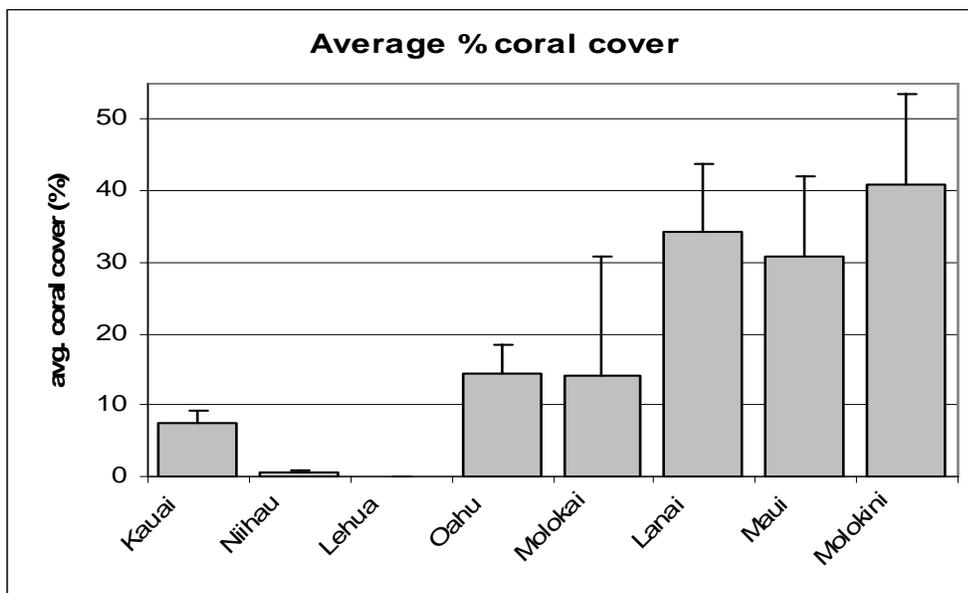
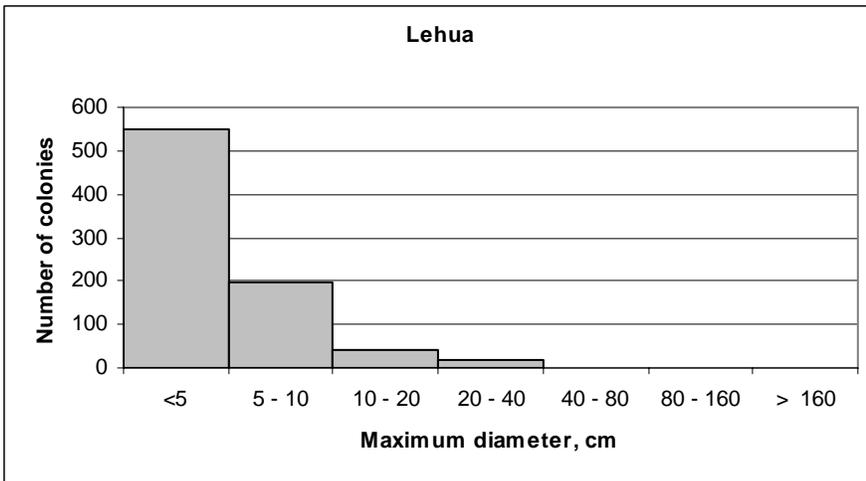
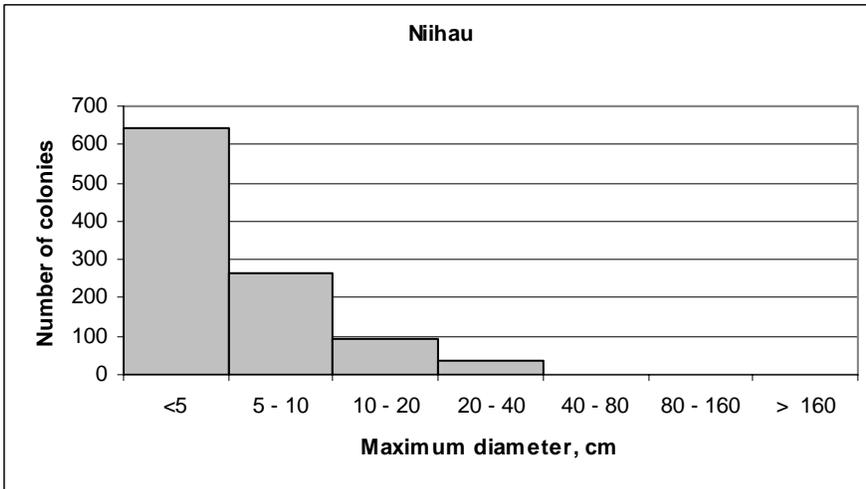
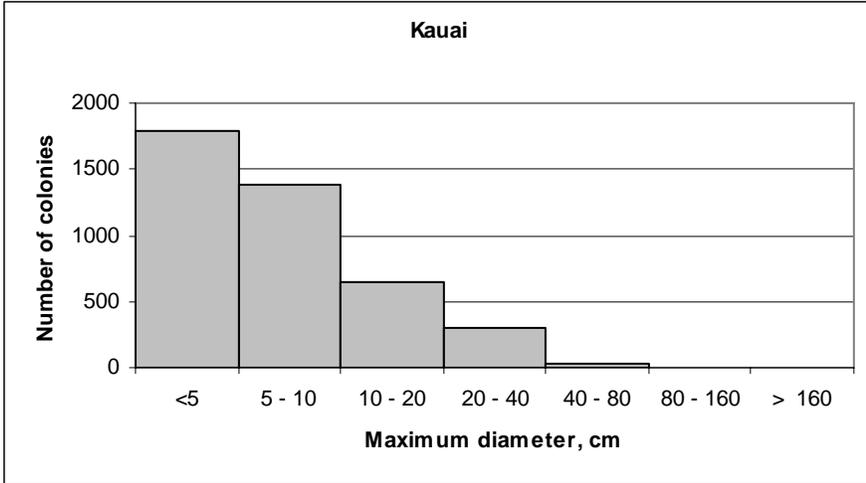
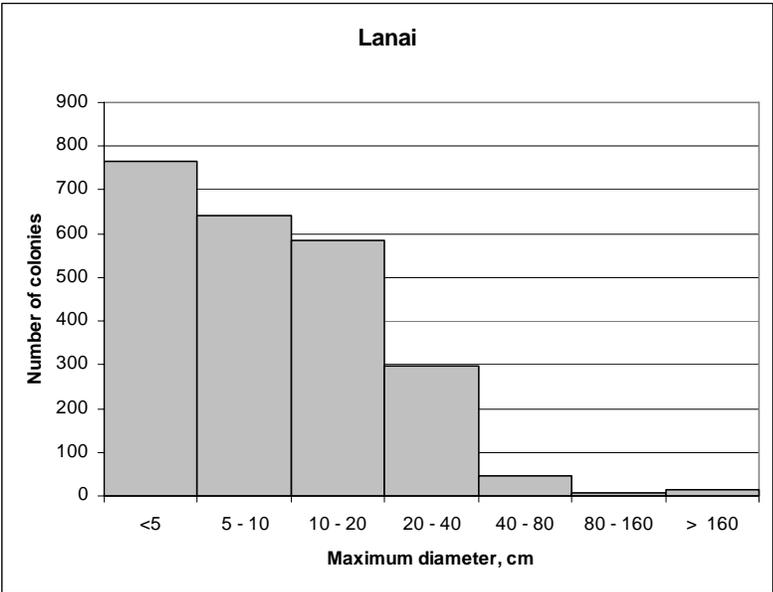
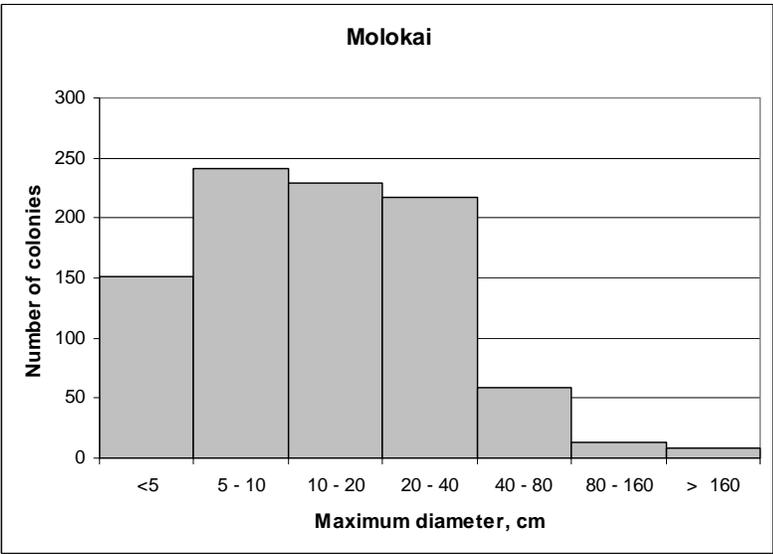
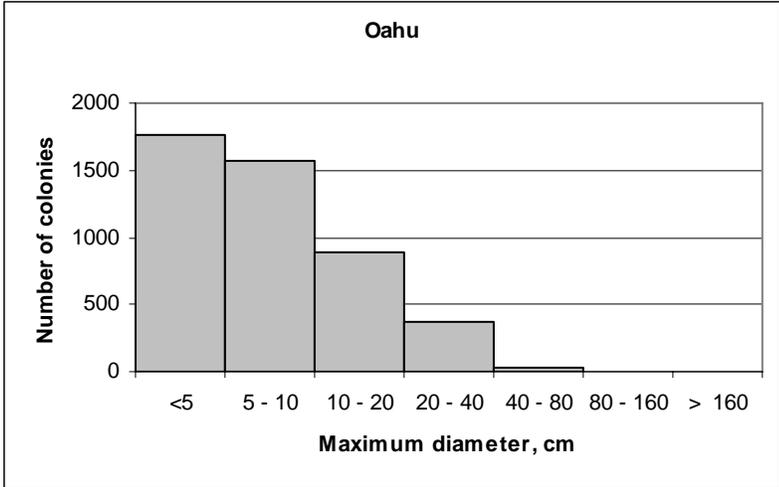


Figure B-2. Average percent live coral cover, from July/August 2005 MHI-REA surveys

Size class distributions of all corals enumerated within belt transects by Kenyon are shown in Figure B-3. Small (<10 cm maximum diameter) colonies characterized the coral community structure at all islands; the proportion of colonies measuring < 10 cm maximum diameter ranged from 41.7% at Molokini to 92.5% at Lehua Rock (Table B-3). These size class distributions serve as a baseline for comparison with size class distribution from surveys at other Hawaiian locations (e.g., NWHI, Appendix B of Cruise Report for HI-04-01) and for repeat surveys at the same sites in future years.





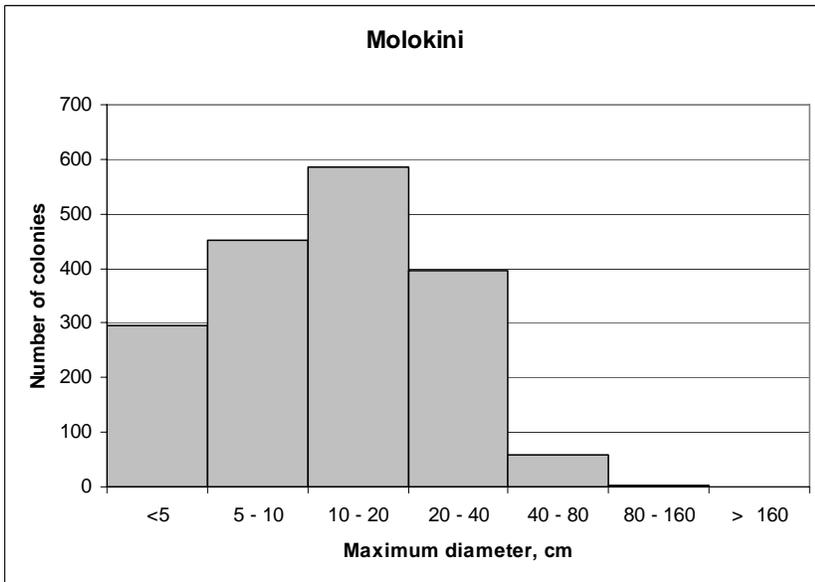
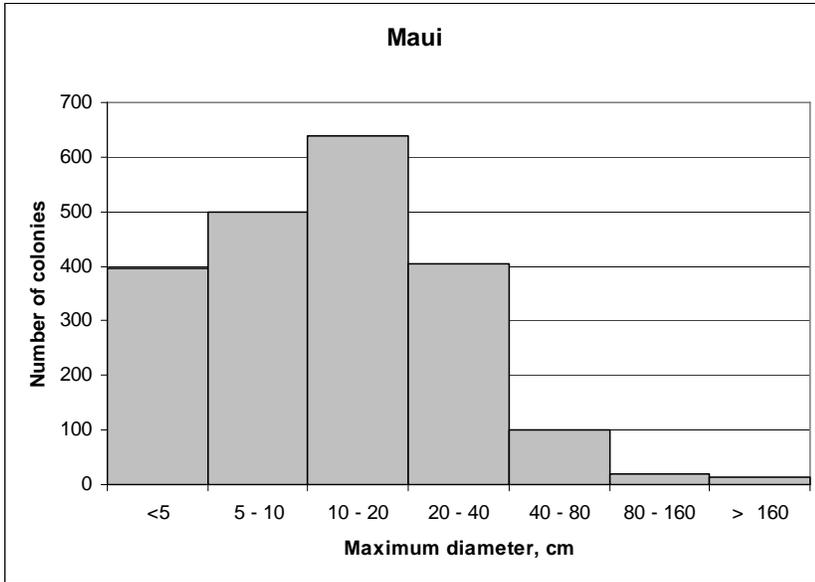


Figure B-3. Size class distributions of anthozoans within belt transects at Kauai, Niihau, Lehua, Oahu, Molokai, Lanai, Maui, and Molokini.

Table B-3. Proportion of anthozoan colonies measuring <10 cm maximum diameter		
Island	Number of colonies	% < 10 cm max. diameter
Kauai	4163	76.2
Niihau	1037	87.9
Lehua	811	92.5
Oahu	4631	72.2
Molokai	918	42.6
Lanai	2357	58.9
Maui	2077	43.1
Molokini	1971	41.7

Corals Samples for Genetic Studies

Collections of *Pocillopora meandrina* for genetic studies of reef connectivity are summarized in Table B-4.

Table B-4. SUMMARY OF <i>P. meandrina</i> COLLECTIONS, MHI-RAMP		
Island	# samples	# sites
Kauai	50	9
Niihau	49	5
Lehua	36	3
Molokai	25	4
Lanai	34	5
Total:	194	

C. Coral Disease Results

Overall health status of the reefs

Six different coral diseases were encountered during the surveys (table 1). The most commonly encountered diseases were with *Porites* trematodiasis (frequency of occurrence =60% of the sites) and *Porites* growth anomalies (50% of the sites). Bleached colonies of *Montipora capitata* were frequently found (83.3% of the sites) and may reflect a normal level of summer bleaching for this coral species. Evidence of COTs (animal or feeding scars present) was found at 10 of the 30 sites surveyed (33.3%). An outbreak of COTs was reported by the tow-boarding team at one site (oahu9) and was subsequently surveyed by the REA team. At this site we counted 45 animals within a 25 by 4 m belt transect with over 100 animals noted elsewhere on the reef.

Table 1

Health status of reef sites surveyed within the main Hawaiian Islands in July, 2005.
 X indicates presence on the reef. Por=*Porites* ; Mont=*Montipora* TL=tissue loss;
 GA=growth anomaly; wspt=white spot; trm=trematodiasis; COT=*Acanthaster planci*

site	area surveyed(m ²)	bleaching	Por Trm	Por GA	Por focal TL	Por TLS	Mont GA	Mont wspt	COT
Kauai 1	300	X	X						
Kauai 2	300	X	X						
Kauai 3	300	X		X					
Kauai 4	300		X	X					X
Kauai 5	222	X	X	X		X			
Kauai 6	300	X	X	X	X	X	X		
kauai7	300	X	X	X					
kauai8	300	X							
kauai9	300	X							
kauai10	300	X	X						
kauai11	300	X		X					
kauai12	300	X	X	X			X		
Niihau 1	300								X
Niihau 2	300								
Niihau 3	300								
Niihau 4	300	X	X						cot scars
Niihau 5	300	X							
Niihau 6	300	X							cot scars
Leh1	300	X							X
Leh2	300	X							cot scars
Leh3	300		X						X
Oahu2	300	X	X	X					
Oahu3	172	X	X	X		X	X		
Oahu4	300	X		X					
Oahu5	300	X	X	X					cot scars
Oahu6	300	X	X	X					
Oahu7	300	X	X				X		
Oahu8	300	X	X	X					
Oahu9	no disease survey; surveyed for COTs instead								X
Oahu10	300	X	X	X					
Oahu11	200	X	X	X			X	X	X

Kauai

Surveys were conducted along 12 sites around Kauai. A total of five coral diseases were found on the reefs of Kauai (*Porites* trematodiasis, *Porites* growth anomalies, *Porites* tissue loss syndrome, *Porites* focal tissue loss, and *Montipora* growth anomalies). Coral disease was found at 10 of the 12 sites (83.3%). Coral cover varied from <1-18.6%.

Niihau

Six surveys were conducted at Niihau. Only one coral disease was found (*Porites* trematodiasis) and it was only found at one site. However, coral cover was also found to be quite low (range<1-2.9%).

Lehua Rock

Three surveys were conducted around Lehua with one coral disease (*Porites* trematodiasis) found at a single site. Similar to Niihau, coral cover was low (<1%).

Oahu

Ten surveys were conducted around Oahu. Disease assessment was done at nine of the sites with one site being surveyed for a reported Crown-O-Thorns outbreak. Five diseases were encountered around Oahu (*Porites* trematodiasis, *Porites* growth anomalies, *Porites* tissue loss syndrome, *Montipora* white spot, and *Montipora* growth anomalies). Disease was found at all nine sites surveyed (100%). Coral cover ranged from 1% to 33%.

Appendix C: **Algal Rapid Ecological Assessment (REA) Team Activity Summary** (*Peter Vroom, Ryan Okano, and Emily Krause*)

Methods

Standardized quantitative sampling methods for remote tropical Pacific islands were developed and published for marine algae (Preskitt et al., Pacific Science 2004). To allow for vertical sampling in areas of high relief (walls), the method was modified slightly by Vroom et al. (in review, Coral Reefs) and entails photographing quadrats, collecting algal voucher specimens, creating in situ algal species lists, and ranking relative algal abundance. This modified “Preskitt method” has been used by CRED since 2003 in the Northwestern Hawaiian Islands, Guam/Mariana Islands, Pacific Remote Island Areas, and American Samoa.

Results

GPS coordinates for all sites are listed in Table B-1.

1. Oahu (Table C-1)

Site Descriptions

OAH-2 7/14/05

This site was located at Kaena Point. Site was pavement with turf algae and occasional sand patches, some large pinnacles. Occasional *Halimeda*, *Laurencia*, *Padina*, and a few individuals of *Neomeris*. Rare species included *Gibsmithia hawaiiensis* and *Dictyosphaeria cavernosa*. Overall, the site looked very scoured.

OAH-3, 7/22/05

Northwest side of island, offshore from Dillingham Airfield. Rugose reef system with high carbonate benches separated by deep sand channels; depths ranged from 55 to 65 feet. Coral and fish diversity high. Macroalgae were not particularly common, although large stands of *Asparagopsis taxiformis* were observed off the transect lines. In our photoquadrats we recorded mainly *Neomeris annulata*, *Amansia glomerata*, *Dictyopteris plagiogramma*, and *Dictyota friabilis*. On the random swim, we found *Portieria hornemannii*, *Acanthophora pacifica*, and a species of *Padina*.

OAH-4, 7/22/05

South of Kaena Point, off Makua valley. Flat pavement reef boarding deeper sandy area. Caves existed where the pavement and sand met. Most of the pavement was covered with cyanobacteria and algal turf; depths ranged from 37 to 40 feet. *Halimeda discoidea* was the most common macroalga. During the random swim we also found: *Dictyosphaeria cavernosa*, *Caulerpa taxifolia*, *Martensia flabelliformis*, *Avrainvillea amadelpa*, *Padina* sp., *Amansia glomerata*, and *Neomeris annulata*.

OAH-5, 7/22/05

Site located off Makaha valley. Lots of vertical relief with steep drop-offs; depths ranging from 29 to 47 feet. Carbonate structures separated by sand channels. *Halimeda discoidea*, *Amansia*

glomerata, and a species of *Padina* were extremely common. In our photoquadrats we also found *Avrainvillea amadelpa*, *Neomeris annulata*, *Spyridea filamentosa*, and *Tolypocladia glomerulata*. On the random swim we found: *Liagora* sp., *Gibsmithia hawaiiensis*, *Martensia flabelliformis*, *Dictyosphaeria cavernosa*, and *Caulerpa taxifolia*.

OAH-6, 7/23/05

North side of Oahu, close to Kualoa. Relatively flat pavement with depths between 45 and 47 feet. This site had some of the densest algal meadows with the greatest algal diversity of any site visited during this cruise. Corals and fish were relatively scarce. Inside our photoquadrats, *Halimeda discoidea*, *Neomeris annulata*, *Amansia glomerata*, *Asparagopsis taxiformis*, *Laurencia* sp., *Dictyota* sp., and a branched coralline were common. Other algae included: *Codium arabicum*, *Dictyosphaeria cavernosa*, *Champia viellardii*, *Gibsmithia hawaiiensis*, *Martensia flabelliformis*, and several others.

OAH-7, 7/23/05

North side of Oahu, close to Punaluu. This area consisted of carbonate pinnacles with tops reaching about 50 feet, dropping to 90+ feet. The pinnacle we surveyed had depths of 47 to 54 feet. *Dictyosphaeria cavernosa*, *Halimeda discoidea*, *Neomeris annulata*, and a species of *Padina* were very common in photoquadrats. Other algae included *Galaxaura* sp., *Gibsmithia hawaiiensis*, *Laurencia* sp., *Liagora* sp., and *Martensia flabellata*.

OAH-8, 7/23/05

North side of Oahu, south of Turtle Bay. Relatively flat pavement reef with depths from 43 to 46 feet. Fish and corals relatively scarce. *Halimeda discoidea*, *Microdictyon setchellianum*, *Amansia glomerata*, *Hypnea* sp., and a species of *Laurencia* were common in our photoquadrats. Other algae found included: *Avrainvillea amadelpa*, *Dictyosphaeria cavernosa*, *Asparagopsis taxiformis*, *Liagora* sp., *Martensia flabelliformis*, *Trichogloea* sp., and a species of *Padina*.

OAH-9, 7/24/05

North side of Oahu, south of Turtle Bay, very close to OAH-8. This site was experiencing an *Acanthaster* outbreak. Pavement pinnacles with deep sand channels dropping to 70+ feet; transects were laid between 42 and 51 feet. *Halimeda discoidea*, *Microdictyon setchellianum*, and *Neomeris annulata* were the most common macroalgae. Other species found included *Acanthophora pacifica*, *Asparagopsis taxiformis*, *Gibsmithia hawaiiensis*, *Laurencia* sp., *Padina* sp., and *Lobophora variegata*.

OAH-10, 7/24/05

North side of Oahu off Haleiwa. Flat pavement covered with algal turf. Depths ranged from 42 to 44 feet. *Dictyosphaeria cavernosa*, *Halimeda discoidea*, *Microdictyon setchellianum*, *Neomeris annulata*, *Tolypocladia glomerulata*, *Tricleocarpa fragilis*, *Padina* sp., and *Amansia glomerata* were the most common macroalgae. *Caulerpa webbiana*, the invasive algae *Acanthophora spicifera*, *Botryocladia skottsbergii*, *Dasya iridescens*, dense patches of *Asparagopsis taxiformis*, *Galaxaura* sp., *Gibsmithia hawaiiensis*, *Laurencia* sp., *Martensia flabellata*, and *Spyridea filamentosa* were also collected.

OAH-11, 7/24/05

North side of Oahu off Mokuleia. Flat pavement adjacent to deep drop off. Depths ranging from 45 to 55 feet. *Halimeda discoidea*, *Microdictyon setchellianum*, *Neomeris annulata*, and species of *Padina* were the most common macroalgae found in our photoquadrats. During the random swim, we found *Galaxaura marginata*, *Acanthophora pacifica*, *Gibsmithia hawaiiensis*, and *Tolypocladia glomerulata*.

Table C-1: Algae of Oahu. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	OAH2	OAH3	OAH4	OAH5	OAH6	OAH7	OAH8	OAH9	OAH10	OAH11
Green algae										
<i>Avrainvillea amadelpha</i>			*	16.67 3.5			*			
<i>Bryopsis</i> sp.	*									
<i>C. taxifolia</i>			*	*						
<i>C. webbiana</i>								8.33 6.0		
<i>Codium arabicum</i>					8.33 7.0					
<i>Dictyosphaeria cavernosa</i>	*		*	*	16.67 6.0	33.33 4.8			41.67 5.6	
<i>Halimeda discoidea</i>	58.33 2.4		41.67 3.6	100.00 3.3	100.00 3.7	100.00 2.4	91.67 3.7	66.67 3.1	75.00 3.0	41.67 3.4
<i>Microdictyon setchellianum</i>							41.67 3.8	25.00 3.7	66.67 4.0	41.67 2.0
<i>Neomeris</i> spp.	8.33 4.0		8.33 5.0	25.00 5.3	33.33 7.5	50.00 5.2		25.00 5.0		66.67 4.5
Red algae										
<i>Acanthophora pacifica</i>			*					8.33 4.0		*
<i>Acanthophora spicifera</i>									*	
<i>Amansia glomerata</i>		33.33 2.3	8.33 2.0	75.00 2.6	50.00 2.3		75.00 3.0		41.67 4.0	8.33 2.0
<i>Asparagopsis taxiformis</i>		*			41.67 5.0		16.67 3.5	16.67 3.0	*	8.33 4.0
<i>Botryocladia skottsbergii</i>									8.33 5.0	8.33 4.0
Branched coralline			8.33 3.0		25.00 5.3	25.00 4.3			8.33 9.0	
<i>Champia viillardii</i>						8.33 8.0				
Crustose coralline		33.33 2.5	50.00 3.3	66.67 4.3	50.00 4.5	25.00 3.0	50.00 5.2	58.33 3.0	25.00 5.3	66.67 3.4

Kauai (Table C-2)

Site descriptions:

KAU-1, 7/15/05

East side of Kauai. This site was relatively flat with dense meadows of turf algae interspersed with small coral heads. *Microdictyon setchellianum*, *Dictyosphaeria cavernosa*, *Halimeda discoidea*, and crustose coralline red algae were common.

KAU-2, 7/15/05

Northeast side of Kauai. This site was very similar to Kau-1, being relatively flat with dense meadows of turf algae interspersed with small coral heads. *Microdictyon setchellianum* and *Halimeda discoidea* were common.

KAU-3, 7/15/05

North side of Kauai, inside small bay west of Kilauea lighthouse. This site was rugose, with deep sand channels separated by smooth spurs of rock. Coral was much more abundant than at sites visited earlier in the day. Common macroalgae included: *Laurencia* sp., *Microdictyon setchellianum*, *Amansia glomerata*, and *Halimeda discoidea*.

KAU-4, 7/16/05

East side of Kauai. Strong current (no algal photoquadrats taken), boulder field with sand and pavement between crevices. Coral was fairly abundant, but small in size. Common macroalgae included: *Acanthophora pacifica*, *Portieria hornemannii*, *Halimeda discoidea*, *Dictyota* sp., *Dictyota friabilis*, *Amansia glomerata*, *Neomeris* sp., *Galaxaura filamentosa*, and *Dictyosphaeria versluysii*.

KAU-5, 7/16/05

South side of Kauai. Reef bordering sand plain. Small corals common, dotting a level pavement substrate with occasional boulders. Fairly large fish observed. Macroalgae not overly common, however, *Martensia flabelliformis*, *Laurencia* sp., *Neomeris annulata*, and *Amansia glomerata* occurred in photoquadrats.

KAU-6, 7/16/05

South side of Kauai. Gentle reef slope with many small- to moderate-sized corals, and great diversity of fish and invertebrates. Common macroalgae included: *Halimeda discoidea*, *Amansia glomerata*, and *Tolypiocladia glomerulata*.

KAU-7, 7/20/05

Northwest side of Kauai. High current, only four photoquadrats taken. Pavement benches around 38 ft deep surrounded by deeper sand channels. Diverse algal assemblage including: *Dasya iridescens*, *Laurencia* sp., *Martensia flabelliformis*, *Galaxaura* sp., *Neomeris annulata*, *Gibsmithia hawaiiensis*, *Acanthophora pacifica*, *Caulerpa taxifolia*, *Amansia glomerata*, *Trichogloea* sp., *Halimeda discoidea*, *Padina* sp., *Liagora* sp., and *Spyridea filamentosa*.

KAU-8, 7/20/05

West side of Kauai, depths 42 to 45 feet. Relatively poor visibility and moderate current. Pavement fingers reaching out from shore interspersed with sand channels. Algal flora was diverse, with *Amansia glomerata*, *Liagora* sp., *Neomeris annulata*, *Trichogloea* sp., and *Tricleocarpa fragilis* located within photoquadrats. *Halymenia* sp., *Acanthophora pacifica*, *Padina* sp., *Dictyota* sp., *Gibsmithia hawaiiensis*, and *Martensia flabelliformis* were found during the random swim.

KAU-9, 7/20/05

West side of Kauai, depth an even 59 ft. Sand, sand, sand, with a small bench at the beginning of transect 1. Inside our photoquadrats we saw *Sargassum* sp., *Amansia glomerata*, *Haliptilon* sp., *Padina* sp., and a species of *Laurencia*. During the random swim we encountered *Neomeris annulata*, *Dictyota* sp., *Tricleocarpa fragilis*, *Halimeda discoidea*, and a species of *Liagora*.

KAU-10, 7/21/05

Southwest side of Kauai. No current, great visibility. Low benches separated by shallow sand channels, depths ranging from 38 to 44 feet. *Halimeda discoidea* and *Amansia glomerata* were the most common macroalgae. *Martensia flabelliformis*, *Padina* sp., *Dasya iridescens*, *Laurencia* sp., *Codium reediae*, *Hypnea* sp., and *Gibsmithia hawaiiensis* were also found.

KAU-11, 7/21/05

Southwest side of Kauai. Very silty and murky, depths ranging from 51 to 54 feet, substrate composed of silt and turf covered pavement. *Halimeda discoidea* and *Amansia glomerata* were the most common macroalgae. *Dasya iridescens*, *Gibsmithia hawaiiensis*, *Padina* sp., *Liagora* sp., *Martensia flabelliformis*, and an unidentified goeey red.

KAU-12, 7/21/05

South side of Kauai. Silt and turf covered pavement, murky conditions, slightly surgy, depths ranging from 38 to 42 feet. *Halimeda discoidea*, *Neomeris annulata*, and *Jania* sp. were the most common macroalgae. *Scinaia hormoides*, *Acanthophora pacifica*, *Halymenia* sp., *Martensia flabelliformis*, *Dasya iridescens*, *Liagora* sp., *Galaxaura* sp., *Amansia glomerata*, *Dictyota* sp., *Hypnea* sp., *Padina* sp., *Peyssonnelia* sp., *Gibsmithia hawaiiensis*, a variety of corallines, and an unidentified goeey red.

Table C-2: Algae of Kauai. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	KAU1	KAU2	KAU3	KAU4	KAU5	KAU6	KAU7	KAU8	KAU9	KAU10	KAU11	KAU12
Green algae												
<i>C. taxifolia</i>							*					
<i>C. edule</i>	*	*										
<i>C. reediae</i>										8.33 4.0		

	KAU1	KAU2	KAU3	KAU4	KAU5	KAU6	KAU7	KAU8	KAU9	KAU10	KAU11	KAU12
<i>C. sp.</i>	25.00 6.3											
<i>Dictyosphaeria cavernosa</i>	50.00 4.3	25.00 6.7										8.33 5.0
<i>D. versluysii</i>				*	8.33 4.0							
<i>Halimeda discoidea</i>	83.33 2.6	83.33 3.1	25.00 3.3	*		41.67 4.2	*		*	50.00 2.5	75.00 2.7	58.33 4.9
<i>Microdictyon Setchellianum</i>	75.00 2.4	8.33 8.0	25.00 2.3									
<i>Neomeris spp.</i>	8.33 7.0	16.67 5.0	8.33 5.0	*	8.33 4.0	8.33 6.0	*	16.67 3.0	*	16.67 3.0	8.33 4.0	58.33 5.0
Red algae												
<i>Acanthophora pacifica</i>				*			*					*
<i>Amansia glomerata</i>	33.33 3.0	41.67 2.2	25.00 2.7	*	8.33 3.0	50.00 2.5	*	16.67 2.0	16.67 3.5	33.33 2.3	41.67 2.2	
<i>Botryocladia skottsbergii</i>	16.67 6.0											
Branched coralline		16.67 4.0				58.33 3.7						33.33 3.8
Crustose coralline	83.33 4.9	33.33 5.8	33.33 2.8	*	75.00 2.1	75.00 3.2		41.67 2.8		16.67 4.5	25.00 3.3	41.67 3.8
<i>Dasya iridescens</i>							*			*	*	16.67 5.5
<i>Dasya sp.</i>		8.33 3.0										
<i>Galaxaura filamentosa</i>				*								
<i>Galaxaura sp.</i>	8.33 4.0	33.33 4.3					*					*
<i>Gibsmithia hawaiiensis</i>							*	*		*	*	8.33 6.0
<i>Haliptilon subulatum</i>								16.67 3.0			8.33 3.0	
<i>Halymenia sp.</i>							*					*
<i>Hypnea sp.</i>												25.00 4.3
<i>Jania sp.</i>										8.33 6.0		91.67 2.3
<i>Laurencia sp.</i>		41.67 3.6	50.00 3.0		25.00 2.7		*	8.33 6.0	16.67 4.0			
<i>Liagora spp.</i>							*	16.67 3.5			8.33 2.0	8.33 4.0
<i>Martensia sp.</i>	33.33 5.0	8.33 6.0	8.33 2.0		33.33 2.5		*			*	8.33 5.0	8.33 6.0
<i>Peyssonnelia spp.</i>		16.67 4.0										8.33 4.0
<i>Portieria hornemannii</i>				*			*					

	KAU1	KAU2	KAU3	KAU4	KAU5	KAU6	KAU7	KAU8	KAU9	KAU10	KAU11	KAU12
<i>Scinaia hormoides</i>		8.33 4.0										*
<i>Spyridea filamentosa</i>							*					
<i>Tolypocladia glomerulata</i>		8.33 2.0				50.00 2.3						
<i>Trichogloea</i> sp.							*	8.33 3.0				
<i>Tricleocarpa fragilis</i>								8.33 2.0				
Brown algae												
Brown crust											8.33 3.0	
<i>Dictyota friabilis</i>				*								
<i>Dictyota</i> sp.				*								16.67 5.5
<i>Padina</i> sp.	8.33 4.0					16.67 6.0	*		8.33 2.0	*	*	33.33 6.3
<i>Sargassum</i> sp.									8.33 2.0			
Blue-green algae	41.67 3.8	41.67 4.2	41.67 3.0	*		25.00 3.7	*	16.67 4.0		50.00 3.0	25.00 2.7	
Algal turf	100.00 1.0	100.00 1.0	100.00 1.0	*	100.00 1.0	100.00 1.0	*	100.00 1.0	33.33 1.0	100.00 1.0	100.00 1.0	100.00 1.0

3. Niihau (Table C-3)

Site Descriptions

NII-1, 7/17/05

Northeast side of Niihau. Boulder and pavement reef bordering extensive sandy area. Lots of small to medium sized corals, and a diverse population of large, mature fish. Turf, cyanophytes, and crustose coralline algae were very abundant. The most common macroalga was *Neomeris annulata*, with a little bit of *Bornetella sphaerica*.

NII-2, 7/17/05

East side of Niihau. Poor visibility with silty substrate. Essentially no coral or fish. Substrate covered with dense turf algal communities. Calcified macroalgae were common, including: *Jania* sp., *Haliptilon subulatum*, *Halimeda discoidea*, and *Neomeris annulata*. *Siphoncladus tropicus* was also fairly common in our photoquadrats.

NII-3, 7/17/05

Southeast side of Niihau. Substrate and biological communities very similar to Nii-2, but the visibility was much better. The calcified algae *Jania* sp., *Haliptilon subulatum*, *Halimeda discoidea*, *Padina* sp., and *Neomeris annulata* were extremely common.

NII-4, 7/19/05

Northwest side of Niihau. Substrate consisted of turf algal covered pavement with urchin burrows, depths of 37-40 feet. Several species of cyanophyte commonly overgrew algal turf. Macroalgae was sparse, with occasional individuals of *Neomeris annulata* and a brown crust.

NII-5, 7/19/05

West side of Niihau. Turf, cyanophyte, and crustose coralline covered pavements dissected by slightly deeper channels containing sand or boulders. Immediately beyond the second transect line, a dense bed of *Dictyopteris palagiogramma* occurred with between 25 and 100% cover. On the transect lines, small tufts of *Dictyopteris*, *Padina* sp., *Neomeris annulata*, and *Jania* sp. were observed. Depths ranged from 39 to 47 feet.

NII-6, 7/19/05

Southwest side of Niihau. Strong current, substrate consisted of large boulder field interspersed with extensive sandy regions. Boulders were covered with dense turf algal and cyanophyte assemblages. The sparse macroalgal population consisted of *Neomeris annulata*, *Padina* sp., and *Lobophora variegata*. In crevices between boulders, dense *Lobophora variegata* populations occurred with some *Halimeda discoidea* and *Amansia glomerata*. Depths ranged from 47 to 54 feet.

Table C-3: Algae of Niihau. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	NII1	NII2	NII3	NII4	NII5	NII6
Green algae						
<i>Bornetella sphaerica</i>	8.33 4.0	8.33 5.0	16.67 6.0			
<i>C. edule</i>			*			
<i>Dictyosphaeria cavernosa</i>			8.33 6.0			
<i>Halimeda discoidea</i>		50.00 4.3	100.00 3.1		*	*
<i>Neomeris</i> spp.	66.67 3.9	83.33 4.0	58.33 5.0	16.67 3.5	25.00 3.3	16.67 2.0
<i>Siphonocladus tropicus</i>		25.00 4.7				

	NII1	NII2	NII3	NII4	NII5	NII6
Red algae						
<i>Amansia glomerata</i>	*		8.33 2.0			*
<i>Amphiroa</i> sp.			8.33 4.0			
<i>Botryocladia skottsbergii</i>			8.33 8.0			
branched coralline		8.33 2.0				
crustose coralline	75.00 2.8	50.00 2.8	33.33 3.8	50.00 3.0	41.67 2.8	
<i>Dasya</i> sp.			*			
<i>Galaxaura</i> sp.			*			
<i>Haliptilon subulatum</i>		50.00 2.8	33.33 3.3			
<i>Jania</i> sp.		58.33 2.1	50.00 2.5		8.33 4.0	
<i>Laurencia</i> sp.	8.33 3.0					
<i>Portieria hornemannii</i>	8.33 3.0					
<i>Spyridea filamentosa</i>			41.67 3.4			
Brown algae						
Brown crust				16.67 3.5		
<i>Dictyopteris palagiogramma</i>					16.67 3.0	
<i>Dictyota friabilis</i>		8.33 4.0				
<i>Dictyota</i> sp.		8.33 4.0				
<i>Lobophora variegata</i>						8.33 2.0
<i>Padina</i> sp.	*		41.67 5.4		33.33 3.8	16.67 3.0
<i>Turbinaria ornate</i>	*			*		
Blue-green algae		91.67 2.2	8.33 3.0	100.00 1.9	66.67 2.3	50.00 2.0
Algal turf	100.00 1.0	100.00 1.0	100.00 1.0	100.00 1.1	100.00 1.0	100.00 1.0

4. Lehua (Table C-4)

Site Descriptions

LEH-1, 7/18/05

South side of Lehua Rock. Boulder field close to shore, depths from 46-51 feet. Small corals, substrate primarily dominated by turf algae, cyanophytes, and crustose coralline algae. *Neomeris*

annulata was fairly common, but few other macroalgae were seen. BIG shark (~9 feet) circled during safety stop.

LEH-2, 7/18/05

Inside crater of Lehua Rock. Boulder field immediately adjacent to vertical rock wall, located close to shore. Depths ranged from 52-61 feet. Turf algae and cyanophytes dominated the benthos, although small corals were also present. *Neomeris annulata*, *Lobophora variegata* (or possible *Distromium*), and *Amansia glomerata* were the macroalgae found in our photoquadrats.

LEH-3, 7/18/05

West side of Lehua Rock. Steep cliffs above shore continued underwater. This site was located geographically to shore, but in 38-44 feet of water on a 33-45 degree incline. Rock-boring urchins had worn numerous crevices into the steep substrate. As at other Lehua sites, macroalgae were scarce, but turf algae and cyanophytes dominated the substrate. A diminutive (possibly because of grazing pressures?) species of *Dictyota* was rather ubiquitous, but most other macroalgae encountered were found in less than 20% of photoquadrats. These species included: *Dictyosphaeria versluisii*, *Jania* sp., and a species of *Sargassum*.

Table C-4 Algae of Lehua. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	LEH 1	LEH2	LEH3
Green algae			
<i>Derbesia fastigiata</i> (<i>Halicystis</i> stage)			8.33 4.0
<i>D. versluisii</i>			8.33 3.0
<i>Neomeris</i> spp.	25.00 3.7	33.33 2.8	
Red algae			
<i>Amansia glomerata</i>		8.33 4.0	
crustose coralline	83.33 2.7	16.67 3.0	16.67 4.0
<i>Jania</i> sp.			16.67 4.0
<i>Tolypocladia glomerulata</i>	*		
Brown algae			
Brown crust	25.00 3.7		
<i>Dictyota</i> sp.			91.67 3.1
<i>Lobophora variegata</i>	8.33	33.33	

	3.0	2.3	
<i>Padina</i> sp.	*		
<i>Sargassum</i> sp.	*		16.67 4.5
Blue-green algae	91.67 2.1	75.00 2.2	100.00 2.0
Algal turf	100.00 1.1	100.00 1.0	100.00 1.0

5. Molokai (Table C-5)

MOL-1, 7/31/05

This site is known as Kawakiunui; it is located on the west side of Molokai. Our transects were placed 100-200 meters offshore in 30-40 feet of water. The substrate was flat with little rugosity. The benthos was dominated by algae. The major contributors of this algal community mostly consisted of turf, blue green algae, *Microdictyon setchellianum*, *Halimeda discoidea*, and *Dictyosphaeria cavernosa*. There was little coral cover and fish biomass was minimal.

MOL-2, 8/1/05

This portion of the coastline is known as Kauhala; it is located on the southwestern side of Molokai. Our transects were placed 100-200 meters offshore in 30-40 feet of water. The substrate was similar to MOL-1 with a bit more rugosity, coral, and fish. The major contributors of this algal community consisted mostly of turf, blue green algae, and *Halimeda discoidea*.

MOL-3, 8/1/05

This site is known as Kanalukaha; it is located just west of Haleolono Harbor on the Island of Molokai. Our transects were placed 100-200 meters offshore in 30-40 feet of water. This reef was coral and algal dominant. Turf, coralline crustose algae, *Halimeda opuntia*, *Portieria hornemannii*, *Jania* sp., and *Tolypocladia glomerulata* were the dominate algae on this reef. Although not as abundant as the other algae, *Asparagopsis taxiformis* was obvious on the reef due to the large thalli of this population. Adjacent to the reef in 50 feet of water was a sand habitat dominated by *Halimeda kanaloana*. *Galaxaura marginata* was also abundant at the sand reef border. *Halimeda* segments were observed in the sand at this site.

MOL-4, 8/1/05

This site is known as Halena; it is located just east of Haleolono Harbor on the Island of Molokai. Our transects were placed 100-200 meters offshore in 30-40 feet of water. Although this reef seemed to be exposed to sedimentation event coral cover was quite high. Turf, coralline crustose algae, *Halimeda opuntia*, *Dotyella hawaiiensis*, *Jania* sp., and *Tolypocladia glomerulata* were the abundant algae on this reef. *Halimeda* segments were observed in the sand at this site.

Table C-5 Algae of Molokai. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	MOL1	MOL2	MOL3	MOL4
Green algae				
<i>Caulerpa racemosa</i>			*	
<i>Caulerpa serrulata</i>			*	
<i>Caulerpa webbiana</i>			8.33 5.0	
<i>Codium edule</i>	*			
<i>Dictyosphaeria cavernosa</i>	66.67 4.3	8.33 3.0		
<i>Halimeda discoidea</i>	83.33 3.4	50.00 3.5		
<i>Halimeda kanaloana</i>			*	
<i>Halimeda opuntia</i>			50.00 4.3	41.67 3.4
<i>Microdictyon setchellianum</i>	91.67 2.8	41.67 3.8		
<i>Neomeris annulata</i>	*	75.00 4.9	33.33 4.0	
<i>Rhipidosiphon javensis</i>		8.33 5.0		*
<i>Ventricaria ventricosa</i>				*
Red algae				
<i>Acanthophora pacifica</i>		*	*	*
<i>Actinotrichia fragilis</i>			*	
<i>Amansia glomerata</i>		8.33 4.0		8.33 2.0
<i>Asparagopsis taxiformis</i>		*	*	
<i>A. t. falk</i>				25.00 3.0
<i>Dasya iridescens</i>	*	*		
<i>Dasya pilosa</i>				*
<i>Dotyella hawaiiensis</i>				*
<i>Galaxaura</i> sp.		*		
<i>Galaxaura marginata</i>			*	
<i>Gibsmithia hawaiiensis</i>	*	*		
<i>Haloplegma dupperreyi</i>			*	
<i>Halymenia stipitata</i>		*		
<i>Jania</i> sp.	8.33 5.0		41.67 4.8	
<i>Laurencia</i> sp.	*			
<i>Laurencia parvipapillata</i>		*		
<i>Liagora</i> sp.		*		
<i>Martensia flabelliformis</i>			*	

	MOL1	MOL2	MOL3	MOL4
<i>Peyssonnelia inamoena</i>				8.33 2.0
<i>Portieria hornemannii</i>			75.00 3.4	8.33 3.0
<i>Spyridea filamentosa</i>	8.33 5.0			
<i>Tolypocladia glomerulata</i>			66.67 2.0	*
<i>Tricleocarpa fragilis</i>	*	8.33 4.0		
Brown algae				
<i>Dictyota</i> sp.	16.67 4.5	16.67 2.5		
<i>Padina</i> sp.	25.00 5.33			
Blue-green algae	75.00 2.33	58.33 2.6	16.67 2.0	
Algal turf	100.00 1.0	100.00 1.1	100.00 1.0	100.00 1.0
Coralline crustose algae		83.33 2.4	33.33 3.0	58.33 2.1

6. Lanai (see Table C-6)

LAN-1, 8/2/05

This site is known as Kaea, on the northwestern part of Lanai. Our transects were placed 50-100 meters offshore in 40-50 feet of water. The transects went over soft bottom. The dominate alga in this habitat was *Halimeda kanaloana*. There were little coral cover and minimal fish biomass, but the fish that was there were unique to this habitat. One of the most impressive features of this site was the giant wire coral.

LAN-2, 8/2/05

This site is known as Kaapahu, on the west side of Lanai. Our transects were placed in a cove created by a peninsula-like rock formation. They were 50-100 meters offshore in 35-45 ft of water. This site could be classified as a boulder field. Turf, coralline crustose algae, *Jania* sp., *Tolypocladia glomerulata*, and *Halimeda opuntia* were the most abundant algae at this site. There were decent numbers of fish. *Pocillopora meandrina* and *Porites lobata* were the dominant coral species.

LAN-3, 8/2/05

This site was just south of Kaunalapau Harbor, on the west side of Lanai. Our transects were 50-100 meters offshore of a 70-100-meter high cliff in 40-50 ft of water. The major structure of this reef was formed by boulders. Turf, blue green algae, *Neomeris annulata*, and *Jania* sp. were the most abundant algal species. There were decent numbers of fish. *Pocillopora meandrina* was the dominant coral specie.

LAN-4, 8/3/05

This site was just south Kapua, on the south side of Lanai. Our site was located about 100-200 meters offshore of a sandy beach in 40-50 ft of water. The reef could be considered a compressa reef with a gradual slope. Turf, coralline crustose algae, *Halimeda opuntia*, *Asparagopsis taxiformis* (“Falkenbergia” phase) were the most abundant algae species. Just off the reef at about 60 feet of water a dense *Halimeda kanaloana* meadow began.

LAN-5, 8/3/05

This site was just east of Kalaeokahano which is east of Manele bay, on the island of Lanai. Our site was located about 200-250 meters of shore in 35-45 ft of water. The reef could be considered a compressa reef with a little more than gradual slope. Our transect went around a pinnacle. Turf, coralline crustose algae, *Halimeda opuntia*, *Asparagopsis taxiformis* (“Falkenbergia” phase), *Rhipidosiphon javensis*, and *Jania sp.* were the most common algal species. Just off the reef in about 60-70 ft of water was a sparse *Halimeda kanaloana* meadow. While we were there a pod of spinners 60-80 strong made three passes.

LAN-6, 8/3/05

This site is known as Poopoo which is a little west of Manele bay, on the island of Lanai. Our site was located about 200-250 meters of shore in 35-45 ft of water. The first transect went over a compressa reef with a little more than gradual slope. The second transect was on a wall. The wall had an interesting and unique algal community. Large thalli of both *Padina melemele* and *Acanthophora pacifica* was quite common. At the base of the wall in about 50 ft of water *Galaxaura marginata* and *obtusata* were collected while just off the base a dense bed of *Halimeda opuntia* was present. Black coral and snow flake coral were also observed on the wall.

Table C-6 Algae of Lanai. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga’s relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	LAN-1	LAN-2	LAN-3	LAN-4	LAN-5	LAN-6
Green algae						
<i>Caulerpa racemosa</i>					8.33 4.0	
<i>Caulerpa webbiana</i>			8.33 7.0		*	
<i>Chlorodesmis caespitosa</i>				*	16.67 4.0	
<i>Codium edule</i>						
<i>Dictyosphaeria cavernosa</i>		*		8.33 5.0	*	
<i>Halimeda discoidea</i>		*				
<i>Halimeda</i>	41.67			*	*	

	LAN-1	LAN-2	LAN-3	LAN-4	LAN-5	LAN-6
<i>kanaloana</i>	1.6					
<i>Halimeda opuntia</i>		*	16.67 2.5	41.67 3.4	91.67 2.5	41.67 3.0
<i>Microdictyon umbilicatum</i>				*		
<i>Neomeris annulata</i>	*	16.67 5.0	50.00 4.0	25.00 5.0	25.00 5.0	8.33 5.0
<i>Rhipidosiphon javensis</i>		*	*	33.33 5.0	41.67 5.0	8.33 6.0
<i>Siphonocladus tropicus</i>				8.33 4.0	*	
<i>Ventricaria ventricosa</i>		*			*	
Red algae						
<i>Acanthophora pacifica</i>	*		*		*	*
<i>Actinotrichia fragilis</i>			*		8.33 4.0	
<i>Amansia glomerata</i>		16.67 4.0	*			*
<i>Amphiroa sp.</i>		8.33 4.0	8.33 2.0	25.00 4.0	16.66 4.0	16.67 4.0
<i>Asparagopsis taxiformis</i>		8.33 4.0			*	*
<i>A. t. falk</i>		16.67 4.0		50.00 2.7	50.00 3.3	8.33 3.0
<i>Dasya iridescens</i>	*			*	8.33 5.0	
<i>Dasya pilosa</i>						
<i>Dotyella hawaiiensis</i>				*	*	
<i>Galaxaura marginata</i>		*	*			*
<i>Galaxaura obtusata</i>						*
<i>Gibsmithia hawaiiensis</i>			*		*	*
<i>Jania sp.</i>	8.33 3.0	33.33 3.5	58.33 3.4	33.33 3.8	41.67 4.8	66.67 3.0
<i>Martensia flabelliformis</i>	*					
<i>Peyssonnelia sp.</i>					8.33 4.0	
<i>Portieria hornemannii</i>			*	16.67 4.5	16.67 4.5	*
<i>Tolypiocladia glomerulata</i>		41.67 2.6	16.67 6.5		8.33 5.0	8.33 2.0
Brown algae						
<i>Dictyota sp.</i>	8.33 3.0	8.33 4.0				8.33 5.0

	LAN-1	LAN-2	LAN-3	LAN-4	LAN-5	LAN-6
<i>Dictyota friabilis</i>		8.33 3.0	8.33 5.0			
<i>Lobophora varigata</i>			*			8.33 5.0
<i>Padina sp.</i>			8.33 3.0			
<i>Padina melemele</i>	*		8.33 3.0			*
Blue-green algae			58.33 2.3			
Algal turf	16.67 1.0	91.67 1.0	91.67 1.0	91.67 1.1	91.67 1.1	91.67 1.1
Coralline crustose algae	41.67 2.0	41.67 2.0	25.00 2.67	66.67 2.1	50.00 2.5	66.67 2.3
Branched coralline crustose algae		8.33 7.0				

7. Maui (see Table C-7)

MAI-4, 8/4/05

This site is known as Kamanamana which is located about 0.5 miles east of Keoneoio (Iperusse) Bay on the Island of Maui. Our site, 50-100-meter lava flow from Haleakala in 40-45 ft of water. This site was very sandy. Turf, *Hypnea valentiae*, and a Gelid species was the most abundant algae at this site. Coral cover and fish biomass were minimal at this site.

MAI-5, 8/4/05

This site is known as Kaluiahakoko which is located in the Kihei area on the Island of Maui. Our site was about 100 meters offshore in 35-40 ft of water on an offshore patch reef. Algal diversity was very low on the transects; this may be due to the high coral cover and abundance of urchins. The dominant algae at this site was turf, coralline crustose algae, and blue-green algae. Fish biomass at this site was minimal. A *Halimeda kanaloana* bed was found in 55 ft of water just off the reef.

MAI-6, 8/4/05

This site is known as Nahuna which is located in the Wailea area on the Island of Maui. Our site was 50-100 meters offshore in 20-30 ft of water. Our transects were adjacent to a basalt ridge. Although there was decent coral cover in the area, our transects were on sand and rubble. Turf, *Tolypocladia glomerulata*, and a Gelid species were the most common algal species at this site. The ridge itself was quite interesting. A green sea turtle, two frog fish, and the most snowflake coral I ever saw were observed on the ridge. This site was blessed with one of the largest *Halymenia formosa* thallus I have ever seen.

MAI-7 8/5/05

This site was located off north Kapalua on the northwest side of Maui. Our site was about 25-50 meters offshore in 45-55 ft of water. Our transects were adjacent to a basalt ridge. The first transect was on the ridge, while the second was adjacent to it. Turf, coralline crustose algae, and blue-green algae were the most common algae at this site.

MAI-8 8/5/05

This site is known as Launiupoko on the west side of Maui. Our site was about 100-200 meters offshore in 25-35 meters of water. This site had quite a diverse assemblage. We observed at least 30 identifiable algal species at this site. Turf, coralline crustose algae, blue-green algae, *Jania sp.*, and a Gelid species were the most abundant algae at this site. There was also a *Halimeda kanaloana* bed in about 60-70 ft of water just off the reef.

MAI-9 8/5/05

This site is known as Ukumehame on the west side of Maui. Our site was about 150-200 meters offshore in 40-45 ft of water. Although this reef was structurally similar to MAI-8 it seemed to be overrun with algae. *Tolypiocladia glomerulata* just covered the reef. I would suspect that there were a lack of urchins and/or an increased nutrient load. Even the *Halimeda kanaloana* bed located just off the reef in 55 ft of water was epiphytized by *Spyridea filamentosa*. There was also a robust *Peyssonnelia* morphology on the reef.

Table C-7 Algae of Maui. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	MAI-4	MAI-5	MAI-6	MAI-7	MAI-8	MAI-9
Green algae						
<i>Bryopsis sp.</i>		*				
<i>Caulerpa racemosa</i>		*			*	
<i>Caulerpa serrulata</i>	*				8.33 8.0	*
<i>Caulerpa webbiana</i>		*			*	*
<i>Codium edule</i>						
<i>Dictyosphaeria cavernosa</i>		*	*	8.33 6.0	8.33 4.0	8.33 4.0
<i>Halimeda discoidea</i>				8.33 5.0	8.33 2.0	16.67 4.5
<i>Halimeda kanaloana</i>		*		16.67 3.5	*	*
<i>Halimeda opuntia</i>		*	*	*	25.00 3.3	50.00 4.2
<i>Microdictyon setchellianum</i>				8.33 10.0		
<i>Neomeris annulata</i>	*		*	33.33	8.33	8.33

	MAI-4	MAI-5	MAI-6	MAI-7	MAI-8	MAI-9
				5.0	11.0	5.0
<i>Rhipidosiphon javensis</i>		*			16.67 5.5	33.33 5.0
<i>Ventricaria ventricosa</i>			*		*	*
Red algae						
<i>Actinotrichia fragilis</i>						*
<i>Amansia glomerata</i>	*	8.33 3.0	16.67 4.5	33.33 5.0	16.67 6.0	16.67 5.0
<i>Amphiroa sp.</i>			8.33 3.0	16.67 6.0	8.33 4.0	
<i>Asparagopsis taxiformis</i>			*		*	*
<i>A. t. falk</i>			8.33 4.0			16.67 5.5
<i>Dasya sp.</i>					8.33 2.0	
<i>Dasya iridescens</i>	8.33 3.0					*
<i>Galaxaura filamentosa</i>					*	
<i>Galaxaura marginata</i>			*	*		*
<i>Gelid</i>	50.00 2.0		33.33 3.8	8.33 6.0	41.67 3.2	
<i>Gibsmithia hawaiiensis</i>		*		8.33 11.0		*
<i>Haloplegma duperreyi</i>			*		*	8.33 3.0
<i>Halymenia formosa</i>	*		*			
<i>Hypnea valentiae</i>	16.67 2.0					
<i>Jania sp.</i>			25.00 3.3	33.33 4.3	50.00 4.0	
<i>Laurencia sp.</i>	16.67 3.5		8.33 6.0	25.00 3.3	16.67 4.5	8.33 7.0
<i>Laurencia parvipapillata</i>			*			
<i>Martensia flabelliformis</i>	8.33 4.0				*	
<i>Peyssonnelia sp.</i>						16.67 2.5
<i>Portieria hornemannii</i>				8.33 9.0		*
<i>Platoma ardreanum</i>	*	*				
<i>Spyridea filamentosa</i>			*			*
<i>Tolypiocladia</i>	*		91.67	25.00	16.67	91.67

	MAI-4	MAI-5	MAI-6	MAI-7	MAI-8	MAI-9
<i>glomerulata</i>			2.3	4.0	2.5	2.1
<i>Tricleocarpa fragilis</i>			*			
Brown algae						
<i>Dictyota sp.</i>	8.33 5.0		16.67 2.5	25.00 3.7	16.67 6.0	
<i>Dictyota friabilis</i>				16.67 5.0	*	
<i>Padina sp.</i>				8.33 8.0	*	*
Blue-green algae	8.33 2.0	50.00 1.8	33.33 3.5	41.67 3.2	16.67 2.0	50.00 4.5
Algal turf	100.00 1.0	100.00 1.8	100.00 1.0	100.00 1.3	100.00 1.0	100.00 1.0
Coralline crustose algae	8.33 2.0	100.00 1.8	33.33 2.5	91.67 1.7	58.33 2.6	50.00 3.0

8. Molokini (see Table C-8)

MOK-1 8/6/05

Our first site of the day was at the back side of Molokini Islet. The transects were directly offshore in 40-55 ft of water. Our dive was basically on a wall. We were lucky that the current was minimal. Turf and coralline crustose algae was the most common algae on the wall.

MOK-2 8/6/05

Our second site of the day started at west point of Molokini Islet and headed to the backside. The transects were 20 meters offshore in 40-55 ft of water. The substrate was at a 40 degree slope. Turf, coralline crustose algae, blue-green algae, *Microdictyon setchellianum*, and *Dictyota friabilis* were the most common algae at this site. There seemed to be a blue-green alga bloom in 20 ft of water at this site.

MOK-3 8/6/05

Our third site of the day was in Molokini Crater. Our transects were in the center of the crater in 45-50 ft. The substrate was basically flat. Our transect went through coral, sand, and rubble. Turf, coralline crustose algae, and blue-green algae were the most common algae at this site. Blue-green algae was diverse and abundant at this site.

Table C-8 Algae of Molokini. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviation of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	MOK-1	MOK-2	MOK-3
Green algae			
<i>Caulerpa serrulata</i>			8.33 4.0
<i>Dictyosphaeria cavernosa</i>	8.33 5.0		8.33 4.0
<i>Halimeda opuntia</i>		8.33 4.0	
<i>Microdictyon setchellianum</i>	*	41.67 3.0	*
<i>Neomeris annulata</i>	*	25.00 6.0	16.67 4.5
<i>Rhipidosiphon javensis</i>	8.33 3.0	8.33 7.0	16.67 4.5
<i>Ventricaria ventricosa</i>	*	*	*
Red algae			
<i>Amansia glomerata</i>	8.33 3.0		
<i>Amphiroa sp.</i>	16.67 4.0	8.33 6.0	
<i>Dasya iridescens</i>		*	
<i>Gelid</i>	8.33 5.0		
<i>Gibsmithia hawaiiensis</i>		8.33 5.0	*
<i>Jania sp.</i>	16.67 3.5		8.33 4.0
<i>Laurencia sp.</i>			*
<i>Laurencia parvipapillata</i>	*		
<i>Martensia flabelliformis</i>	8.33 4.0	*	
<i>Peyssonnelia sp.</i>	8.33 5.0		
Brown algae			
Brown crust		41.67 3.0	8.33 3.0
<i>Dictyota sp.</i>		25.00 5.0	25.00 4.7
<i>Dictyota friabilis</i>	16.67 3.5	58.33 3.6	8.33 4.0
<i>Lobophora varigata</i>	*	*	
<i>Padina sp.</i>		8.33 5.0	

	MOK-1	MOK-2	MOK-3
<i>Sargassum sp.</i>	16.67 5.0		
Blue-green algae	83.33 3.0	83.33 3.1	91.67 2.5
Algal turf	91.67 1.1	91.67 1.3	91.67 1.0
Coralline crustose algae	91.67 1.1	75.00 3.0	75.00 2.6

Appendix D: **Macroinvertebrate Rapid Ecological Assessment (REA) Team Activity Summary**
(*Scott Godwin and Ranya Hensen*)

Introduction

Surveys focusing on marine invertebrates other than corals were performed in conjunction with surveys of coral and macroalgae, collectively termed the benthic survey. This benthic survey was conducted collaboratively with fish surveys. This report will cover the non-coral invertebrates encountered and from this point forward any mention of marine invertebrates will mean this particular group.

Methods

Quantitative counts for specific target marine invertebrates were done along two separate 2X25 meter belt transects. This was followed by two 10X25 meter quadrat surveys accomplished by swimming a zigzag search pattern. A quadrat survey was conducted in conjunction with both 2X25 transects, which were used as the reference line for the long axis. The counts from these two 10X25 quadrats were combined into a single 10X50 meter area. Additionally, ten .25m² quadrats were enumerated for each 2X25 meter belt transect to determine the average percent cover of certain sessile target species or for subsampling large populations of mobile species (e.g., boring urchins).

Based on data from previous rapid ecological assessments, a group of target species was chosen for quantitative counts. The species in this list were chosen because they have been shown to be common components of the reef habitats of the central and southern Pacific, and they are species that are generally visible (i.e., non-cryptic) and easily enumerated during the course of a single 50-60-minute SCUBA survey.

These target species were:

CNIDARIA

Zoanthids – rubber corals

Actiniaria – Anemones

Hydrocorals – Lace corals

ECHINODERMS

Echinoids – sea urchins

Holothuroids – sea cucumbers

Asteroids – sea stars

MOLLUSCA

Bivalves – ark shells, spondylid oysters, pearl oysters, tridacnid clams

Nudibranchs – sea slugs

Gastropods – snails

Cephalopods - octopus

CRUSTACEA

hermit crabs, lobsters, large crabs and shrimp

Collections of species that could not be identified in the field and samples of coral rubble were brought back to the laboratory on the research vessel. The cryptic organisms found in the rubble were picked out and preserved and the sand samples were dried and bagged so they could be examined for micro-mollusks at a later date.

Site Surveys

Total survey sites: 50

Oahu

OAH-2

7/14/05

Kaena Point

Combined boulder and carbonate pavement habitat with occasional raised pinnacles that were 5 m at their highest. The boring urchins *Echinometra mathaei* and *Echinostrephus aciculatus* were common, as were the larger echinoids *Echinothrix calamaris*. On the pinnacles, there were far more species than on the pavement and boulder habitat. The pinnacles had sponges of the genus *Clathria* and *Stylinos*, didemnid tunicates, cowries, nudibranchs, and the starfish *Acanthaster planci*.

OAH-3

7/22/05

Dillingham

Northwest side of island, offshore from Dillingham Airfield. Spur and groove reef system separated by moderately deep sand channels; depths ranged from 55 to 65 feet. Low macroinvertebrate abundance overall, with boring urchins being the most common. Overhangs on the slopes of the spurs contained sponges from the genus *Hyrtilis* and *Clathria* and a yellow tunicate from the genus *Didemnum*.

OAH-4

7/22/05

Makua

Flat pavement reef off Makua Valley. Most of the pavement was covered with cyanobacteria and algal turf and had numerous holes and loose rock that provided cryptic habitat for numerous macroinvertebrates. There were many species of macroinvertebrate species such as the bivalves *Arca ventricosa* and *Pinctada margaritifera*, octopus, lobster, hermit crabs, and various echinoderms.

OAH-5

7/22/05

Makaha

Site located off Makaha valley. There was much vertical relief, rubble, and overhangs with fine sand substrate. The majority of macroinvertebrate diversity was located on the upper slopes of the vertical structures. Rare unique species, such as *Cypraea tigris* and a variety of sponges were located within cave and overhang structures.

OAH-6

7/23/05

Kualoa

Windward side of Oahu offshore from Kualoa. The site was a flat pavement reef habitat with dense algal coverage. Corals and fish were relatively scarce and macroinvertebrates were very cryptic and low in abundance.

OAH-7

7/23/05

Punaluu

Site was located offshore from Punaluu and consisted of carbonate pinnacles with steep slopes. The top of the pinnacles had low growing coral and cryptic macroinvertebrates. The slopes had wire corals, urchins, and lobster in abundance.

OAH-8

7/23/05

Waialeale

Relatively flat pavement reef offshore from Sunset Beach with scarce fish and corals. There was a low abundance of macroinvertebrates and species such as the hermit crab *Calcinus laurentae*, and various gastropods were located within cryptic locations under rocks and in holes.

OAH-9

7/24/05

3 Miles SE of Turtle Bay

A coral pinnacle site identified by the towboard survey as having large numbers of Crown-of-Thorns starfish. This pinnacle had high coral cover and a diversity of macroinvertebrates. The abundance of *Acanthaster* was large but not unusual compared to other aggregations of this type. This concentration of *Acanthaster* was also not uniform across the site and was more prominent along the western side and base of the pinnacle.

OAH-10

7/24/05

Haliewa

OAH-11

7/24/05

Mokuleia

Sites with pinnacles and spur and groove with similar species makeup. Overall abundance of macroinvertebrates is low but diversity is quite high. A variety of gastropod mollusks, hermit crabs, and echinoderms were present.

Kauai

KAU-1,2

7/15/05

These two sites had the same habitat and species makeup. The carbonate pavement that dominated these sites was inhabited by boring urchins and cone shells.

KAU-3

7/15/05

Kilauea Point

This site was due north of the point in 35 feet of water. Variable habitat made up of boulders, carbonate pavement, overhangs, and caves. In the open areas there was little to be seen. Under ledges and within caves there was a high abundance of the sponge *Hyrtios*.

KAU-4

7/16/05

Nawiliwili

Due north off the harbor entrance. This was a boulder field with sparse coverage of Pocillopora corals and sand substrate. The dominant macroinvertebrates were zoanthids and cone shells. The zoanthid was *Palythoa caesia*, and the cones shells were *Conus lividus* and *Conus flavidus*. There was a rare occurrence of the Tiger Cowrie *Cypraea tigris*. The sea star *Acanthaster planci* was occasional at this site.

KAU-5

7/16/05

Hanapepe

Shallow reef area due west of the point that was composed of boulders and carbonate pavement and fronted by a broad sand expanse beginning at 30 feet deep. Zoanthids and the octocoral *Sarcothelia edmondsoni* were quite common.

KAU-6

7/16/05

Port Allen

Carbonate pavement with healthy growth of Pocillopora, Montipora, and Porites at the edge of a slope located due west of Port Allen. This site has diverse and abundant macroinvertebrates. The sponge *Spirastrella vagabunda* was quite common throughout the site, and trapezid crabs within the Pocillopora spp. were quite numerous. The echinoid *Echinothrix calamaris* was very abundant, while holothuroids were only occasional.

KAU-7

7/20/05

Haena

KAU-8

7/20/05

4 miles W
of Haena

KAU-9

7/20/05

East of Barking Sands

These three sites were all similar in habitat and species composition. These are high-energy sites with mostly sand substrate with fingers of rock projecting out from the cliff faces. The dominant macroinvertebrate type at these sites was sponges. The common sponge at all three sites was the boring species *Spirastrella*. The rock substrate was the location of all the species recorded, and most were located in holes and under ledges.

KAU-10

7/21/05

Missile Range

Due south of the southern boundary of the southern end of the Pacific Missile Range. The primary habitat was low rock structures with sand channels. The uppermost part of this habitat was populated by two boring sponge species: *Spirastrella* and *Hamigera*. Ledges and overhangs contained cleaner shrimps and other sponge species such as *Hyrtios* and *Clathria*.

KAU-11 KAU-12
 7/21/05 7/21/05
 Kekaha Pahala

These two sites were similar in habitat and species composition. These sites were composed of hard substrate covered with a fine layer of silty sand. There was a large variety of macroinvertebrate species and sponges, and bryozoans were the dominant organisms. Nudibranch species were also quite common and three species were common: *Halgerda terramtuensis*, *Phyllidia varicosa* and *Chromodoris albopustulosa*.

Niihau

NII-1
 7/17/05
 Poleho

Northeast side in 45 feet of water with boulder and sand habitat. The site is dominated by the urchin *Echinothrix calamaris* and the sea star *Linckia multifora*, and there is a rare occurrence of the corallivorous sea star *Acanthaster planci*. There were also a rare occurrence of the octocoral *Sinularia densa*.

NII-2
 7/17/05
 Kalaloa Valley

This site was composed of carbonate pavement covered with dense turf algae. There were few obvious macroinvertebrates other than gastropods and sponges. The gastropods were mostly cone shells and there were two sponge species present: *Spirastrella vagabunda* and an unknown Spongiidae, likely *Dactylospongia*.

NII-3
 7/17/05
 Kowahi

A site on the southeastern side of the island composed of carbonate pavement. There were few small dead and live coral heads that provided small islands of life for sessile invertebrate fauna, such as tunicates. Two sponge species were common throughout the site. One species appears to be an axinellid species that looked like *Reniochalina*, and the other is an unknown purple species that grew closely to the substrate.

NII-4
 7/19/05
 Puu Okoae

Site composed of pavement and slabs and small boulders. The site had a very high abundance of echinoderms, especially echinoids. There was a great abundance of gastropods under loose rock. There was an unknown anemone recorded underneath rocks but this was rare.

NII-5

7/19/05

Puu Wai

The habitat was made up of large boulders and many overhangs were present. Overall abundance of macroinvertebrates was low at this site. There were rare occurrences of holothuroids and an unidentified white sponge, which was growing on the undersides of boulders.

NII-6

7/19/05

Pahau (SW Side)

A combination of large boulders and expansive sand defined this site. There was little in the way of macroinvertebrate abundance. There were rare occurrences of gastropods and holothuroids and echinoids.

Lehua Island

LEH-1

7/18/05

Southeast Side

Very complex habitat composed of large rock slabs and sand patches. There was an abundance of echinoids, and the two hermit crabs *Calcinus laurentae* and *Calcinus elegans* were common. An unknown yellow boring sponge was common in most dead coral heads and rock outcrops. The most common species of macroinvertebrates were boring urchins, while sea stars were rare.

LEH-2

7/18/05

East side inside crater

Solid pavement with large cracks and high wall were the habitat of this site. The wall had large boulders at its base and the wall itself was covered with old and active depressions of boring urchins. These depressions provided habitat for crustaceans and sponges. A steep slope existed behind this wall and it harbored boring urchins and zoanthids. The cushion sea star *Culcita novaeguinea* was occasional in this habitat.

LEH-3

7/18/05

West side

Steeply sloping substrate with many depressions created by differential solution and boring urchins. There was quite an abundance of boring urchins throughout the site. The banded coral shrimp *Stenopus hispidus* was common throughout, and the wire coral *Cirrhopathes anguina* and the sea star *Thromidia catalai* were rare.

Molokai

MOL-1

7/31/05

Kawakiunui

Flat sandy reef habitat with intermittent depressions and holes. The most numerous macroinvertebrate were the urchins *Tripneustes gratilla* and *Echinostrephus calamaris*. There were also numerous banded coral shrimp (*Stenopus hispidus*). There was a rare occurrence of an unidentified green sponge within the depressions.

MOL-2

8/1/05

Kaunala

Algal dominated coral reef community with moderate relief and high rugosity. The site was dominated by hermit crabs and nudibranchs. The hermit crabs were *Calcinus laurentae*, *Calcinus hazletti*, *Dardanus sanguinocarpus*, and *Ciliopagurus strigatus*. The nudibranchs were *Halgerda terramtuentus*, *Glossodoris rufomarginata*, *Phyllidiella pustulosa*, *Flabellina bicolor*, Haminoea sp. and an unknown species.

MOL-3

8/1/05

Kanalukaha

High coral cover with few macroinvertebrates. The dominant macroinvertebrate was an unknown Green sponge with yellow interior tissue.

MOL-4

8/1/05

Halena

Extremely high coral cover with few macroinvertebrates. There was occasional occurrence of both *Palythoa caesia* and *Zoanthus* cf. *pacificus*.

Lanai

LAN-1

8/2/05

Kaea

Sand expanse with *Halimeda* and closely associated coral "islands" that were occasional. The "islands" had a moderate cover of sponges, including a cryptic yellow species. The Antipatharian coral *Cirrhopathes anguina* was quite common, as was *Spirastrella* and *Stylinos*. The area receives a fine load of sediment that appears to smother some of the sessile species present.

LAN-2

8/2/05

Kaapahu

Composed of large boulders and small rock and coral rubble. High coral cover and a variety of sponges, mollusks, and crustaceans were present.

LAN-3

8/2/05

Kaunalapali

Same as LAN-2

LAN-4

8/3/05

A coral reef area with associated sand expanse that was composed of *Porites lobata*, *Porites compressa* and *Montipora*. There were numerous *Tripneustes gratilla* and *Echinothrix calamaris* urchins throughout and the rare occurrence of *Chondrocidaris gigantea* in deeper areas. There was a single individual of a holothuroid from the genus *Stichopus* present and *Holothuria atra* was occasional. *Acanthaster planci* was present but rare at the site.

LAN-5

8/3/05

Manele Bay

Pinnacle to the north of the bay entrance dominated by *Porites lobata*, *Porites compressa*, and *Pocillopora meandrina*. There were abundant hydroids (*Gymnangium hians*) and the rare occurrence of *Chondrocidaris* and *Echinothrix* urchins. An unknown species of the tunicate *Aplidium* was present but rare. The sponge *Clathria* was common, as was the boring species *Spirastrella*.

LAN-6

8/3/05

West of Manele Bay

Porites compressa and *Pocillopora meandrina* were the dominant coral species in this diverse habitat. Unique wall habitats were home to the black coral *Antipathes* and the octocoral *Carijoa rissei*.

Maui

MAI-4

8/4/05

Kamanamana

Dominated by rock and sand with sparse coral cover. Very few macroinvertebrate species existed at the site other than a few species of urchins and the boring sponge *Spirastrella*.

MAI-5

8/4/05

Kalua'ehakoko Pt

This was an isolated reef area surrounded by sand expanses that was dominated by *Porites compressa*, *Porites lobata*, and *Montipora*. The urchins *Tripneustes gratilla* and *Heterocentrotus mammilatus* were the dominant macroinvertebrate species throughout the site. A rare occurrence of the black lip pearl oyster *Pinctada margaritifera* was recorded. An unknown gray sponge was present but very rare.

MAI-6

8/4/05

Nahuna Pt

An isolated coral reef habitat composed of fingers of carbonate structure with caves and overhangs, and coral mounds and rubble existed between these fingers. There were large numbers of the urchins *Echinothrix calamaris*, *Tripneustes gratilla*, and *Heterocentrotus mammilatus*. The alien octocoral *Carijoa riisei* was common within cave habitats.

MAI-7

8/5/05

West Maui, NW side

Small isolated pinnacles with high abundance and diversity of macroinvertebrates. The dominant species were the urchins *Tripneustes gratilla* and *Echinothrix calamaris*. There was also high coverage of the sponge *Clathria* and abundant *Arca ventricosa* bivalves. The slipper lobster *Parabacus antarticus* was noted to be abundant under ledges.

MAI-8

8/5/05

Launiupoko Pt.

MAI-9

8/5/05

Ukumehame

Pinnacles with high coral cover but low abundance of macroinvertebrates. There was a rare occurrence of the Triton's Trumpet snail *Charonia* and octopus. The most abundant macroinvertebrate was the sacoglossan sea slug *Plakobranchus ocellatus*.

Molokini

MOK-1

8/6/05

East Side

This was a wall habitat with steep drop-off that is exposed to strong currents. The habitat was dominated by the sponge *Clathria*. There were abundant *Echinothrix calamaris* urchins and the occasional occurrence of *Diadema paucispinum*. At the higher levels of the wall beginning at 15 feet deep, the hydroid *Dynamena* was very abundant. The antipatharians *Antipathes sp* and *Cirrhopathes anguina* were present at depths of 40 or more feet.

MOK-2

8/6/05

SW side

Coral slope with abundant *Echinothrix calamaris* and *Heterocentrotus mammilatus* urchins. The antipatharian *Cirrhopathes anguina* was present at depths of 30 feet and greater. The gastropod *Cypraea tigris* was abundant at this site.

MOK-3

8/6/05

Central crater

Coral and sand area with very little macroinvertebrate abundance. There were rare occurrences of the urchins *Echinothrix calamaris* and *Chondrocidaris gigantea* and the holothuroid *Holothuria atra*.

Specific Findings

Below are tables reporting the findings of the inventory for species identified in the field and the relative abundance data for the most common species, which are echinoderms, and the average percent cover of zoanthids and sponges.

Oahu

The reef habitats surveyed varied in their species composition and structure. Most sites surveyed were classic reef pavement that had boring urchins as the dominant macroinvertebrate. Sites along the north shore and a single site at Punaluu on the windward side had either complex rubble or pinnacle habitats. An aggregation of *Acanthaster planci* was noted at a site on the north shore near Turtle Bay. Additional sites within this area would have to be surveyed to determine whether this is a large aggregation event. Although the site had numerous *Acanthaster*, they were not uniformly distributed. The average abundance across two (2X25m) belt transects was $.35/m^2$, while the average for two swim quadrats (10X25) was $.20/m^2$. This is high in comparison to other Oahu sites surveyed but *Acanthaster* populations tend to be patchy in their distributions, and the presence of this feeding aggregation is not unusual.

Oahu Inventory

Island	Oahu	Oahu	Oahu	Oahu	Oahu	Oahu	Oahu	Oahu	Oahu	Oahu
Date	7/14/05	7/22/05	7/22/05	7/22/05	7/23/05	7/23/05	7/23/05	7/24/05	7/24/05	7/24/05
Site	OAH-02	OAH-3	OAH-4	OAH-5	OAH-6	OAH-7	OAH-8	OAH-9	OAH-10	OAH-11
Depth(feet)	45	62	41	50	50	65	40	65	67	65
Habitat	Boul/Pave	Spur& groove	rub/pave	rub/pave	Pave	Pinnacle	pavement	Pinnacle	Pinnacle	spur& groove
CNIDARIA										
Hydrozoa	2	1	0	0	1	0	0	1	0	0
Actiniaria	0	0	1	0	0	0	0	0	0	0
Zoantharia	1	1	0	0	1	1	1	1	1	1
Octocorallia	0	1	1	1	1	1	0	3	1	1
Antipatharian	0	0	0	0	0	1	0	1	0	0
ANNELIDA	1	1	2	1	2	2	2	2	2	2
PLATYHELMINTHES	0	1	1	0	0	0	0	0	0	0
MOLLUSCA										
Gastropoda	5	5	8	6	7	2	7	3	11	6
Bivalvia	3	2	3	2	1	1	0	2	1	2
Cephalopoda	0	0	1	1	0	1	0	1	0	0
CRUSTACEA	3	5	8	8	5	6	3	8	6	10
ECHINODERMATA										
Asteroidea	1	0	1	0	0	2	0	3	1	2
Ophiuroidea	2	3	4	2	3	3	3	3	2	2
Echinoidea	6	5	6	5	5	5	5	5	4	4
Holothuroidea	1	1	2	2	2	3	1	1	1	1
BRYOZOA	1	1	1	1	1	2	1	2	1	2
PORIFERA	1	6	1	6	3	2	3	5	3	5
UROCHORDATA	3	2	1	1	1	0	0	0	2	0
Grand Total	30	35	41	36	33	32	26	41	36	38

Relative Abundance of Echinoderms and %Cover Sponges-Oahu

Island	Oahu									
Date	7/14/05	7/22/05	7/22/05	7/22/05	7/23/05	7/23/05	7/23/05	7/24/05	7/24/05	7/24/05
Site	OAH-2	OAH-3	OAH-4	OAH-5	OAH-6	OAH-7	OAH-8	OAH-9	OAH-10	OAH-11
	%Cover									
Porifera (%Cover)	0	0.025	0	0	1.1	1.5	0	1.5	0.675	0
	Avg#/m ²									
Echinodermata-Echinoids										
Echinostrephus	0.35	0.09	0.01	0.04	0	0	0.06	0.01	0.03	0.06
Echinometra sp.	0.39	0.04	0	0.01	0	0	0	0	0.05	0
Echinothrix sp.	0.03	0.06	0.07	0.04	0	0	0	0.1	0	0.01
Heterocentrotus	0	0	0	0.01	0	0	0	0	0	0
Tripneustes	0.012	0.03	0.05	0.03	0	0	0	0	0	0
Diadema	0	0	0.02	0	0	0	0	0	0	0
Pseudobolentia	0	0	0	0	0	0	0	0	0	0
Other Echinoid	0	0	0	0	0	0	0	0	0	0
Echinodermata-Holothuroids										
Holothuria atra	0	0	0	0	0	0	0	0.02	0	0
Holothuria whitmaei	0	0	0.01	0	0	0	0	0	0	0
Actinopyga obesa	0	0	0	0	0	0	0	0	0	0
Actinopyga mauritiana	0	0	0	0	0	0	0	0	0	0
Other Holothuroid	0	0	0	0	0	0	0	0	0	0
Echinodermata-Asteroidea										
Linckia multifora	0	0	0	0	0	0	0	0	0	0
Linckia guildingi	0	0	0	0	0	0	0	0	0	0
Acanthaster planci	0.002	0	0	0	0	0	0	0.35	0	0.02
Mithrodia fisheri	0	0	0	0	0	0	0	0	0	0.01

Kauai

Most of the habitats surveyed on Kauai had low coral cover and were mostly sand substrate with rock substrate and occasional low spur and groove. The most common macroinvertebrate feature at all site were sponges. The density of sponges was rarely great except for unique habitats such as ledges and caves. There were many species that were unknown and will require continued work for identification.

Kauai Inventory

Island	Kauai	Kauai	Kauai	Kauai	Kauai	Kauai	Kauai	Kauai	Kauai	Kauai	Kauai	Kauai
Date	7/15/05	7/15/05	7/15/05	7/16/2005	7/16/2005	7/16/2005	7/20/05	7/20/05	7/20/05	7/21/05	7/21/05	7/21/05
Site	KAU-1	KAU-2	KAU-3	KAU-4	KAU-5	KAU-6	KAU-7	KAU-8	KAU-9	KAU-10	KAU-11	KAU-12
Depth(feet)	45	52	35	34	25	50	42	50	55	45	50	55
Habitat	Pave	Pave	Boul/Pave	Boulder	Boul/Sand	Pave	sand/rock	sand/rock	sand/rock	sand/rock	sand/rock	sand/rock
CNIDARIA												
<i>Hydrozoa</i>	0	0	0	0	0	0	0	0	1	1	0	0
<i>Actiniaria</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Zoantharia</i>	1	1	1	1	2	1	0	1	1	1	0	0
<i>Octocorallia</i>	0	0	0	0	1	1	0	0	0	0	1	1
<i>Antipatharian</i>	0	0	0	0	0	0	0	0	0	0	1	0
ANNELIDA	1	1	1	1	2	1	0	1	1	1	1	2
PLATYHELMINTHES	0	0	0	0	1	0	0	0	1	0	0	0
MOLLUSCA												
<i>Gastropoda</i>	6	4	1	5	7	7	0	2	5	3	6	4
<i>Bivalvia</i>	1	0	0	0	0	0	0	1	0	0	0	0
<i>Cephalopoda</i>	0	0	0	0	0	0	0	0	0	0	1	1
CRUSTACEA	3	1	2	5	3	9	1	4	3	3	6	5
ECHINODERMATA												
<i>Asteroidea</i>	0	1	2	1	1	2	0	0	0	0	0	0
<i>Ophiuroidea</i>	2	2	2	0	2	2	0	1	2	1	1	2
<i>Echinoidea</i>	4	3	2	4	4	4	0	1	2	3	4	5
<i>Holothuroidea</i>	0	0	1	2	2	3	0	0	0	1	0	0
BRYOZOA	0	0	0	0	1	3	0	0	1	0	2	2
PORIFERA	1	1	4	1	4	3	0	4	2	5	1	3
UROCHORDATA	2	2	3	1	1	2	0	2	0	0	1	0
Grand Total	21	16	19	21	31	38	1	17	19	19	25	25

Relative Abundance of Echinoderms and % Cover Sponges-Kauai

Island	Kauai											
Date	7/15/05	7/15/05	7/15/05	7/16/2005	7/16/2005	7/16/2005	7/20/2005	7/20/2005	7/20/2005	7/21/2005	7/21/2005	7/21/2005
Site	KAU-1	KAU-2	KAU-3	KAU-4	KAU-5	KAU-6	KAU-7	KAU-8	KAU-9	KAU-10	KAU-11	KAU-12
	% Cover											
Porifera (%C)	0.675	0.675	0.25	0.2	0.35	1.6	1.925	0.775	0.65	1.7	12.775	1.4
	Avg#/m ²											
Echinodermata-Echinoids												
Echinostrephus	0	0.02	0.03	0.12	0	0	0	0	0	0	0	0
Echinometra sp.	0.12	0	0	0.01	0	0	0	0	0.02	0	0	0
Echinothrix sp.	0	0.01	0.01	0	0.008	0.03	0	0	0	0	0	0
Heterocentrotus	0	0	0	0	0	0	0	0	0	0	0	0
Tripneustes	0	0	0	0	0	0	0	0	0	0	0	0.02
Diadema	0	0	0	0	0	0.05	0	0	0	0	0	0
Pseudobolentia	0	0	0	0	0	0	0	0	0	0	0	0
Other Echinoid	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata-Holothuroids												
Holothuria atra	0	0	0.002	0.002	0	0.004	0.004	0	0	0	0	0
Holothuria whitmaei	0	0	0	0	0	0.004	0	0	0	0	0	0
Actinopyga obesa	0	0	0	0	0	0.004	0	0	0	0	0	0
Actinopyga mauritiana	0	0	0	0	0.002	0	0	0	0	0	0	0
Other Holothuroid	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata-Asteroidea												
Linckia multifora	0	0	0	0	0	0	0	0	0	0	0	0
Linckia guildingi	0	0	0	0	0	0	0	0	0	0	0	0
Acanthaster planci	0	0	0	0.01	0	0	0	0	0	0	0	0
Mithrodia fisheri	0	0	0	0	0	0	0	0	0	0	0	0

Niihau/Lehua

Boulder habitat was very common at these two locations but there was also classic carbonate pavement with varying degrees of slope. Niihau habitats had gradually sloping topography while Lehua had more drastic changes. Unique assemblages of sponges were recorded at one site on the southeastern side of Niihau (NII-3), while the site within the crater of Lehua had a unique wall habitat with diverse invertebrate assemblages.

Niihau/Lehua Inventory

Island	Niihau	Niihau	Niihau	Lehua	Lehua	Lehua	Niihau	Niihau	Niihau
Date	7/17/05	7/17/05	7/17/05	7/18/05	7/18/05	7/18/05	7/19/05	7/19/05	7/19/05
Site	NII-1	NII-2	NII-3	LEH-1	LEH-2	LEH-3	NII-4	NII-5	NII-6
Depth(feet)	40	30	45	45	55	66	41	32	50
Habitat	Boul/Sand	Pave/Turf	Pave	Boulder	Boulder	Boulder	Pave/Boul	Boulder	Boulder
CNIDARIA									
<i>Hydrozoa</i>	0	0	1	1	0	0	0	1	1
<i>Actinaria</i>	1	0	1	0	0	0	1	0	0
<i>Zoantharia</i>	1	1	1	1	1	0	1	1	1
<i>Octocorallia</i>	2	0	0	0	1	0	0	0	0
<i>Antipatharian</i>	0	0	0	0	0	0	0	0	0
ANNELIDA	1	0	0	2	1	2	1	1	1
PLATYHELMINTHES	0	0	0	0	0	0	0	1	0
MOLLUSCA									
<i>Gastropoda</i>	3	2	0	10	6	7	5	3	4
<i>Bivalvia</i>	1	0	0	1	2	1	1	1	0
<i>Cephalopoda</i>	1	1	0	0	0	0	0	0	0
CRUSTACEA	7	1	4	4	4	5	5	1	1
ECHINODERMATA									
<i>Asteroidea</i>	2	0	0	2	0	2	1	0	1
<i>Ophiuroidea</i>	3	0	1	0	1	0	2	2	1
<i>Echinoidea</i>	6	1	0	4	4	5	6	4	3
<i>Holothuroidea</i>	2	0	1	2	1	1	3	2	2
BRYOZOA	0	0	1	0	0	0	0	0	0
PORIFERA	3	2	6	2	1	2	2	1	1

UROCHORDATA	0	0	3	1	0	1	0	0	0
Grand Total	33	8	19	30	22	26	28	18	16

Relative Abundance of Echinoderms and % Cover Sponges-Niihau/Lehua

Island	Niihau	Niihau	Niihau	Lehua	Lehua	Lehua	Niihau	Niihau	Niihau
Date	7/17/05	7/17/05	7/17/05	7/18/05	7/18/05	7/18/05	7/19/05	7/19/05	7/19/05
Site	NII-1	NII-2	NII-3	LEH-1	LEH-2	LEH-3	NII-4	NII-5	NII-6
	% Cover								
Porifera (%C)	1.25	5.6	4.05556	0	0.075	0.15	0.25	0.2	0
	Avg#/m ²								
Echinodermata-Echinoids									
Echinostrephus	0.24	0	0	0	0.52	4	1.6	1	0.24
Echinometra sp.	0.1	0	0	0	0.24	15.25	25	0	0
Echinothrix sp.	0.118	0	0	0.004	0	0	0.026	0.004	0
Heterocentrotus	0	0	0	0	0	0.002	0.012	0	0
Tripneustes	0	0	0	0	0	0	0.018	0.002	0
Diadema	0	0	0	0	0	0	0	0	0
Pseudobolentia	0	0	0	0	0	0	0	0	0
Other Echinoid	0	0	0	0	0	0	0	0	0
Echinodermata-Holothuroids									
Holothuria atra	0.01	0	0	0	0	0	0.04	0	0
Holothuria whitmaei	0.006	0	0	0	0.02	0.02	0	0.004	0.02
Actinopyga obesa	0	0	0	0	0	0	0	0	0
Actinopyga mauritiana	0	0	0	0	0	0	0	0	0
Other Holothuroid	0	0	0	0	0	0	0	0	0
Echinodermata-Asteroidea									
Linckia multifora	0.028	0	0	0	0	0	0	0	0.02
Linckia guildingi	0	0	0	0.002	0	0	0	0	0
Acanthaster planci	0.002	0	0	0	0	0	0.002	0	0
Mithrodia fisheri	0	0	0	0	0	0	0	0	0

Molokai

Only four sites were surveyed on Molokai: two sites on the west side and two sites on the southwest side. The two west side sites had low coral cover and abundant algae, and the dominant macroinvertebrates were gastropods and hermit crabs. The southern shore sites were coral dominated with very few macroinvertebrate species other than sponges. These high coral cover sites also had a high level of silt, which did not appear to inhibit coral growth.

Molokai Inventory

Island	Molokai	Molokai	Molokai	Molokai
Date	7/31/05	8/1/05	8/1/05	8/1/05
Site	MOL-1	MOL-2	MOL-3	MOL-4
Depth(feet)	38	36	55	56
Habitat	pave/sand	Coral/algae	Coral/sand	Coral/sand
CNIDARIA				
<i>Hydrozoa</i>	0	1	0	1
<i>Actinaria</i>	0	0	0	0
<i>Zoantharia</i>	0	1	1	2
<i>Octocorallia</i>	0	1	1	1
<i>Antipatharian</i>	0	0	0	0
ANNELIDA	1	1	1	1
PLATYHELMINTHES	0	0	0	0
MOLLUSCA				
<i>Gastropoda</i>	3	6	4	4
<i>Bivalvia</i>	2	3	1	1
<i>Cephalopoda</i>	1	1	0	0
CRUSTACEA	4	10	2	3
ECHINODERMATA				
<i>Asteroidea</i>	0	0	0	0
<i>Ophiuroidea</i>	1	1	1	0
<i>Echinoidea</i>	4	2	2	4
<i>Holothuroidea</i>	0	0	0	0
BRYOZOA	0	1	0	0

PORIFERA	4	4	1	0
UROCHORDATA	0	2	0	0
Grand Total	20	34	14	17

Relative Abundance of Echinoderms and % Cover Sponges-Molokai

Island	Molokai	Molokai	Molokai	Molokai
Date	7/31/05	8/1/05	8/1/05	8/1/05
Site	MOL-1	MOL-2	MOL-3	MOL-4
	%Cover	%Cover	%Cover	%Cover
Porifera (%C)	0.9	2.8	0	0
	Avg#/m ²	Avg#/m ²	Avg#/m ²	Avg#/m ²
Echinodermata-Echinoids				
Echinostrephus	0.05	0.6	0	0
Echinometra sp.	0	1	0	0
Echinothrix sp.	0.01	0.03	0	0.002
Heterocentrotus	0	0	0	0
Tripneustes	0.02	0	0	0.002
Diadema	0	0	0	0
Pseudobolentia	0	0	0	0
Other Echinoid	0	0	0	0
Echinodermata-Holothuroids				
Holothuria atra	0	0	0	0
Holothuria whitmaei	0	0	0	0
Actinopyga obesa	0	0	0	0
Actinopyga mauritiana	0	0	0	0
Other Holothuroid	0	0	0	0
Echinodermata-Asteroidea				
Linckia multifora	0	0	0	0
Linckia guildingi	0	0	0	0
Acanthaster planci	0	0	0	0
Mithrodia fisheri	0	0	0	0

Lanai

A diverse set of habitats were surveyed that included coral, boulder, and sand expanses. The sand expanses typically had a large population of *Halimeda* macroalgae. Most sites were dominated by the corals *Porites compressa* and *Montipera*. Macroinvertebrate populations were diverse but not abundant. A rare occurrence of an undescribed holothuroid species *Stichopus sp.* was recorded in water of 35 feet deep. Possibly endemic, this *Stichopus* species is usually only seen at depths below 50 feet.

Lanai Inventory

Island	Lanai	Lanai	Lanai	Lanai	Lanai	Lanai
Date	8/2/05	8/2/05	8/2/05	8/3/05	8/3/05	8/3/05
Site	LAN-1	LAN-2	LAN-3	LAN-4	LAN-5	LAN-6
Depth(feet)	49	42	54	50	48	55
Habitat	Sand/Algae	Boulder	Boulder	Coral/sand	Pinnacle	Pinnacle
CNIDARIA						
<i>Hydrozoa</i>	2	0	2	2	1	2
<i>Actiniaria</i>	0	0	0	0	0	0
<i>Zoantharia</i>	1	1	1	0	2	0
<i>Octocorallia</i>	1	1	1	0	0	1
<i>Antipatharian</i>	1	0	0	1	1	1
ANNELIDA	1	2	2	1	1	1
PLATYHELMINTHES	0	0	0	0	0	0
MOLLUSCA						
<i>Gastropoda</i>	0	4	5	1	2	1
<i>Bivalvia</i>	1	1	1	1	1	1
<i>Cephalopoda</i>	0	0	0	0	0	0
CRUSTACEA	5	6	5	1	1	2
ECHINODERMATA						
<i>Asteroidea</i>	1	2	2	2	2	0
<i>Ophiuroidea</i>	0	0	0	0	1	0
<i>Echinoidea</i>	0	5	4	6	3	3
<i>Holothuroidea</i>	0	1	0	2	1	0

BRYOZOA	0	1	1	0	1	0
PORIFERA	2	7	5	5	7	0
UROCHORDATA	0	1	0	0	1	0
Grand Total	15	32	29	22	25	12

Relative Abundance of Echinoderms and % Cover Sponges-Lanai

Island	Lanai	Lanai	Lanai	Lanai	Lanai	Lanai
Date	8/2/05	8/2/05	8/2/05	8/3/05	8/3/05	8/3/05
Site	LAN-1	LAN-2	LAN-3	LAN-4	LAN-5	LAN-6
	%Cover	%Cover	%Cover	%Cover	%Cover	%Cover
	Avg#/m ²					
Porifera (%C)	0.5	0	0	0	0	0
Echinodermata-Echinoids						
Echinostrephus	0	0	0	0	0	0
Echinometra sp.	0	0.03	0.02	0	0	0
Echinothrix sp.	0	0.014	0.02	0.02	0	0
Heterocentrotus	0	0	0	0	0	0
Tripneustes	0	0.002	0	0.26	0	0
Diadema	0	0	0	0.098	0	0
Pseudobolentia	0	0	0	0	0	0
Other Echinoid	0	0	0	0.002	0	0
Echinodermata-Holothuroids						
Holothuria atra	0	0	0	0.006	0	0
Holothuria whitmaei	0	0	0	0	0	0
Actinopyga obesa	0	0	0	0	0	0
Actinopyga mauritiana	0	0	0	0	0	0
Other Holothuroid	0	0	0	0	0	0
Echinodermata-Asteroidea						
Linckia multifora	0	0	0.03	0	0	0
Linckia guildingi	0	0	0	0	0	0
Acanthaster planci	0	0	0.004	0.004	0	0
Mithrodia fisheri	0	0	0	0	0	0

Maui/Molokini

Continuation of survey efforts conducted in February 2005, with a total of nine sites being surveyed. The sites MAI-5,6,7 were the only sites with high numbers of macroinvertebrate species. These three sites were dominated by a diverse assemblage of sea urchins and possessed unique habitats such as ledges and caves. Site MAI-6 had the alien octocoral *Carijoa riisei* within cave habitats and site MAI-7 had abundant slipper lobster.

Three sites were surveyed at the islet of Molokini, which is a State of Hawaii marine Life Conservation District, and is heavily visited every day. Two sites outside the crater were surveyed, which were wall habitats. These two sites possessed unique species but only average diversity. The unique species were the antipatharians *Antipathes sp* and *Cirripathes anguina* and the gastropod *Cypraea tigris*.

Maui/Molokini Inventory

Island	Maui	Maui	Maui	Maui	Maui	Maui	Molokini	Molokini	Molokini
Date	8/4/05	8/4/05	8/4/05	8/5/05	8/5/05	8/5/05	8/6/2005	8/6/2005	8/6/2005
Site	MAI-4	MAI-5	MAI-6	MAI-7	MAI-8	MAI-9	MOK-1	MOK-2	MOK-3
Depth(feet)	42	45	30	55	36	50	55	52	45
Habitat	Sand/rubble	coral/sand	Coral	Pinnacle	Coral	Coral	Wall	Coral slope	Coral/sand
CNIDARIA									
<i>Hydrozoa</i>	1	0	1	2	1	1	3	0	0
<i>Actinaria</i>	0	0	0	0	0	0	0	0	0
<i>Zoantharia</i>	1	1	1	1	1	1	1	0	0
<i>Octocorallia</i>	1	0	2	1	0	0	1	0	0
<i>Antipatharian</i>	0	0	2	0	0	0	2	0	0
ANNELIDA	1	1	2	2	2	2	1	0	0
PLATYHELMINTHES	0	0	0	0	0	0	0	0	0
MOLLUSCA									
<i>Gastropoda</i>	2	0	2	5	3	3	2	2	0
<i>Bivalvia</i>	1	2	2	4	3	1	2	0	0

Appendix E: **Towed-Diver Habitat/Fish Survey Team Activity Summary** (*Joe Laughlin, Casey Wilkinson, Ben Richards, Jamie Gove (Leg I), and Elizabeth Keenan (Leg II)*)

Methods

The fish towboard, outfitted with a forward-looking digital video camera, recorded fish distribution and habitat complexity. The diver on this board recorded fishes larger than 50 cm total length along a 10-m swath. The downward looking benthic towboard, affixed with a high-resolution digital camera with dual strobes, photographed the benthic substrate every 15 seconds. The diver on this board calculated substrate percentage every 5 minutes and tallied the quantity of macro-invertebrates. Each towboard was equipped with a SBE 39 which recorded temperature and depth every 5 seconds along the tow. A global positioning system was used to record each tow track to geo-reference the collected data.

Results

Location	Days surveyed	# of Tows	Towed km
Kauai (KAU)	4	23	54.1
Niihau (NII)	3	13	39.7
Lehua Rock (LEH)	1	3	*
Oahu (OAH)	4	17	48.4
Molokai (MOL)	2	7	18.9
Lanai (LAN)	2	10	19.2
Maui (MAI)	3	13	26
Total	20	86	206.3

*Lehua distance included in Niihau

1. Kauai

Twenty-three towed-diver habitat and fish surveys were conducted at Kauai during 4 days of field operations covering a total of 54.1 km of benthic habitat. The tows were as evenly spaced as possible to ensure full island coverage but were limited by support ship positioning and weather conditions.

Fish observations

The green jobfish (*Aprion virescens*) was the most commonly observed fish larger than 50 cm TL with 15 individuals encountered. The second most commonly encountered fish was the redlip parrotfish (*Scarus rubroviolaceus*) with 12 individuals observed during the surveys. Relatively few sharks were encountered during the surveys with only two reef whitetip sharks (*Trianodon obesus*) encountered. Other notable observations included two sightings of the spotted knifejaw (*Oplegnathus punctatus*) on the north shore and the discovery of a dead 8-ft Sandbar shark (*Carcharhinus plumbeus*) on the south west coast, stuck and dead in a piece of derelict fishing net.

Benthic observations

The dominant habitats off Kauai were sand and sand/pavement areas covered with macroalgae. Twenty-five Crown of thorns (COTs) were seen around the island. In areas that had coral, the percentage of stressed colonies was low (0-10%).

2. Niihau/Lehua Rock

The tow team conducted 16 towed-diver habitat and fish surveys around Niihau and Lehua Rock. A total of 37.9 km of habitat was surveyed during 4 days of operations.

Fish Observations

The redlip parrotfish (*Scarus rubroviolaceus*) was the most commonly observed fish larger than 50 cm TL with 47 observations made. The second most commonly observed fish was the bluefin trevally (*Caranx melampygus*) with 12 encounters. Ten reef whitetip sharks (*Trianodon obesus*) were observed around Niihau and Lehua Rock, primarily on the northeast corner of Niihau. Notable observations included the sighting of a large >10-ft Galapagos shark (*Carcharhinus galapagensis*) on the south side of Lehua Rock.

Benthic observations

The habitat around Niihau was dominated by macroalgae and sand. Lehua habitat was mostly macroalgae and rock. There were areas around Niihau that showed relatively high levels of stressed coral (20-30%). A total of 19 COTs were observed around both islands.

3. Oahu

A total of 12 tows, 48.4 km, around Oahu were performed. Tows were spaced to provide maximum coverage of the north, west, and east shores primarily based on support ship position and sea conditions.

Fish Observations

The most commonly observed fish was the giant trevally (*Caranx ignobilis*) with 30 individuals sighted in one large aggregation inside a large cave on the east side north of Kaneohe Bay. The second most commonly encountered large fish was the redlip parrotfish (*Scarus rubroviolaceus*) with 16 sightings. Other notable observations included the sighting of two large African pompano (*Alectis ciliaris*) on the north shore off Waimea Bay.

Benthic observations

Oahu Reefs were dominated by sand and macroalgae with a few areas comprised of higher coral coverage (up to 30%). One dive revealed an outbreak of COTs. In under 5 minutes, more than one thousand COTs were observed. They were in an area of higher coral coverage. Not surprisingly the level of stressed coral in this area reached up to 30%. Thirty-six COTs were found throughout the rest of Oahu.

4. Molokai

A total of seven towed-diver surveys were conducted around Molokai covering 18.9 km. Tows were concentrated on the south and west sides of the island due to high winds during the survey period on windward coasts.

Fish Observations

The most commonly observed fish was the redlip parrotfish (*Scarus rubroviolaceus*) with only three observations made during the survey period. Molokai yielded the lowest counts for islands surveyed for fishes over 50cm TL. It was noted that no sharks were observed on any of the tows conducted at Molokai. Notable observations included high concentrations of the relatively rare Parrotfish (*Scarus dubius*) located in the *Porites sp.* coral rich habitats of the south shore.

Benthic Observations

The tows found areas of sand and algae to be common around Molokai. There were three tows that found coral coverage up to 100%. There were no significant signs of coral stress. Six COTs were seen off Molokai.

5. Lanai

Ten towed-diver habitat and fish surveys were conducted around Lanai during 2 days of field operations covering a total of 19.2 km of benthic habitat. Tows were spaced as evenly as possible around the leeward sides because high winds made conditions on windward Lanai unworkable.

Fish Observations

The most commonly observed fish during the surveys was the black tongue surgeonfish (*Naso hexacanthus*) with 49 sightings. The redlip parrotfish (*Scarus rubroviolaceus*) was the second most commonly observed fish larger than 50 cm TL with 19 fish observed. Shark sightings were limited to one sighting of the reef whitetip shark (*Trianodon obesus*).

Benthic Observations

Most of the tows around Lanai revealed high percentages of coral cover (50-100%). There was little evidence of stressed coral and only three tows where sand and algae dominated. Forty-four COTs were seen off Lanai.

6. Maui

Fifteen towed-diver habitat and fish surveys were conducted off Maui during 3 days of field operations covering a total of 26 km of benthic habitat. One tow was partially completed at Molokini Crater. Tows were spaced out as evenly as support ship positioning and weather conditions would allow. Because of strong trade winds during the survey period, tows were limited to the leeward coasts of Maui.

Fish Observations

The two most commonly observed fishes were the redlip parrotfish (*Scarus rubroviolaceus*) and the cornetfish (*Fistularia commersonii*) with only four observations each. Maui yielded relatively

low numbers of fishes over 50 cm TL. Only one reef whitetip shark (*Trianodon obesus*) was observed during the survey period.

Benthic Observations

The dominant habitat around Maui is sand and algae. There were a few areas with high coral cover, however. Divers observed higher percentages of macroalgae when towed offshore from golf courses. Fifty COTs were observed off Maui.

Appendix F: **Mooring Deployments and Oceanographic Data Collection** (Kyle Hogrefe, Ron Hoeke, Charles Young, and Jamie Gove)

Monitoring and Assessment Methodology

The Coral Reef Ecosystem Division (CRED) has been conducting multidisciplinary research in the Northwestern Hawaiian Islands (NWHI) since 2000. The oceanographic component of this research has been well established, but the methodologies used by the CRED Oceanography Team have just recently been applied to the Main Hawaiian Islands (MHI) during OES0502. Therefore, the sampling and deployments conducted during HI0505 represent an effort to further establish comparable methods of oceanographic study between the NWHI and the MHI in order to monitor long-term trends and assess oceanographic conditions.

Oceanographic monitoring and assessment were accomplished by the following:

1. Wave and Tide Recorders (WTR): Moored instruments were used to measure spectral wave energy, precision tidal elevation, and subsurface water temperature.
2. Subsurface Temperature Recorders (STR): Moored instruments that measure high resolution subsurface temperatures were used.
3. Shallow water (30 m) conductivity, temperature and depth (CTD) casts using a Seabird Electronics SBE 19*plus* augmented with a WET Labs C-Star Transmissometer were performed at regularly spaced intervals around each island. CTD casts were used to sample vertical profiles of water properties providing a spatial assessment of water mass variability.
4. Water samples were obtained for chlorophyll measurements at select sites around each island. Samples were conducted in concert with shallow water CTD and were typically collected at 1, 10, 20, and 30 meters depth for the purpose of obtaining both physical and biological water mass characteristics. In addition, transects of water samples were performed at select nearshore environs and riverine outflows in order to study and assess the influence of fresh water input to the marine environment.
5. Shipboard deep water CTD and fluorometric casts were performed to a maximum depth of 500 meters at targeted locations around and between islands. Water samples were collected for chlorophyll measurements at 150, 125, 100, 80, and 8 meters during each cast. As with shallow water CTD casts, these profiles sampled vertical water properties providing indications for water mass movement, local sea water chemistry changes, and chlorophyll concentration. Refer to the Night Operations Activities Summary for more information on deepwater CTD casts.
6. Acoustic Doppler Current Profiler (ADCP) transects: ADCP transects provide information on oceanographic current structure with depth. Refer to the Night Operations Activities Summary for more information on deepwater ADCP activity.

7. Continuous recording of surface and subsurface water temperatures as a function of depth were kept during all towed-diver operations, providing a broad and diverse spatial and thermal sampling method. Refer to the Towed Diver Habitat/Fish Survey Team Activity Summary for site and isobath information.

Protocol 1: Water Sampling Methods – MHIRAMP-HI0505

Prepared By: Chip Young

Chlorophyll Sampling

*Based on the University of Hawaii's Hawaii Ocean Time-series (HOT) program and the Department of Oceanography water sampling protocol.

Lab preparation:

Prepare an oil-free vacuum pump in line with a vacuum filter system for filtering the seawater grab samples. Be sure to set up a water "safety" reservoir to help ensure that sample water filtrate isn't drawn into the pump. Water in the pump will damage it. The filters used in this chlorophyll-a filtration procedure are 25-mm GFF filters from Millipore. Prepare for sample storage by placing one filter and a square cut piece of aluminum foil (~3 cm by 3 cm) in one Millipore Petri plate.

Field preparation:

Use the uniquely labeled brown rectangular 125-ml HPDE bottles for seawater sample collection. These bottles have been precisely measured for volume. Store the bottles for sample collection in the cooler marked "Mooring Team" with available "blue ice" packages. Ensure that each bottle has been thoroughly rinsed three times with deionized water (DIW). It is important to have brown bottles to limit further light exposure to the samples and use the "blue ice" to keep the samples cool and slow the metabolic activities of organisms present within the sample. Four Niskin bottles, four messengers, and the ~35 m deployment rope are needed to take grab samples at depth. The entire setup for water sampling can be stored in the plastic red tub. Samples are recorded on the Mooring team data log sheet for CTD and Water Sample casts.

Sample collection:

Five-liter Niskin bottles, deployed from a small boat, are used to collect seawater samples at various depths. The standard sampling depths are 1, 10, 20, and 30 meters deep and the deployment line is marked as such. The seawater collected in each Niskin bottle is then subsampled and collected in the uniquely labeled brown rectangular 125-ml HPDE bottles. Ensure that each sample bottle is filled to the brim. The seawater samples are filtered/processed in the ship's laboratory later that night. The balance of the seawater in the Niskin bottle is discarded. On the data log sheet annotate the CTD cast ID, the PRR file(s), latitude and longitude, date, time, water depth, and sample bottle number and sample depth. For "small boat" grab samples, sample labels are constructed as follows: a) the first three letters of the location from which the sample was taken, b) the CTD cast number, c) the sample bottle number, and d) the depth at which the sample was taken. The depth notation will follow a convention of 1-m samples = "A", 10-m samples = "B", 20-m samples = "C", and 30-m samples = "D". (note: that the NOAA vessel may also take "shipboard" seawater grab samples from the rosette while conducting CTD casts. These

chlorophyll-a sample labels will follow the same convention as manually taken, “small boat,” grab samples, but will specify the actual depth at which it was taken instead of the letters A-D)

Sample processing:

Once back in the lab with the seawater samples, prepare individual labels for each sample on lab tape, identifying the date the sample was taken and identifying the sample ID, using the label convention mentioned above. Place one label on one prepared Petri plate “set-up” with a filter and square of aluminum foil inside. Prepare the vacuum system by thoroughly rinsing the filtration funnels and filter grids with DIW. Using forceps, which are DIW rinsed and dried with Chemwipes, place one 25-mm GFF filter per filter grid and secure the filtration funnel on top of the filter/filter grid assembly. Pour the seawater sample from the 125-ml bottle into the funnel and turn on the vacuum to draw water through the filter. Rinse the 125-ml bottle with DIW, shake and pour the rinse into the filter funnel to be filtered as well. Also, rinse the sides of the funnel with DIW to ensure that the entire sample has passed through the filter. The vacuum system CRED has is an in-line 3-filter system which allows three samples to be drawn at the same time. The vacuum draw on each funnel can be controlled with a nozzle control found at the base of each funnel. After the entire sample has been filtered, turn off the pump and disconnect the funnel. Remove the filter with DIW rinsed forceps and place the sample filter in its appropriately labeled Petri plate, on top of the aluminum square. The filter is then folded in half with the aluminum square being folded on the outside of the filter. Be careful not to cross contaminate the samples while folding the filters and aluminum foil. This can be done by restricting your touch on the filter to the edges and by not touching the middle of the filter. The purpose of the aluminum is to shield the filter and the contents on top of the filter from light. Secure the top of the Petri plate and place the sample into the ship’s -30 degrees Celsius freezer for storage.

Log book/Computer recording:

Using the Mooring team data log sheet for CTD and Water Sample casts, the .xls file which tracks chlorophyll-a samples can be filled out. An example .xls form can be found within the “M:/Cruise/Cruise Data Server/Data/Oceanography/Water Sampling” folder within the “Water Sampling HII0505.xls” file.

Sample turn over for analysis:

Processed samples are turned over to a private contractor for analysis. What they expect from CRED is for us to provide frozen filters folded in aluminum foil and protected in labeled Petri plates. Additionally, we are to provide the needed amount of test tubes, test-tube caps, and acetone for analysis. A custody record will also be signed by a representative from both CRED and the private contractor to track the possession and handling times of the samples.

Oceanographic data collection and instrumentation activities:

Oahu

Sixty-six shallow water CTDs were conducted along the northern coasts of the island from Kaneohe Bay to Makaha. Thirteen water sample profiles were performed with six of them occurring along a transect

out of Kahana Bay, five of them following a transect out of Haleiwa Harbor and two being open ocean sites.

Five STRs were deployed in nearshore areas close to REA sites. Three of these STRs were deployed in a transect extending offshore following a channel. This deployment strategy is intended to monitor temperature gradients that may result from solar heating and inshore/offshore mixing.

Kauai

One hundred and three shallow water CTDs were conducted around the periphery of the island. Twenty-one water sample profiles were cast with seven of them occurring along transect off Nawiliwili, six of them along a transect off of Hanalei Bay, four extending from Waimea River and four being open ocean sites.

Two STRs were deployed in nearshore areas close to REA sites, and one WTR was deployed on Mana Reef off the western point of the island.

Niihau/Lehua

Fifty-two shallow water CTDs were conducted around the periphery of the island. Three water sample profiles were cast at open ocean sites.

Two STRs were deployed in nearshore areas close to REA sites.

Maui

Sixty-one shallow water CTDs were conducted along the west, south, and southeastern shorelines of Maui from Honolua Bay to Huakini Bay.

One STR was deployed on the south shore of Maui at REA site ukumehame.

Lanai

Forty CTD profiles were taken along the northwest, west, south, and eastern shorelines of the island. Eighteen water samples were taken at five separate locations.

Two STRs were deployed off the southwest tip and southern coast.

Molokai

Thirty shallow water CTD casts were conducted along the western and southern shorelines. Fourteen water samples were obtained with 10 taken along a transect from nearshore to offshore on the southern coast.

Two STRs were deployed at Molokai, one on the northwest tip and one on the southwest tip of the island.

Molokini

Ten closely spaced shallow water CTDs were conducted in and around Molokini Crater.

Two STRs were deployed on the outside of the crater.

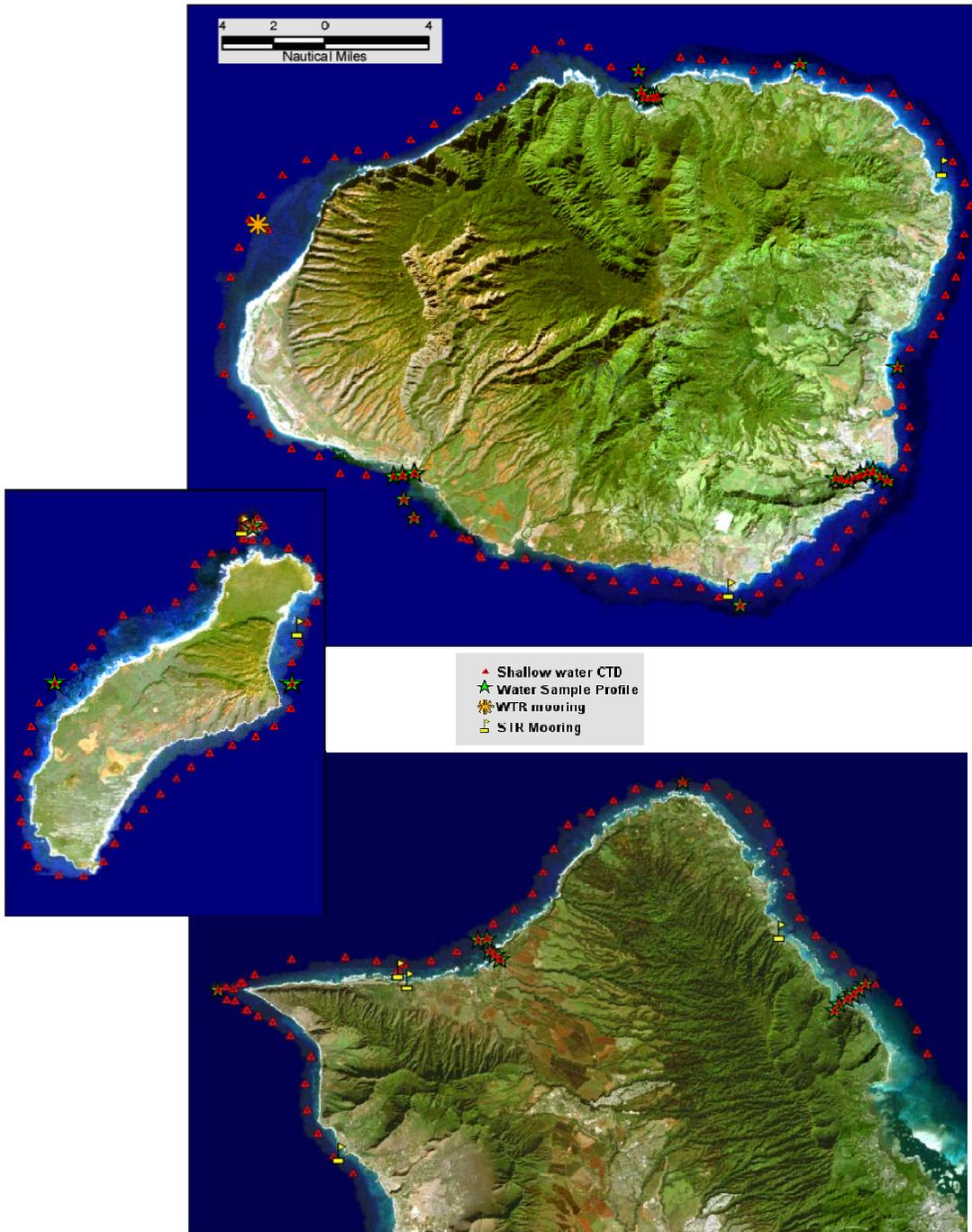


Figure 1: Mooring deployment, CTD cast and Water Sample Profile location maps. (Top, Kauai; center, Niihau; bottom, Oahu)

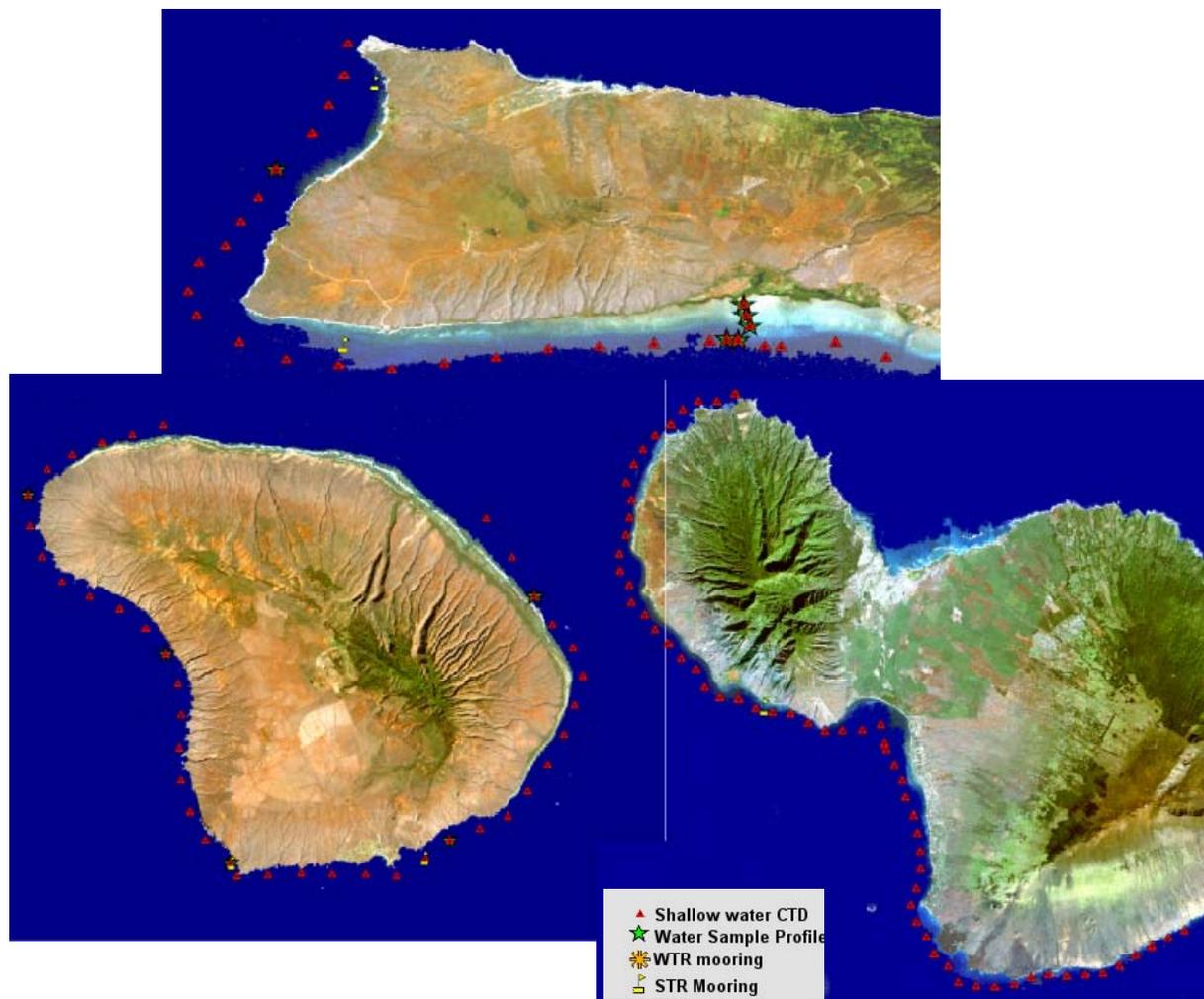


Figure 2: Mooring deployment, CTD cast and Water Sample Profile location maps (Top, Molokai; bottom left, Lanai; bottom right: Maui). Note: Maps not to scale

Table 1. Summary of shallow water CTD casts and chlorophyll samples obtained during MHIRAMP Cruise HI0505.

Table 1: Oceanographic Sampling Summary

Location	CTD sites	Water sample sites	Chlorophyll samples collected	Comments
Oahu	66	13	41	Samples collected at 1, 10, 20 and 30 M as permitted by depth at site.
Kauai	103	21	51	Samples collected at 1, 10, 20 and 30 M as permitted by depth at site. 15 additional samples collected during HI Deepwater CTD casts.
Ni'ihau	52	3	11	Samples collected at 1, 10, 20 and 30 M as permitted by depth at site. 25 additional samples collected during HI Deepwater CTD casts.
Maui	61	0	0	N/A
Lanai	40	5	18	Samples collected at 1, 10, 20 and 30 M as permitted by depth at site.
Molokai	30	2	14	Samples collected at 1, 10, 20 and 30 M as permitted by depth at site.
Molokini	10	0	0	N/A

Table 2. Summary of oceanographic instruments deployed during MHIRAMP Cruise HI0505.

Table 2: Instrumentation Summary

Location	WTR	STR	Comments
Oahu		5	Three of the STRs were deployed in a horizontal/vertical transect to monitor inshore/offshore mixing.
Kauai	1	2	
Niihau		2	
Maui		1	
Lanai		2	
Molokai		2	
Molokini		2	STRs were deployed in a horizontal/vertical transect to monitor inshore/offshore mixing.
Acronyms: WTR = Wave and Tide Recorder, STR = Subsurface Temperature Recorder			

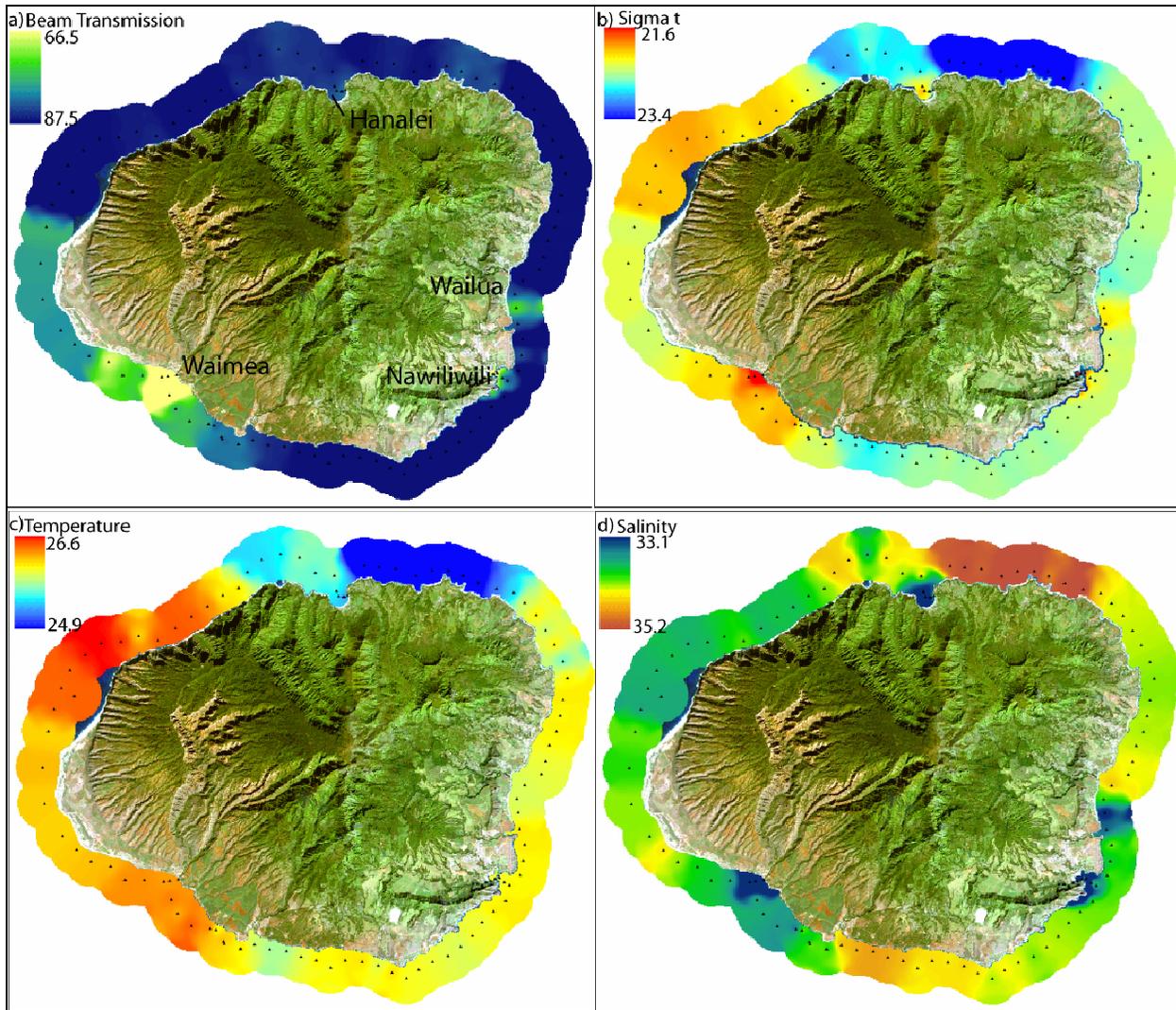


Figure 3. Shallow water CTD data at selected depths around Kauai, July 2005. Color bars in upper left of panels provide scale. Figure 3a: % beam transmission, or water clarity at 1 m; turbid waters are observed near freshwater inputs at Hanalei Bay, Wailua River, Nawiliwili Harbor, and especially Waimea River. Figure 3b: σ -t values (density) at 20 m; higher density water along the north coast may indicate upwelling. Figure 3c: temperature ($^{\circ}$ C) at 20 m; cooler temperatures along north coast corresponding to higher density water. Figure 3d: salinity (psu) at 20 m, higher salinity along north coast corresponding to higher density water is readily apparent, as are lower salinity areas corresponding to freshwater inputs.

Analysis of shallow water CTD profiles taken during the MHIRAMP cruise, HI0505, indicates variable oceanographic conditions around Kauai Island. Beam transmission, which measures water clarity and serves as a proxy for turbidity, shows high transmission values (low turbidity) around most of the island with the exception of three locations: Nawiliwili Harbor, Wailua River, and most notably, Waimea River (Fig. 3a). Calculated sigma-t values indicate strong density gradients at various locations. A high density water mass is observed on the northwest coast of the island, whereas lighter waters are found near Nawiliwili Harbor, Wailua

River, Hanalei Bay, and Waimea River (Fig. 3b). Intra-island temperatures varied little (~ 1.6 °C) during the cruise; however, specific regions of the island show distinct homogeneity. Warm temperatures (>26.5 °C) are observed east of Ha'ena to Barking Sands; cooler temperatures (24.9 °C) occur from Hanalei Bay to Kepuhi Point; and intermediate water temperatures (~ 25.6 °C) are observed south of Papaa extending beyond Hanapepe Bay (Fig. 3c). Measured salinity values show concurrent variance with sigma-t values; less saline waters are observed near Nawiliwili Harbor, Wailua River, Hanalei Bay, and Waimea River, while saltier waters are located to the northwest of the island, from Hanalei Bay to Kepuhi Point.

Based on these preliminary findings, it appears a number of factors are influencing hydrographic conditions around the island. Riverine inputs of freshwater and terrigenous material are likely influencing density, salinity, and turbidity values at select locations. Waimea River, for example, is a source of suspended sediment and freshwater to nearshore waters, as a plum of low salinity, low density, and significantly high turbidity (low water clarity) occurs at the river mouth (Figs. 3a,b,d). Waimea is a vast watershed and likely has a large volume of natural sediment input; however, it is important to note the land use in this area is predominantly agricultural based, which may potentially be an additional source of terrigenous input.

The cooler, saltier, and denser body of water located to the northeast of the island is also of oceanographic interest (Figs. 3b,c,d). Although more data is required to properly assess the source of this water mass, it is possible that an upwelling phenomena is occurring or some mesoscale feature is impinging on the island at that particular location.

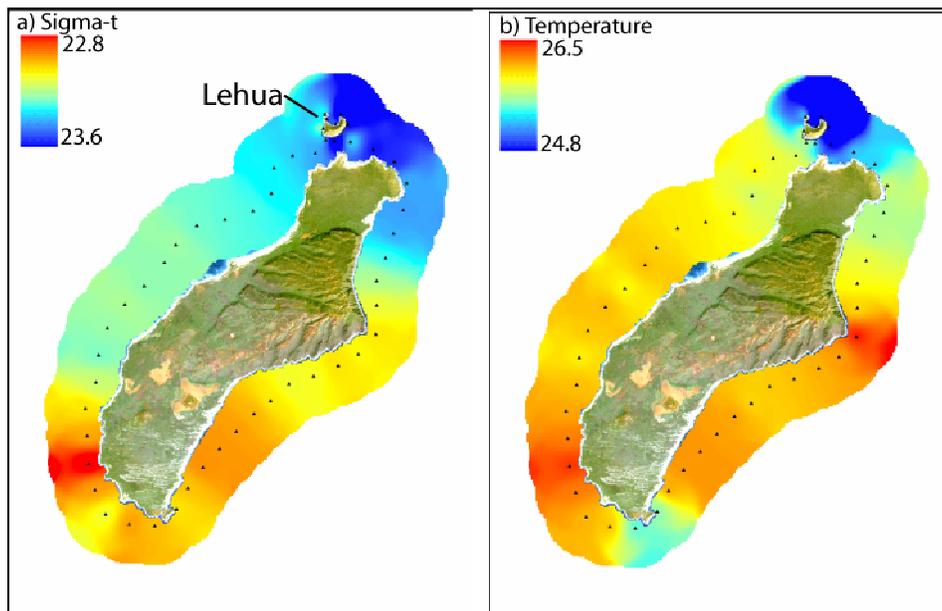
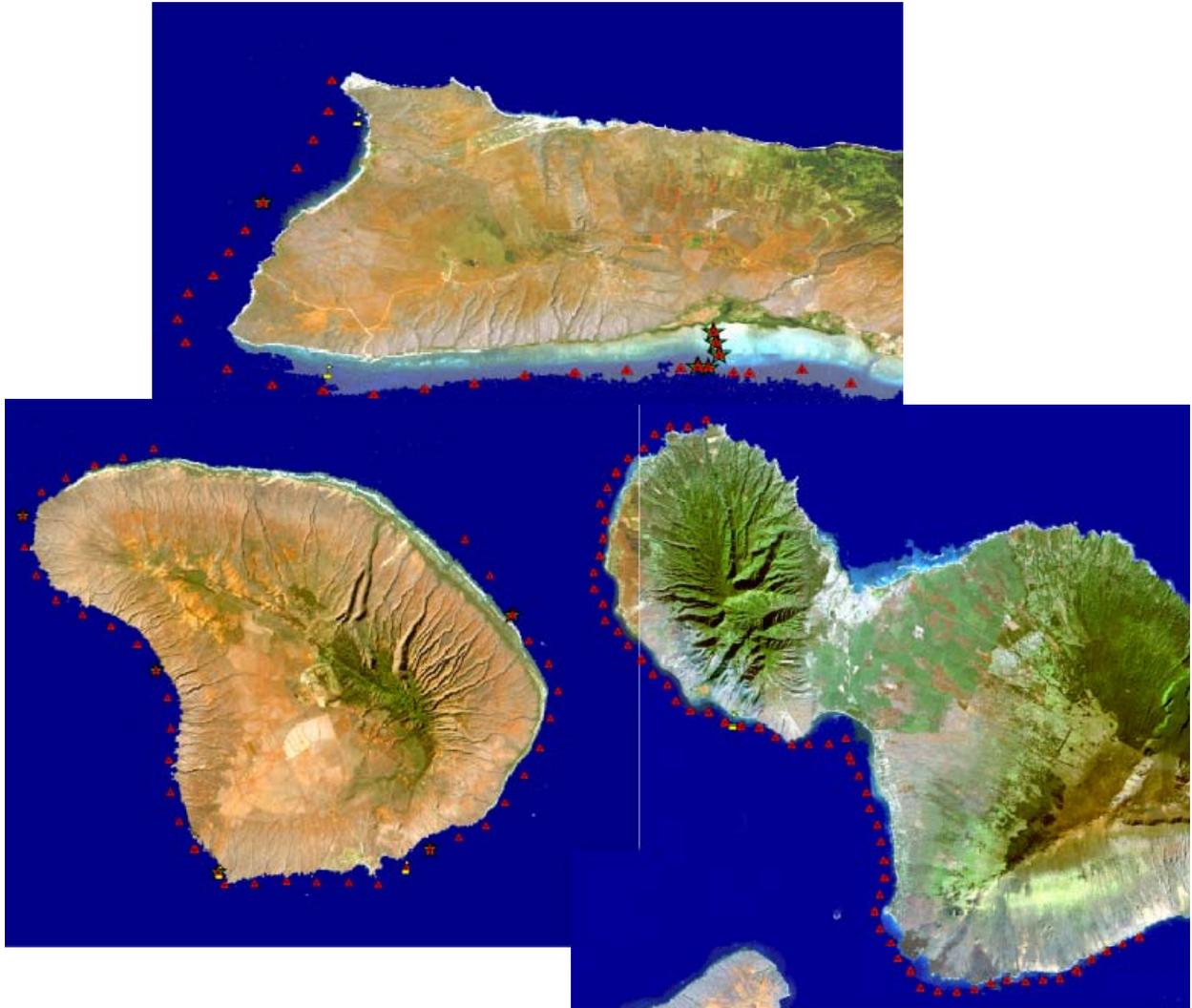


Figure 4. Shallow water CTD data taken at 10 m around Ni'ihau during the MHIRAMP Cruise, HI0505, July 2005. Sigma-t (4a) and temperature (4b) values indicate low variability around most of the island, with the exception of Lehua Rock, where an isolated body of cool, dense water is located.

Temperature and sigma-t values around Ni'ihau show general homogeneity with the exception of the northern most portion of the island. As shown in Figure 4, cooler and denser water is observed near Lehua Rock and the northeast corner. This feature, as with the cooler water mass to the northwest of Kauai, potentially indicates upwelling of subsurface waters to the

near surface. Analysis of chlorophyll samples, ADCP data, and deepwater CTD data may potentially help elucidate the source of this signal.



Appendix G: **Night Operations Activities Summary** (*John Rooney, Suzy Holst, Jeremy Jones, Parker Mason, Delisse Ortiz*)

The Mapping team consisting of Susanna Holst (Leg I), Parker Mason (Leg I), Jeremy Jones (Leg II), Delisse Ortiz ((Leg II), and John Rooney (Legs I and II) executed the following operations during the MHI RAMP cruise: Conductivity-Temperature-Depth (CTD) casts, Acoustic Doppler Current Profiler (ADCP) transects, water samples, multibeam surveying, and Tethered Optical Assessment Device (TOAD) deployments. Night operations typically consisted of TOAD deployments from 6:30 PM until about 1:00 AM followed by CTD casts, water samples, and multibeam surveying until about 5:00 AM. ADCP transects were conducted continuously.

Table 1. Synopsis of Mapping/Night Operations for HI0505

Island	# TOAD deployments	# CTD casts	# Water samples	KM² of multibeam
O'ahu	4	4	0	46.3
Kaua'i	13	7	3	4.4
Ni'ihau	12	5	3	83.8
Molokai	0	1	0	20.3
Lanai	0	3	0	61.9
Maui	0	3	0	29.6
Totals	29	21	6	246.3

CTD Casts

The CTD was deployed 21 times in support of physical oceanographic studies and/or multibeam surveying. Each CTD was lowered over the side of the *Hi'ialakai* to approximate depths of either 100 m or 500 m. Each 500-m cast was accompanied by five Niskin bottles to collect water samples at specified intervals along the ascent path. CTD deployment served a twofold purpose: 1) to collect data for oceanographic analysis; 2) to provide a sound-velocity profile to support multibeam surveying. *Hi'ialakai* Survey Technician, Drew Rapp, contributed greatly to the Mapping team's success in CTD operations. For the first few CTD casts, an auxiliary CTD was attached to the CTD platform as the primary CTD was not functioning properly.

Ideally, we would have preferred to conduct CTD casts at the four corners of an imaginary rectangle around each island; however, due to the size of the Main Hawaiian Islands and the limited time between the end of TOAD operations and the beginning of daytime operations, the "four corners" CTD strategy was simply not feasible.

Water Samples

Water samples were collected in Niskin bottles along the ascent path of our 500-m CTD casts at depths of 150 m, 125 m, 100 m, 80 m, and 3 m. The water samples were then processed for analysis in the wet lab. All of the water samples collected on this cruise will be subsequently analyzed for their chlorophyll-a concentration.

Multibeam Surveying

Multibeam surveying was conducted around Ni'ihau, Kaua'i, O'ahu, Molokai, Lanai, and Maui to fill in gaps in the database of nearshore, high-resolution multibeam coverage for each island. Data from multibeam surveying is stored on the Pacific Islands Benthic Habitat Mapping Center's (PIBHMC) server Ahi-10 for subsequent processing. A limited amount of swath editing of multibeam data collected on HI0505 was done. Surveying was hampered by the lack of a coverage grid depicting the bathymetry from existing multibeam datasets.

TOAD Operations

The TOAD was deployed nightly in order to observe the physical and biological characteristics of the seafloor in a given region. TOAD sites were selected according to a set of criteria based on depth, distance from shore, anticipated drift direction, and spacing. First, due to the length of the optical cable, TOADs were conducted to a maximum depth of about 100 m. Second, the *Hi'ialakai's* night orders specified a minimum distance from shore of 1 nautical mile. Wind direction and current profiles were used to anticipate the path the TOAD would follow while deployed, so that the aforementioned depth and distance criteria were met for as much time as possible. Additionally, TOAD sites were chosen so that stretches of the seafloor could be viewed at as wide a geographic distribution as possible while still maintaining reasonable transit times between sites.

Some noteworthy observations pertaining to TOAD operations:

1. John Rooney and Susanna Holst found the first occurrence of *Acropora* off the southeast coast of Ni'ihau on 7/18/05, which is strong evidence that there is larval transport from the Northwestern Hawai'ian Islands (NWHI) to the Main Hawai'ian Islands (MHI), since there is no known *Acropora* in the MHI. *Acropora* was reported at Mana Reef years ago, but the colonies were reported destroyed during Hurricane Iniki. A manuscript is being planned to discuss this find.
2. A second video camera and monitor were added to the camera sled system recently. Added to provide a visual warning of ledges or other obstacles in the sled's path, tests on a recent mapping cruise showed that the camera was of little benefit. Prior to the current cruise, however, the mounting arrangement for that camera was adjusted. Although a dedicated light would be helpful for illuminating objects further ahead, the second camera and monitor have been a great success and have enabled the operator to safely run the sled closer to the seafloor, thus collecting better quality data.
3. High coverage of live coral was observed at 35 m off Mokuleia, O'ahu and the Na Pali and Mana coasts of Kaua'i. Contrary to our expectations, divers working in shallower water saw markedly less coral coverage in these same areas, showing that it is sometimes possible for the highest coral densities to exist in locations where they are not expected. To effectively manage these resources, it is important to map where high densities of coral coverage are located.

4. Susanna Holst and Parker Mason were trained in all phases of TOAD data collection and shipboard processing.

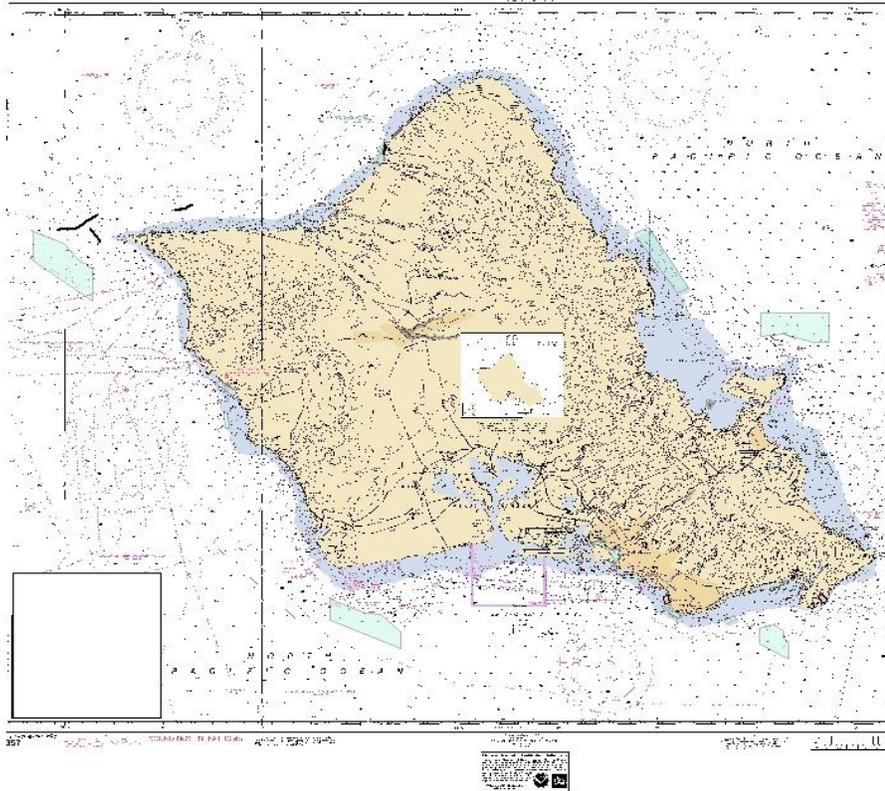
TECHNICAL ISSUES

1. There was a problem with the picture from the TOAD's primary camera getting brighter and darker. The problem gradually worsened to the point where the screen went entirely blank. Testing of different components showed that this was not related to the camera itself, and we were unable to pinpoint the problem. However, the *Hi'ialakai's* Electronics Technician (ET) Mike Crumley hooked leads in the junction box, that connects the camera sled's umbilical to the topside equipment, from the shield on both cameras' coaxial conductors to the ship's deck to ground them. This resulted in a far clearer picture and will be included in future installations.
2. The image from the TOAD's second camera began to drop out occasionally during the second day of towing. Again, the problem gradually worsened to the point where the screen was blank most of the time. Testing of various parts of the system eventually suggested that the cable between the umbilical cable and camera was shorting out. The cable was replaced, thus fixing the problem.
3. Another problem arose in which the Trackpoint II (TPII) Hydrophone would not retract. The problem was traced to a blown fuse in the motor. The fuse was not easily accessible, so there is now talk of running a line so that the fuse will be situated in a more convenient location. The ET speculated that the piston for it might have been a bit out of alignment, which would have overstrained the motor and caused the fuse to blow.
4. On 7/23/05, the TOAD's umbilical cable developed a short that precluded further camera operations. Fortunately, a new cable was ordered a week or 2 ago. Night operations were limited to CTD casts, water samples, ADCP transects, and multibeam surveying for the remainder of the cruise.
5. Numerous small gaps in the real-time display of swath bathymetry began to appear during multibeam surveying on the night of 7/23/05. This problem appears to be related to time synchronization problems reported from previous cruises.
6. Also as reported previously, susceptibility of the ship's sonars to weather-induced noise hampered operations at times. Brisk trade wind conditions rendered the EM 300 virtually useless when heading into weather, and speeds often had to be reduced to 5 or 6 kts to collect reasonable quality data with the EM 3002.

RECOMMENDATIONS

- 1.. ET Mike Crumley also recommended that the thin video cables connecting our different VCRs, monitors, and other equipment be replaced with heavy gauge gold-plated cables to reduce the inevitable loss of signal with each connection.
2. TOAD operations would greatly benefit from having information on the current water depth, the ship's heading and speed, wind conditions, etc. available in the Dry Lab. We recommend that a feed from the ship's computer system be installed in the Dry Lab to display these data.
3. Planning and tracking the ship's operations would be greatly enhanced by the installation of a computer with Nobeltec software in the Dry Lab for use by scientific personnel.
4. During both cruises of HI0504 and HI0505, pumping of CHT was initially done at times that interfered with scientific data collection. On both cruises, we were able to work out a schedule that accommodated the needs of both the ship and the scientific party. It may be worthwhile to work out times for CHT pumping during pre-cruise meetings.
5. Flooding occurred in the bow thruster room due to a broken seawater line, which shorted out the pump for the micro-thermal salinograph (microTSG). Subsequently, we were not getting surface sound velocity (SSV) information. Multibeam surveying can be run with a CTD cast, but the pump should be replaced as soon as possible.

O'ahuTOAD Sites



Kaua'i TOAD Sites

