



CRUISE REPORT¹

VESSEL: *Oscar Elton Sette* Cruise 08-10 (Fig. 1)

CRUISE PERIOD: October 16–November 14, 2008

AREA OF OPERATION: Main Hawaiian Islands: O`ahu, Kaua`i, Ni`ihau, Kaula Rock, Lehua Rock, Moloka`i, Maui, Lāna`i, and Hawai`i

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Division (CRED), Pacific Island Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, and partner agencies, including the Division of Aquatic Resources (DAR) of the Hawai`i Department of Land and Natural Resources and the National Geographic Society conducted Reef Assessment and Monitoring Program (RAMP) studies of the coral reef ecosystems in waters surrounding the main Hawaiian Islands (MHI), including the islands of O`ahu, Kaua`i, Ni`ihau, Kaula Rock, Lehua Rock, Moloka`i, Maui, Lāna`i, and Hawai`i. All activities described in this report were covered under Special Activity Permit SAP2009-40.

ITINERARY:

16 October Start of cruise. Embarked with the following staff members and partners on board: Marc Nadon (rapid ecological assessment [REA] fish), Kostantinos Stamoulis (DAR, REA fish), Marie Ferguson (REA fish), Kevin O'Brien (REA fish), Stephanie Schopmeyer (REA coral), Bernardo Vargas-Ángel (REA coral), Ronald Hoeke (autonomous reef monitoring system [ARMS]-REA invertebrate), Max Sudnovsky (ARMS-REA invertebrate), Cristi Richards (REA algae), Kevin Lino (towed-diver survey fish), Ben Richards (towed-diver survey fish), Edmund Coccagna (towed-diver survey habitat), Jason Helyer (towed-diver survey habitat), Daniel Merritt (oceanography), Frank Mancini (oceanography), Noah Pomeroy (oceanography), Tracey McDole (San Diego State University, microbial biology), Haiying Wang (data manager), Greg Marshal (National Geographic Society), and James Barlow (foreign national escort/biological science technician). Departed Honolulu at 1030 en route

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for windward O`ahu. An introductory welcome aboard meeting was held for all scientific personnel and new crew members at 1230. A dive safety meeting was held for all divers at 1300. Nitrox, oxygen analyzers were left behind on the NOAA Ship *Hi`ialakai*, and, thus, had to be embarked via small boat from a Hawai`i Kai small-boat pier at 1300. Following fire and abandon ship drills, the ship departed en route to Maui County at 1430. At 1830, the scientific party conducted a planning meeting to discuss operations for the next day.

- 17 October Arrived at northeast Maui at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, and 2 invertebrate) completed surveys at 3 sites: MAI-02, MAI-19, and MAI-20. The independent fish REA team (2 divers) completed surveys at 4 additional sites: MAI-50, MAI-51, MAI-52, and MAI-53. The towed-diver survey team completed 5 dives (11.5 km) east to west from near Keanae Point to Opana Point. The oceanography team recovered 1 subsurface temperature recorder (STR); deployed 1 STR; conducted 15 shallow-water conductivity, temperature, and depth (CTD) casts; and performed 4 water-quality profiles, during which water samples were taken to be later analyzed for chlorophyll and nutrient contents and salinity. The microbial biologist collected 4 replicate water samples at REA site MAI-02. During the night of October 16, the staff conducted two 500-m CTD and water-quality casts, collecting samples to be later analyzed for chlorophyll (10 samples) and nutrient (10 samples) content and salinity (2 samples).
- 18 October Arrived at west Maui at 0630 to commence field operations. The benthic REA team (5 divers: 2 coral, 1 algae, and 2 invertebrate) completed surveys at 1 site: MAI-06. No benthic REA survey was conducted at MAI-04, since it was a sand bottom. The fish REA team completed surveys at MAI-04, MAI-06, and MAI-05, and the independent fish REA team completed 4 additional surveys at 4 sites: MAI-54, MAI-55, MAI-56, and MAI-57. The towed-diver survey team completed 6 dives, southwest to west Maui from near Kamanama to Nahuna. The oceanography team recovered 1 STR; deployed 1 STR; recovered 1 ecological acoustic recorder (EAR); deployed 1 EAR; conducted 11 shallow-water CTD casts; and performed 3 water-quality profiles, during which water samples were taken to be later analyzed for chlorophyll (12 samples) and nutrient (12 samples) contents as well as salinity (2 samples). The microbial biologist collected 4 replicate water samples at site MAI-04. During the night of October 17, the oceanography team conducted a 500-m shipboard CTD and water-quality cast, during which samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity. Transited to Lāna`i Island.
- 19 October Arrived at north Lāna`i at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate)

completed surveys at 3 sites: LAN-08, LAN-07, and LAN-04. The independent fish REA team completed additional surveys at LAN-50, LAN-51, LAN-52, LAN-53, and LAN-54. The towed-diver survey team completed 6 tows (16.7 km) north to southeast Lāna`i from near Makaiwa beach to Huawai Bay. The oceanography team recovered and deployed 2 STRs; conducted 17 shallow-water CTD casts; and performed 5 water-quality profiles, during which water samples were taken to be later analyzed for chlorophyll (20 samples) and nutrient (20 samples) contents as well as salinity (2 samples). The microbial biologist collected 4 replicate water samples at site LAN-08. During the night of October 18, the oceanography team conducted one 500-m shipboard CTD and water-quality cast at site KAH-01, during which samples were collected to be later analyzed for chlorophyll (6 samples) and nutrient content (6 samples) as well as salinity (1 sample).

20 October

Arrived at south Lāna`i at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at 3 sites: LAN-05, LAN-06, and LAN-03. The independent fish REA completed 5 additional surveys at LAN-55, LAN-56, LAN-57, LAN-58, and LAN-59. The towed-diver survey team completed 6 tows (15.4 km) south to northwest Lāna`i from near Manele Bay to pass Honopu Bay. The oceanography team conducted 14 shallow-water CTD casts, and performed 3 water-quality profiles, during which water samples were taken to be later analyzed for chlorophyll (12 samples), nutrient (12 samples) contents, dissolved inorganic carbon (DIC) (4 samples), and salinity (1 sample). In addition, the microbial biologist collected 4 replicate water samples at site LAN-05. During the night of October 19, the oceanography team conducted one 500-m shipboard CTD and water-quality cast at 25 km southwest of Lāna`i, during which samples were collected to be later analyzed for chlorophyll and nutrient content, DIC, and salinity. Representatives of the National Geographic Society performed a test deployment of their DropCam at REA site LAN-06. Departed at 1800 en route to Moloka`i Island.

21 October

Arrived at northeast Moloka`i at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at 3 sites between Pelekunu Bay and Mokapu Islet (MOL-08, MOL-07, and MOL-06). The independent fish REA team completed 5 additional surveys at sites MOL-50, MOL-51, MOL-52, MOL-53, and MOL-54. The towed-diver survey team completed 6 tows (15.4 km) east to northwest Moloka`i from near Halawa valley to Kaulapapa peninsula. The oceanography team conducted 17 shallow-water CTD casts and performed 5 water-quality profiles, during which water samples were taken to be later analyzed for chlorophyll (20 samples) and nutrient (20 samples) contents as well as salinity (2 samples). In addition, the microbial biologist collected 4 replicate water

samples at MOL-07. During the night of October 20, the oceanography team conducted one 500-m shipboard CTD and water-quality cast at MOL-02, during which samples were collected to be later analyzed for chlorophyll, nutrient content, and salinity. Transited to Maui Island.

22 October Arrived at north-northwest Maui at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at 3 sites between Waihee Point and Nakalele Point: MAI-B1, MAI-10, and MAI-12. The independent fish REA completed 5 additional surveys at MAI-58, MAI-59, MAI-60, and MAI-11. The towed-diver survey team completed 6 tows (14.4 km) northeast to northwest Maui from near Kahului to Honolulu Bay. The oceanography team deployed 1 STR, conducted 15 shallow-water CTD casts, and performed 4 water-quality profiles, during which water samples were taken to be later analyzed for chlorophyll (15 samples) and nutrient (15 samples) contents as well as salinity (2 samples). The microbial biologist collected 4 replicate water samples at MAI-B1. National Geographic Society representatives conducted a successful 4-h deployment of the DropCam of a depth of ~ 70 m. During the night of October 21, the oceanography team conducted two 500-m shipboard CTD and water-quality casts, during which samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity.

23 October Arrived at northwest Maui at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at 3 sites between Hawea Point to past Lahaina: MAI-07, MAI-B3, and MAI-08. The independent fish REA completed 5 additional surveys at sites between Hawea Point and Olowalu: MAI-58, MAI-59, MAI-60, and MAI-11. The towed-diver survey team completed 6 tows (14.9 km) along northwest Maui in the same area as the independent fish team. The oceanography team conducted 15 shallow-water CTD casts and performed 4 water-quality profiles, during which water samples were taken to be later analyzed for chlorophyll (16 samples) and nutrient (16 samples) contents as well as salinity (2 samples). The microbial biologist collected 4 replicate water samples at MAI-B3. National Geographic Society representatives conducted underwater videography at REA site MAI-08. No shipboard CTD cast activities occurred during the night of October 22. Transited to Moloka`i Island.

24 October Arrived at west Moloka`i at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at 3 sites between Kepuhi Bay and Hale O`lono Harbor: MOL-05, MOL-02, and MOL-03. Within the same stretch of coastline, the independent fish REA completed 5 additional surveys at MOL-54, MOL-55, MOL-56, MOL-57, and MOL-58. The towed-diver survey team completed 6 tows (15.4 km) along northwest and west

Moloka`i in the same area as the independent fish team. The oceanography team deployed 2 STRs, conducted 10 shallow-water CTD casts, performed 4 DIC casts, and 4 water-quality profiles, during which water samples were collected to be later analyzed for chlorophyll (15 samples) and nutrient (15 samples) contents, salinity (2 samples), and DIC (4 samples). The microbial biologist collected 4 replicate water samples at MOL-03. National Geographic Society representatives successfully conducted one 2-h deployment of the DropCam and conducted underwater videography at REA site MOL-03. During the night of October 23, the oceanography team conducted one 500-m shipboard CTD and water-quality cast at Penguin Bank, during which samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity. Transited to Kahului Harbor, Maui.

25 October

Arrived at Pier 1A, Kahului Harbor, Maui, at 0730 to conclude Leg 1. Disembarked Kosta Stamoulis, Greg Marshal, Daniel Merritt, and Ronald Hoeke, and embarked with the following personnel and partners on board: Darla White (UH/DAR, REA fish), Paula Ayotte (REA fish), Kyler Abernathy (National Geographic Society), and Oliver Vetter (oceanography). At 0900 refueling operations took place: 2 hip tanks and six 55-gal drums were replenished with 540 gal of ethanol-free gasoline for small-boat operations. At 1300 SE-03 (Avon boat) was launched to conduct check-out dive and reserve air supply system (RASS) training for Abernathy and White. Divers took a 24-h rest period after 8 consecutive dive days. NOAA Ship *Oscar Elton Sette* departed Kahului Harbor at 1530 en route to the Hamakua coast of windward Hawai`i Island. No shipboard CTD casts activities occurred during the night of October 24.

26 October

Arrived at Upolu Point on the north side of Hawai`i Island at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) resurveyed 3 sites established in 2006 and located between Upolu Point and Paokalani Island: HAW-32, HAW-21, and HAW-20. Deployment of one set of ARMS at HAW-32 was attempted by the ARMS-invertebrate team; however, the substrate was unsuitable for installation. Within the same stretch of coastline, the independent fish REA team (2 divers) completed 5 additional surveys at HAW-50, HAW-51, HAW-52, HAW-53, and HAW-54. The towed-diver survey team completed 6 tows (12.3 km) from Upolu Point to near Waipio Valley. The oceanography team recovered and deployed 1 STR, conducted 14 shallow-water CTD casts, and performed water-quality profiles at 4 sites, during which water samples were collected to be later analyzed for chlorophyll (16 samples) and nutrient (16 samples) contents as well as salinity (2 samples). The microbial biologist collected 4 replicate water samples at HAW-32. National Geographic Society representatives successfully conducted two 2-h deployments of the DropCam—the first to nearly 135 m deep in the vicinity of HAW-32 and

the second to nearly 40 m deep in the vicinity of HAW-20. During the night of October 25, the oceanography team conducted one 500-m shipboard CTD and water-quality cast at HAW-01, during which samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity.

27 October

Arrived in the proximity of Hakalau Bay, northwest Hawai`i Island, at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) resurveyed 3 sites established in 2006 and located between Hakalau Bay and Maulua Bay: HAW-29, HAW-30, and HAW-31. The rocky nature of the substrate at these 3 visited sites precluded appropriate ARMS installation. The independent fish REA team (2 divers) completed 6 additional surveys at HAW-55, HAW-56, HAW-57, HAW-58, HAW-59, and HAW-60. The towed-diver survey team completed 5 tows (12.3 km) from Hakalau Bay to near Waipio Valley. The oceanography team conducted 19 shallow-water CTD casts and performed water-quality profiles at 5 sites, during which water samples were collected to be later analyzed for chlorophyll (20 samples) and nutrient (20 samples) contents as well as salinity (2 samples). The microbial biologist collected 4 replicate water samples at HAW-29. National Geographic Society representatives conducted 2 DropCam deployments—the first for 2 h at ~ 230 m near REA site HAW-29 and the second for 1 h at ~ 43 m deep near HAW-31. During the night of October 26, the oceanography team conducted one 500-m shipboard CTD and water-quality cast at site HAW-02, during which samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity.

28 October

Arrived south of Hilo Bay in the proximity of Kings Landing, Hawai`i Island, at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) resurveyed 2 sites established in 2006 (HAW-25 and HAW-26) and 1 established in 2005 (HAW-01). The rocky nature of substrates precluded appropriate installation of ARMS. The independent fish REA team (2 divers) completed 5 additional surveys at HAW-61, HAW-62, HAW-63, HAW-64, and HAW-65. The towed-diver survey team completed 6 tows (13.2 km) from near Pupuaa Bay to past Pepeekeo Point (excluding Hilo Bay). The oceanography team conducted 17 shallow-water CTD casts and performed water-quality profiles at 4 sites, during which water samples were collected to be later analyzed for chlorophyll (16 samples) and nutrient (16 samples) contents and salinity (1 sample). The microbial biologist collected 4 replicate water samples at HAW-25. National Geographic Society representatives conducted 2 DropCam deployments: the first for 2 h at ~ 130 m near HAW-25 and the second for 1 h at ~ 42 m deep near HAW-01. During the night of October 27, the oceanography team conducted a replicate 500-m shipboard CTD and water-quality cast

at site HAW-02, during which samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity.

29 October

Arrived in Puna, Hawai`i Island, at 0630 to commence field operations. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 1 invertebrate) completed surveys at 3 sites: HAW-08, HAW-09, and HAW-33. Site HAW-33 was established in lieu of HAW-27, which was located 0.5 miles down wind of the point of lava entry into the ocean and within a thick cloud of steam and sulfur gases. No ARMS were deployed due to limited logistical boat support for the day. The independent fish REA team (2 divers) completed 3 additional surveys at HAW-66, HAW-67, and HAW-68. The towed-diver survey team completed 5 tows (10 km) from near Kapoho Bay to past Kaimu. The oceanography team deployed and installed 1 EAR and 1 STR near HAW-09, replaced 1 additional STR at HAW-07 (the previously installed STR was lost), conducted 12 shallow-water CTD casts, and performed water-quality profiles at 3 sites, during which water samples were collected to be later analyzed for chlorophyll (11 samples) and nutrient (11 samples) contents as well as salinity (1 sample). The microbial biologist collected 4 replicate water samples near HAW-09. No DropCam activities were conducted during the day. No shipboard CTD cast activities occurred during the night of October 28.

30 October

Continued coral reef monitoring and assessment surveys off Puna on the southeast side of Hawai`i Island. The fish and benthic REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at 3 sites, 1 established in 2006 (HAW-28) and the other 2 in 2005 (HAW-10 and HAW-11). No ARMS were installed due to the unsuitability of substrate at survey sites. The fish REA team also completed surveys at 2 additional new sites, HAW-74 and HAW-75, and the independent fish REA team (2 divers) conducted surveys at 4 additional new sites: HAW-69, HAW-70, HAW-71, and HAW-72. The towed-diver survey team completed 5 tows (10.6 km). The oceanography team conducted 20 shallow-water CTD casts and performed water-quality profiles at 2 sites, during which water samples were collected to be later analyzed for chlorophyll (6 samples) and nutrient (6 samples) contents as well as DIC (4 samples). The microbial biologist collected 4 replicate water samples near HAW-28. National Geographic Society representatives accomplished a successful 1-h DropCam deployment at ~ 40 m near REA site HAW-11 and conducted underwater videography at MAI-11. During the night of October 29, the oceanography team conducted one 500-m shipboard CTD and water-quality cast 25 km south of Hawai`i Island, during which samples were collected to be later analyzed for chlorophyll and nutrient content, DIC, and salinity.

31 October

Continued coral reef monitoring and assessment surveys in the southeast region of Hawai`i Island. The fish and benthic REA team (7 divers: 2 fish,

2 coral, 1 algae, 2 invertebrate) completed surveys at 3 sites, 1 established in 2006 (HAW-16) and the other 2 in 2005 (HAW-17 and HAW-12). During small-boat loading, chief scientist Bernardo Vargas-Ángel fell overboard the inflatable, 4.6-m Achilles boat; no injuries resulted from this incident. However, this delayed small-boat launch allowed for only coral community structure surveys at 2 sites: HAW-17 and HAW-12. No ARMS were installed due to substrate unsuitability at survey sites. The independent fish REA team (2 divers) conducted surveys at 4 additional new sites: HAW-76, HAW-77, HAW-78, and HAW-80. The towed-diver survey team completed 6 tows (13.3 km). The oceanography team replaced and deployed 2 STRs in the vicinity of HAW-16 and HAW-13, conducted 18 shallow-water CTD casts, and performed water-quality profiles at 2 sites, during which water samples were collected to be later analyzed for chlorophyll (6 samples) and nutrient (6 samples) contents as well as salinity (1 sample). The microbial biologist collected 4 replicate water samples near HAW-16. National Geographic Society representatives accomplished a successful 1-h DropCam deployment at ~ 383 m deep, near HAW-16. During the night of October 20, the oceanography team conducted one 500-m shipboard CTD and water-quality cast, during which samples were collected to be later analyzed for chlorophyll and nutrient content, DIC, and salinity.

1 November

Arrived in the vicinity of Manuka Bay on the southwest side of Hawai`i Island at 0630 to commence field operations. A safety stand-down led by Commander Karl Mangels was held between 0800 and 0930 to review the man-overboard incident from the previous day and review other safety concerns related to REA operations. The fish REA team (2 divers) completed surveys at sites, HAW-34, HAW-24, and HAW-23. Benthic REA, coral and line-point intercept surveys were conducted at sites HAW-34 and HAW-24, and 2 ARMS were deployed and installed at HAW-24. The independent fish REA team (2 divers) conducted surveys at 4 additional new sites: HAW-81, HAW-82, and HAW-83. The towed-diver survey team completed 4 tows (9.9 km) from Manuka Bay to past Pohue Bay. The oceanography team deployed and installed 1 EAR and 1 STR at Manuka Bay near HAW-34; conducted 15 shallow-water CTD casts, 4 of which collected water for DIC analyses; and performed water-quality profiles at 2 sites, during which water samples were acquired to be later analyzed for chlorophyll (6 samples) and nutrient (6 samples) contents and salinity (1 sample). The microbial biologist collected 4 replicate water samples near HAW-23. National Geographic Society representatives accomplished a successful 1-h DropCam deployment at ~ 350 m deep near HAW-34 and acquired underwater EAR installation videography. No shipboard CTD and water-quality casts occurred on October 31.

2 November

Continued coral reef monitoring and assessment surveys in the southeast region of Hawai`i Island. The fish REA team (2 divers) completed surveys

at HAW-13, HAW-14, HAW-22, and HAW-88. Benthic REA, coral community structure, and invertebrate surveys were conducted at HAW-14, HAW-22, and HAW-23 (no line-point intercept surveys were conducted there). The independent fish REA team (2 divers) conducted surveys at 4 additional new sites: HAW-84, HAW-85, HAW-86, and HAW-89. The towed-diver survey team completed 4 tows (6.9 km) from near Pohue Bay to past South Point. The oceanography team deployed and installed 2 sets of ARMS at HAW-14 and HAW-22 and completed the installation that was started the prior day at HAW-24. National Geographic Society representatives successfully accomplished 2-h DropCam deployments at ~ 420 m deep near HAW-14 and HAW-23 and acquired underwater videography of towed-diver survey methodology. Lastly, during the night of November 1, the oceanography team conducted one 500-m shipboard CTD and water-quality cast at HAW-04, during which samples were collected to be later analyzed for chlorophyll and nutrient content, DIC, and salinity. Departed at 1800 en route to Maui Island.

3 November

Arrived in the vicinity of Hana Bay at 0630 to continue monitoring and assessment surveys off the east side of Maui Island. The REA team (7 divers: 2 fish, 2 coral, 1 algae, and 2 invertebrate) completed surveys at 3 sites: MAI-01, MAI-13, and MAI-14. The fish REA conducted 1 additional survey at MAI-69, and the invertebrate-REA team deployed and installed 1 set of ARMS at MAI-01. The towed-diver survey team completed 5 tows (10.5 km) from west of Pukaulua Point to past Mokuia Point. The oceanography team completed 5 shallow-water CTD casts and performed water-quality profiles at 2 sites, during which water samples were acquired to be later analyzed for chlorophyll (6 samples) and nutrient (5 samples) contents. The microbial biologist collected 4 replicate water samples near MAI-15. National Geographic Society representatives successfully accomplished one 1-h DropCam deployment at ~ 80 m deep near REA site MAI-13. No shipboard CTD and water-quality casts were conducted on the nights of November 1–3. Departed Maui Island at 1800 en route to Honolulu.

4 November

Arrived in the vicinity of Barbers Point, O`ahu Island, at 0700 to conduct a helicopter drill with the U.S. Coast Guard. Upon successful completion of this drill, the ship transited en route to Pearl Harbor. Arrived at Pier 9, Ford Island, at 1130 to conclude Leg 2. Disembarked Oliver Vetter, Edmund Coccagna, and Kyler Abernathy, and embarked with staff members Jacob Asher (towed-diver survey habitat) and Jamison Gove (oceanography) on board. At 1330 refueling operations took place: 2 hip tanks and six 55-gal drums were replenished with 500 gal of gasoline for small-boat operations. Divers took a 24-h rest period after 8 consecutive dive days. Ship departed Ford Island at 1700 en route to the Nā Pali Coast on the north side of Kaua`i Island. At 1830 a science planning meeting

was held, and at 1900 dive master Benjamin Richards conducted a dive equipment safety check.

5 November

Arrived in the vicinity of Makaha Point, Nā Pali Coast, Kauaʻi Island, at 0630 to commence field operations. The REA team (5 divers: 2 fish, 2 coral, 1 algae) completed surveys at 3 sites at Mana Reef: KAU-15, KAU-14, and KAU-08. Benthic REA invertebrate surveys were conducted at KAU-15, and 2 sets of ARMS were deployed and installed at KAU-14 and KAU-08. The independent fish REA team conducted additional surveys at KAU-50, KAU-51, KAU-52, KAU-54, and KAU-55. The towed-diver survey team completed 6 tows (15.1 km) from west of Polihale Heiau to past Puanaiea Point. The oceanography team deployed and installed 1 EAR and 1 STR at Mana Reef (KAU-15), deployed and recovered a wave-and-tide recorder (WTR) 2 km west of REA site KAU-15, completed 10 shallow-water CTD casts, and performed water-quality profiles at 2 sites, during which water samples were acquired to be later analyzed for chlorophyll (7 samples) and nutrient (7 samples) contents. The microbial biologist collected 4 replicate water samples near KAU-08. No shipboard CTD and water-quality casts were conducted on the night of November 5.

6 November

Continued coral reef monitoring and assessment surveys off north Kauaʻi Island. The REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at KAU-13, KAU-03, and KAU-02. The ARMS-invertebrate team installed 2 ARMS at KAU-02; therefore, no invertebrate surveys were accomplished for this site. The independent fish REA team conducted additional surveys at KAU-56, KAU-57, KAU-58, KAU-59, and KAU-61. The towed-diver survey team completed 6 tows (12.5 km) from near Haena Point to Anahola Bay. The oceanography team completed 16 shallow-water CTD casts and performed water-quality profiles at 3 sites, during which water samples were acquired to be later analyzed for chlorophyll (10 samples) and nutrient (10 samples) contents. The microbial biologist collected 4 replicate water samples near KAU-13. Lastly, during the night of November 5, the oceanography team conducted 500-m shipboard CTD water-quality casts at 2 sites, north and west of Kauaʻi Island, KAU-03 and NII-01, where water samples were collected to be later analyzed for chlorophyll and nutrient content and salinity.

7 November

Continued coral reef monitoring and assessment surveys off south Kauaʻi Island. The REA team (6 divers: 2 fish, 1 coral, 1 algae, 2 invertebrate) completed surveys at sites KAU-05, KAU-06, and KAU-12; the ARMS-invertebrate team installed 2 ARMS each at KAU-06 and KAU-12; thus, no invertebrate surveys were accomplished at those 2 sites. The independent fish REA team conducted additional surveys at 4 new sites: KAU-62, KAU-63, KAU-64, and KAU-66. The towed-diver survey team completed 6 tows (14.6 km) from near Makawehi to past Kaumakani

Point. The oceanography team recovered and deployed an STR in the vicinity of REA site KAU-05, conducted 15 shallow-water CTD casts, and performed water-quality profiles at 3 sites, during which water samples were acquired to be later analyzed for chlorophyll (10 samples) and nutrient (10 samples) contents. The microbial biologist collected 4 replicate water samples near KAU-05. Lastly, during the night of November 6, the oceanography team conducted 500-m shipboard CTD water-quality casts at 2 sites, east and south of Kaua`i Island, KAU-02 and KAU-01, where water samples were collected to be later analyzed for chlorophyll and nutrient content.

8 November

Arrived at Five Fathom Pinnacle to continue coral reef monitoring and assessment surveys. Unfavorable swell and wind conditions precluded small-boat launches, and the ship transited 40.2 km to northwest Ni`ihau Island to commence operations. The REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at sites NII-04 and NII-09; no ARMS were installed. The independent fish REA team conducted additional surveys at 4 new sites: NII-50, NII-51, NII-52, and NII-53. The towed-diver survey team completed 4 tows (8.4 km) along the outside perimeter of Lehua Rock and in the vicinity of Kaununu off west Ni`ihau Island. The oceanography team recovered 1 EAR, 1 STR, and 1 concrete anchor and deployed 1 STR south of Lehua Rock. This team also conducted 1 shallow-water CTD cast and performed a water-quality profile, during which water samples were acquired to be later analyzed for chlorophyll (2 samples) and nutrient (2 samples) contents. The microbial biologist collected 4 replicate water samples near NII-09. Lastly, during the night of November 7, the oceanography team conducted a 500-m shipboard CTD water-quality cast at site NII-02, during which water samples were collected to be later analyzed for chlorophyll and nutrient content.

9 November

Arrived at Five Fathom Pinnacle to continue coral reef monitoring and assessment surveys. Unfavorable swell and wind conditions precluded small-boat launches; the ship transited 40.2 km to northwest Ni`ihau Island to commence operations. The REA team (7 divers: 2 fish, 2 coral, 1 algae, 2 invertebrate) completed surveys at LEH-02, LEH-01, and NII-07; substrate conditions precluded installation of ARMS. The independent fish REA team conducted additional surveys at 4 new sites: LEH-50, LEH-51, NII-54, and NII-55. The towed-diver survey team completed 5 tows (10.5 km) along the inside perimeter of Lehua Rock and between Kikepa Point and Palikoae in the north region of Ni`ihau Island. The oceanography team recovered and deployed 1 STR in the vicinity of NII-01; conducted 10 shallow-water CTD casts; and performed water-quality profiles at 3 sites, during which water samples were acquired to be later analyzed for chlorophyll (10 samples) and nutrient (10 samples) contents. The microbial biologist collected 4 replicate water samples near NII-01.

Lastly, during the night of November 8, the oceanography team conducted a 500 m shipboard CTD water-quality cast 25 km southwest of Kaula Rock, during which water samples were collected to be later analyzed for chlorophyll and nutrient content, DIC, and salinity.

- 10 November Arrived at southeast Ni`ihau Island to continue coral reef monitoring and assessment surveys. Due to unfavorable swell and wind conditions, the ship relocated to the southwest corner to conduct small-boat launches. The REA team (4 divers: 2 fish, 1 algae, and 1 invertebrate) completed surveys at sites NII-06 and NII-05. REA coral diver Stephanie Shopmeyer reported pain to her left ear during descent on her first dive. Upon immediate return to the ship, examination by the ship's medical officer indicated no severe injury or perforation to the tympanic membrane but noticed swelling, redness, and bulging of the ear drum. Dive buddy coral diver Bernardo Vargas-Ángel remained onboard until medical diagnosis. The ship's medical officer instructed her to let the injury heal and refrain from diving during the rest of the cruise. The independent fish REA team conducted additional surveys at 4 new sites: NII-56, NII-57, NII-58, NII-59, and NII-60. The towed-diver survey team completed 4 tows along southeast and southwest Ni`ihau Island. At 4 sites, the oceanography team conducted 16 shallow-water CTD casts and performed water-quality profiles, during which water samples were acquired to be later analyzed for chlorophyll (11 samples) and nutrient (11 samples) contents, DIC (5 samples), and salinity (4 samples). The microbial biologist collected 4 replicate water samples near NII-05. During the night of November 9, the oceanography team conducted two 500-m shipboard CTD water-quality casts in the vicinity of Kaula Rock at KAU-01 and KAU-02, during which water samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity.
- 11 November Arrived at Five Fathom Pinnacle to commence field operations. The oceanography team deployed 1 EAR, 1 STR, and 1 anchor and recovered 1 STR. In addition, 1 shallow-water CTD cast was conducted, during which water samples were acquired to be later analyzed for chlorophyll (4 samples) and nutrient (4 samples) contents. The towed-diver team provided assistance with the dive and performed a qualitative fish richness survey. All other dive teams took a rest day. The ship departed Five Fathom Pinnacle at 1200 en route to O`ahu Island. During the night of November 12, the oceanography team conducted one 500-m shipboard CTD cast at NII-02, during which samples were collected to be later analyzed for chlorophyll and nutrient contents as well as salinity.
- 12 November Arrived in the vicinity of Ka`ena Point, west O`ahu Island, to continue coral reef monitoring and assessment operations. The REA team (5 divers: 2 fish, 1 coral, 1 algae, and 1 invertebrate) completed surveys at OAH-03, OAH-02, and OAH-04. The independent fish REA team conducted

additional surveys at 4 new sites, OAH-50, OAH-52, OAH-53, and OAH-54 and completed a species presence/absence inventory at OAH-51. The towed-diver team completed 6 tows (12.4 km) from near Mokule`ia Beach to Lehilehi Point (Makaha). The oceanography team deployed and recovered 1 STR and conducted 7 shallow-water CTD casts, during which water samples were acquired to be later analyzed for chlorophyll (13 samples) and nutrient (13 samples) contents. The microbial biologist collected 4 replicate water samples at OAH-02. A cruise debriefing meeting was held for all officers, crew, and scientists at 1830 in the ship's main mess/lounge. Finally, during the night of November 11, the oceanography team conducted one 500-m shipboard CTD water-quality cast at OAH-04, northwest O`ahu Island, during which water samples were collected to be later analyzed for chlorophyll and nutrient content as well as salinity.

13 November

Arrived in the vicinity of Mokolea Rock, southeast O`ahu Island, to continue coral reef monitoring and assessment operations. The REA team (5 divers: 2 fish, 1 coral, 1 algae, and 1 invertebrate) completed surveys at OAH-14, OAH-15, and OAH-12. The independent fish REA team conducted additional surveys at 4 new sites: OAH-55, OAH-56, OAH-57, and OAH-58. The towed-diver team completed 6 tows (14.6 km) from near the Kaneohe Bay Marine Corps Base to Makapu`u Point and Sandy Beach. The oceanography team conducted 1 shallow-water CTD cast, during which water samples were acquired to be later analyzed for chlorophyll (2 samples) and nutrient (2 samples) contents. The oceanography team also assisted the invertebrate diver in the deployment of 6 ARMS at OAH-14 (1), OAH-15 (2), and OAH-12 (3). The microbial biologist collected 4 replicate water samples at OAH-14. During the nights of November 12–13, at OAH-02, OAH-03, OAH-01, and MOL-02, the oceanography team conducted four 500-m shipboard CTD water-quality casts, during which water samples were collected to be later analyzed for chlorophyll and nutrient contents as well as salinity.

14 November

Arrived in Ford Island, Pearl Harbor, Honolulu. Disembarked Marc Nadon, Paula Ayotte, Darla White, Marie Ferguson, Kevin O'Brien, Stephanie Schopmeyer, Bernardo Vargas-Ángel, Max Sudnovsky, Cristi Richards, Kevin Lino, Ben Richards, Jacob Asher, Jason Helyer, Jamison Gove, Frank Mancini, Noah Pomeroy, Tracey McDole, Haiying Wang, and James Barlow. End of cruise.

Table 1. --Cruise statistics for the SE-08-10 MHIRAMP cruise.

Survey Item	Hawai'i	Kaua'i	Lāna'i	Maui	Moloka'i	Ni'ihau	Lehua	O'ahu	Kaula/FFP	TOTAL
Towed-diver habitat/fish surveys	41	18	12	28	12	14	3	6	–	134
Combined tow lengths (km)	91	42.2	32	65	30	28.4	6.5	27	–	322.1
Fish REA	62	24	16	34	16	16	4	14	0	186
Benthic REA	23	9	7	12	6	5	2	6	–	70
ARMS deployed	9	10	–	3	–	–	–	6	–	28
WTRs recovered	–	1	–	–	–	–	–	–	–	1
WTRs deployed	1	1	–	–	–	–	–	–	–	2
EARs deployed	2	1	–	1	–	–	–	–	1	5
EARs recovered	–	1	–	1	–	–	–	–	–	2
STRs deployed	6	2	2	4	2	1	1	1	1	20
STRs recovered	3	1	2	3	2	1	1	1	1	15
Shallow-water CTD casts	89	39	29	57	27	17	3	6	1	268
Shallow-water DIC casts	8	–	4	–	4	4	–	–	–	20
Chlorophyll water samples	81	27	32	54	35	22	–	15	4	270
Nutrient water samples	81	27	32	53	35	22	–	15	4	269
Salinity water samples	8	–	3	4	4	4	–	–	–	23
Microbiology water samples	28	12	8	20	8	12	–	8	–	96
Shipboard CTD casts	6	3	2	5	2	3	0	5	3	29
Scuba dives	360	143	99	220	98	79	32	86	6	1123

SE-08-10 Cruise Report

Table 2.--Fuel consumption during the SE-08-10 MHIRAMP cruise for 3 SAFE boats and 1 Avon boat.

Island Visited	Dates Surveyed	SE-8 (towed diver)				SE-6 (O-team)				SE-4 (REA Benthic)				SE-3 (REA Fish1)			
		5.8-m CRED SAFE boat				5.8-m CRED SAFE boat				4.6-m OES SAFE boat				CRED Avon			
		coxn	Fuel Used (gal)	Distance Traveled (km)	Load Carried (lb)	coxn	Fuel Used (gal)	Distance Traveled (mi)	Load carried (lb)	coxn	Fuel Used (gal)	Distance Traveled (mi)	Load carried (lb)	coxn	Fuel Used (gal)	Distance Traveled (mi)	Load carried (lb)
MAI	10/17	KL	16	32	1500	FM	-	45	800	DR	-	-	1400	JS	4	15	1200
MAI	10/18	KL	20	43	1500	FM	26	27	800	DR	18	12	1400	JS	4	15	1200
LAN	10/19	KL	25	65	1500	FM	-	56	800	LS	20	20	1400	JS	4	12	1200
LAN	10/20	KL	25	40	1500	FM	-	36	800	JS	18	18	1400	DR	4	12	1200
MOL	10/21	KL	20	50	1500	FM	-	42	800	LS	10	8	1400	JS	4	12	1200
MAI	10/22	KL	12	25	1500	FM	-	43	800	JS	5	5	1400	LS	4	12	1200
MAI	10/23	KL	15	34	1500	FM	-	36	800	LS	12	12	1400	JS	5	16	1200
MOL	10/24	KL	12	30	1500	FM	-	30	800	JS	13	15	1400	LS	4	12	1200
MAI	10/25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HAW	10/26	KL	18	40	1500	FM	-	40	800	LS	20	15	1400	MD	6	10	1200
HAW	10/27	KL	18	41	1500	FM	-	45	800	LS	20	20	1400	MD	4	10	1200
HAW	10/28	KL	18	60	1500	FM	30	43	800	MD	12	16	1400	LS	4	16	1200
HAW	10/29	KL	20	40	1500	FM	-	35	1200	LS	15	20	1400	MD	3	10	1200
HAW	10/30	KL	25	50	1500	FM	-	35	1200	MD	10	12	1400	LS	4	15	1200
HAW	10/31	KL	20	45	1500	FM	25	64	800	LD	25	25	1400	MD	7	30	1200
HAW	11/1	KL	12	30	1500	FM	-	26	1200	MD	10	12	1400	LS	4	15	1200
HAW	11/2	KL	12	25	1500	FM	-	30	800	LS	10	12	1400	MD	3	10	1200
MAI	11/3	KL	25	50	1500	FM	-	20	800	MD	8	8	1400	LS	4	10	1200
OAH	11/4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
KAU	11/5	KL	20	43	1500	FM	-	32	1200	LS	14	12	1400	MD	4	8	1200

SE-08-10 Cruise Report

Island Visited	Dates Surveyed	SE-8 (towed diver)				SE-6 (O-team)				SE-4 (REA Benthic)				SE-3 (REA Fish1)			
		5.8-m CRED SAFE boat				5.8-m CRED SAFE boat				4.6-m OES SAFE boat				CRED Avon			
		coxn	Fuel Used (gal)	Distance Traveled (km)	Load Carried (lb)	coxn	Fuel Used (gal)	Distance Traveled (mi)	Load carried (lb)	coxn	Fuel Used (gal)	Distance Traveled (mi)	Load carried (lb)	coxn	Fuel Used (gal)	Distance Traveled (mi)	Load carried (lb)
KAU	11/6	KL	20	60	1500	FM	-	46	800	MD	18	20	1400	LS	5	20	1200
KAU	11/7	KL	15	35	1500	FM	-	45	800	LD	15	18	1400	MD	5	12	1200
NII	11/8	KL	10	25	1500	FM	-	22	1000	MD	10	8	1400	LS	4	14	1200
NII/ LEH	11/9	KL	12	30	1500	FM	-	32	800	LD	15	10	1400	MD	3	5	1200
NII	11/10	JA	15	15	1500	FM	-	35	800	MD	15	10	1400	LS	4	10	1200
⁵ FATHOM	11/11	JA	2	5	1500	FM	-	5	1200	-	-	-	-	-	-	-	-
OAH	11/12	JA	15	30	1500	FM	-	30	800	LS	12	7	-	MD	4	7	-
OAH	11/13	JA	10	20	1500	FM	-	15	1200	DR	8	12	-	MD	4	12	-

Table 3.--Fuel consumption during the SE-08-10 MHIRAMP cruise, recorded for 1 Avon boat and 1 Achilles boat.

Island Visited	Dates Surveyed	SE-5 (REA Fish2)				SE-2 (REA ARMS)			
		CRED Avon				4.6-m OES Achilles			
		Coxn	Fuel Used (gal)	Distance Traveled (mi)	Load Carried (lb)	Coxn	Fuel Used (gal)	Distance Traveled (mi)	Load Carried (lb)
MAI	10/17	JB	4	8	900	LS	–	–	500
MAI	10/18	JB	3.5	8	900	LS	5	5	500
LAN	10/19	JB	5	13	900	DR	4	10	500
LAN	10/20	JB	4	11	1100	LS	4	15	500
MOL	10/21	JB	3.5	9	900	DR	4	15	500
MAI	10/22	JB	6	16	1100	DR	4	15	500
MAI	10/23	JB	7	26	900	DR	6	20	500
MOL	10/24	JB	9.5	13	900	DR	6	20	500
MAI	10/25	–	–	–	–	–	–	–	–
HAW	10/26	JB	4.5	14	900	DR	4.5	25	500
HAW	10/27	JB	5	16	900	DR	4	18	500
HAW	10/28	JB	4.5	14	900	DR	4	16	500
HAW	10/29	JB	4	11	900	–	–	–	–
HAW	10/30	JB	5	16	900	DR	3.5	15	500
HAW	10/31	JB	6	17	900	DR	4.5	25	500
HAW	11/1	JB	3.5	10	900	DR	2	10	500
HAW	11/2	JB	3	9	900	DR	2.5	10	500
MAI	11/3	JB	3.5	10	900	DR	3	12	500
OAH	11/4	–	–	–	–	–	–	–	–
KAU	11/5	JB	5	16	900	DR	2	10	500
KAU	11/6	JB	6	24	900	DR	12	20	500
KAU	11/7	JB	5	17	900	DR	5	18	500
NII	11/8	JB	3.5	10	900	DR	3	10	500
NII/LEH	11/9	JB	4	10	900	DR	2.5	8	500
NII	11/10	JB	4	9	900	DR	1	3	500
FIVE FATHOM	11/11	–	–	–	–	–	–	–	–
OAH	11/12	JB	4	11	900	DR	2	5	300
OAH	11/13	JB	3.5	10	900	–	–	–	–

Notes: KL: Kevin Lino; JA: Jake Asher; FM: Frank Mancini; JB: James Barlow; DR: Doug Roberts; LS: Lester Scott; JS: Jeff Sage; MD: Mills Dunlap.

MISSIONS:

- A. Conduct ecosystem monitoring of the species composition, abundance, percentage of cover, size distribution, and general health of the fish, corals, other invertebrates, and algae of the shallow-water (< 35 m) coral reef ecosystems of the main Hawaiian Islands, including Hawai`i, Kaua`i, Lāna`i, Maui, Moloka`i, Ni`ihau, Lehua, Kaula Rock/Five Fathom Pinnacle, and O`ahu.
- B. Deploy and recover an array of subsurface WTRs, STRs, and EARs to allow remote long-term monitoring of oceanographic and environmental conditions affecting coral reef ecosystems of the main Hawaiian Islands.
- C. Collect water samples for analysis of nutrient and chlorophyll levels.
- D. Conduct shipboard CTD casts to a depth of 500 m and shallow-water CTD casts from small boats to a depth of ~ 30 m around reef ecosystems to examine physical and biological linkages supporting and maintaining these island and atoll ecosystems.
- E. Determine the existence of threats to the health of these coral reef resources from anthropogenic sources, including marine debris.

RESULTS:

See Appendices B–J.

SCIENTIFIC PERSONNEL:

Rapid Ecological Assessment (REA)

Benthic

Bernardo Vargas-Ángel, Chief Scientist, Coral, UH-JIMAR, PIFSC-CRED*
Stephanie Schopmeyer, Benthic REA Team Lead, Coral, UH-JIMAR, PIFSC-CRED
Cristi Richards, Alage, UH-JIMAR, PIFSC-CRED
Max Sudnovsky, Invertebrate-ARMS, UH-JIMAR, PIFSC-CRED
Kevin O'Brien, Invertebrate-ARMS, UH-JIMAR, PIFSC-CRED
Ronald Hoeke, Invertebrate-ARMS, UH-JIMAR, PIFSC-CRED

Fish

Marc Nadon, Fish REA Team Lead, UH-JIMAR, PIFSC-CRED
Paula Ayotte, UH-JIMAR, PIFSC-CRED
Marie Ferguson, UH-JIMAR, PIFSC-CRED
Kostantinos Starnouli, DAR**
Darla White, UH/DAR**

Towed-diver Surveys

Kevin Lino, Towed-diver Team Lead, Fish, UH-JIMAR, PIFSC-CRED
Benjamin Richards, Fish, UH-JIMAR, PIFSC-CRED
Edmund Coccagna, Benthic, UH-JIMAR, PIFSC-CRED
Jason Helyer, Benthic, UH-JIMAR, PIFSC-CRED
Jacob Asher, Benthic, UH-JIMAR, PIFSC-CRED

Oceanography

Frank Mancini, Team Lead, UH-JIMAR, PIFSC-CRED
Daniel Merritt, UH-JIMAR, PIFSC-CRED
Noah Pomeroy, UH-JIMAR, PIFSC-CRED
Oliver Vetter, UH-JIMAR, PIFSC-CRED
Jamison Gove, UH-JIMAR, PIFSC-CRED

Microbial Biology

Tracey McDole, San Diego State University

Outreach and Education

Greg Marshal, National Geographic Society
Kyler Abernathy, National Geographic Society

Data Manager

Haiying Wang, UH-JIMAR, PIFSC-CRED

* University of Hawai'i (UH) Joint Institute for Marine and Atmospheric Research (JIMAR), Pacific Island Fisheries Science Center (PIFSC) Coral Reef Ecosystem Division (CRED).

** State of Hawai'i Division of Aquatic Resources (DAR).

DATA COLLECTED:

- Digital images from photoquadrats.
- Algal voucher specimens necessary for algal species identification.
- Benthic line-point intercept data.
- Coral community structure data, including number of colonies by species within belt transects of known area and overall coral colony density per site.
- Coral community structure data, including size-class metrics by species within belt transects of known area.
- Digital still photos of overall character of REA survey sites and typical benthos at each site.
- Field notes on signs of coral bleaching or disease.
- Quantitative survey data for coral bleaching and disease prevalence.
- Digital images of diseased coral.
- Voucher tissue samples of diseased coral for histopathological analysis.
- Density counts of targeted organisms within belt transects.
- Urchin test size diameters.
- Installation of ARMS to eventually provide an index of biodiversity.
- Digital images of noncoral marine invertebrates.
- Samples of targeted species undergoing genetic connectivity work throughout the Hawai'i Archipelago.
- Transect surveys of all fish ≥ 1 cm in 600 m², ID to species and estimate size.
- Fish species presence checklists for community diversity estimates at each site.
- Digital images of rare or interesting fish species.
- Digital images of the benthic habitat from towed-diver surveys.
- Macroinvertebrate counts from towed-diver surveys.

- Quantitative surveys of reef fishes (> 50 cm in total length) to species level from towed-diver surveys.
- Habitat lineation from towed-diver surveys.
- Benthic composition estimations from towed-diver surveys.
- Shipboard CTD profiles to 500 m with fluorometer attached.
- Water samples to 500 m: chlorophyll and nutrients, 5 depths per cast; carbonate chemistry, 2 depths per cast.
- Shallow-water CTD casts: 30 m with transmissometer and dissolved oxygen sensor attached.
- Shallow-water samples to 30 m: chlorophyll and nutrients, 4 depths per cast; carbonate chemistry, 2 depths per cast.
- Benthic carbonate chemistry sampling.
- Sea surface and subsurface temperature at variable depths.
- Sea surface and subsurface salinity at variable depths.
- Spectral wave energy and tidal elevation.
- Directional ocean currents.
- EAR data.

(/s/Bernardo Vargas-Ángel)

Submitted by: _____
Bernardo Vargas-Ángel, PhD
Chief Scientist

(/s/Michael Seki) for

Approved by: _____
Samuel Pooley, PhD
Science Director
Pacific Islands Fisheries Science Center

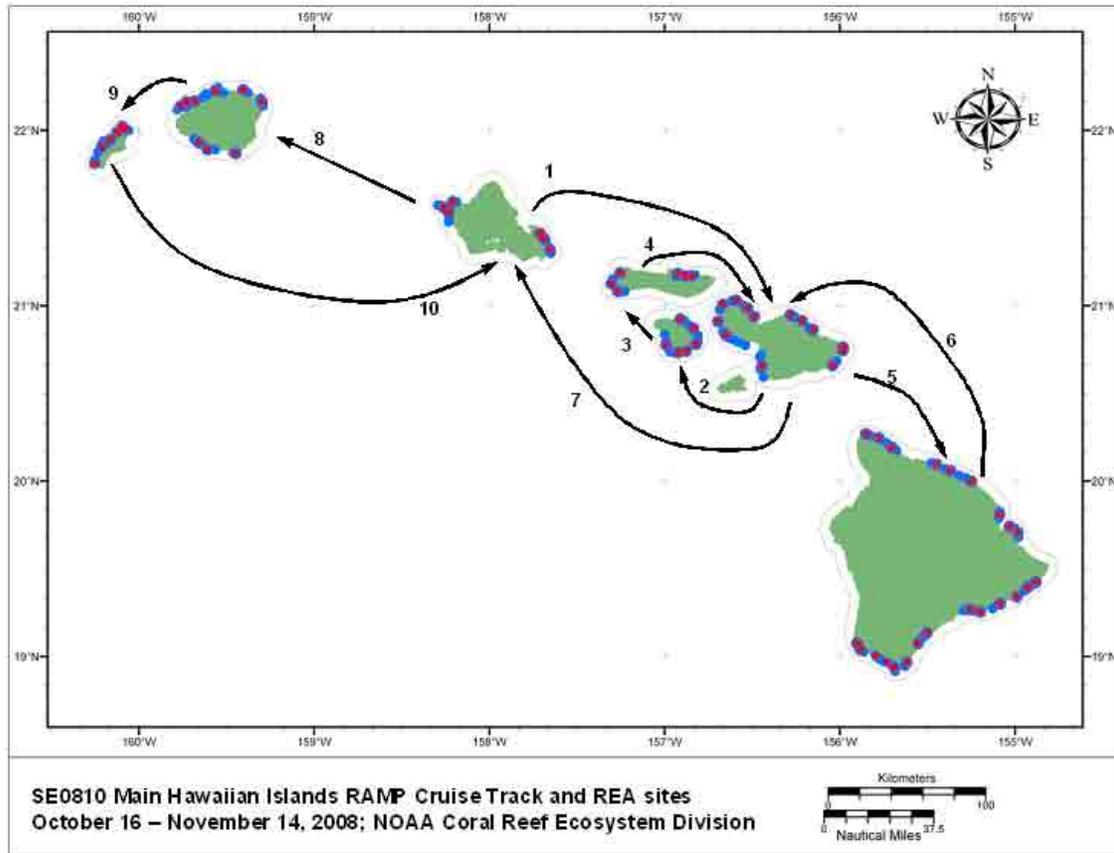


Figure 1.--Track of the NOAA Ship *Oscar Elton Sette* and the REA survey sites during the SE-08-10 main Hawaiian Island RAMP cruise, October 16–November 14, 2008.

Appendix A: Methods

A.1. Oceanography and Water-quality Methods

(*Frank Mancini, Jamie Gove, Oliver Vetter, Daniel Merritt, Noah Pomeroy, and Tracey McDole*)

The Coral Reef Ecosystem Division (CRED) has been conducting multidisciplinary research in the main Hawaiian Islands since 2005. The recovery and deployment of instrument platforms and the continuation of oceanographic measurements represent ongoing monitoring of some of the oceanographic properties around the islands. During the SE-08-10 main Hawaiian Islands (MHI) Reef Assessment and Monitoring Program (RAMP) cruise, the oceanography team used established methods to monitor long-term trends and variability in temperature, wave climate, water chemistry, and acoustic signals in the nearshore water of the MHI.

Long-term oceanographic monitoring in the main Hawaiian Islands was accomplished by deployment and retrieval of a variety of internally recording and near real-time telemetered instrument platforms, including the following instruments:

- Wave-and-tide recorders (WTR): Measure surface gravity waves, tides, and subsurface water temperature.
- Subsurface temperature recorders (STR): Measure high-resolution subsurface water temperature.
- Ecological acoustic recorders (EAR): Record ambient subsurface biotic and abiotic sounds.

In situ oceanographic and water chemistry monitoring were conducted by implementing the following sampling techniques:

- Shallow-water conductivity-temperature-depth (CTD) casts (max. depth 30 m) conducted from small boats at regularly spaced intervals along the 30-m isobath around each island/atoll/shoal with an SBE 19*plus* Seacat Profiler (Sea-Bird Electronics Inc.), which is a conductivity, temperature, and depth recorder, a C-Star (WET Labs Inc.) auxiliary transmissometer, and an SBE 43 oxygen sensor. Shallow vertical water profiles provide insight into local water property variation and water mass interactions.
- Shallow-water benthic carbonate chemistry sampling over various calcifying reef habitats. Typically, sites were chosen based on various degrees of coral cover and were on or near established benthic REA sites so that the biological data can later be correlated with the carbonate chemistry analyses. Water samples (for later analysis of dissolved inorganic carbon [DIC] and total alkalinity [A_T]) and “static” CTD casts were carried out at 2 nearby sites (e.g., within ~ 50 ft of each other at the same depth range and habitat type) directly above the reef: 1 site in the mid depth of the water column and 1 site just beneath the surface to yield a crude vertical profile of the seawater carbonate chemistry. One salinity sample was collected at each benthic site to calibrate the CTD cast data.
- Shipboard deepwater CTD casts conducted from the NOAA Ship *Oscar Elton Sette* with an SBE 911*plus*, an auxiliary SBE 43 dissolved oxygen sensor, and an *ECO* FLNTU (WET Labs Inc.) combination fluorometer and turbidity sensor. Shipboard CTD casts to 500 m—complemented by water samples collected at the depths of 3 m, 80 m, 100 m,

125 m and 150 m for nutrient and chlorophyll analysis—were conducted along a latitudinal transect of permanent stations. Additionally, water samples subsequently analyzed for seawater carbonate chemistry, specifically for dissolved inorganic carbon (DIC) and total alkalinity (A_T), were collected at the depth of 3 m and at the depth closest to ~ 50 m below the mixed layer depth, which is determined real-time from the downward shipboard CTD cast and is usually the depth of 125 or 150 m. One salinity sample was collected during each deepwater CTD cast to calibrate the CTD cast.

- Surface and subsurface water temperatures as a function of depth were continuously recorded during all towed-diver operations, providing a broad and diverse spatial and thermal sampling method. For site and isobath information, refer to the activity summary for the towed-diver habitat/fish survey team, which is provided in each of the island-area appendices. These data are part of the towed-diver team ArcView (ESRI) project.
- Shipboard meteorological observations including wind speed and direction, relative humidity, air temperature, and barometric pressure.
- Shipboard oceanographic measurements of sea surface temperature, salinity, and currents using an acoustic Doppler current profiler (ADCP).

A.1.1 Oceanography and Water-quality Data

- A total of 29 permanent shipboard CTD site stations were sampled around the main Hawaiian Islands during the SE-08-10 MHIRAMP cruise (Fig. A.1.1). At each of these sites, a CTD profile collecting temperature, conductivity, and pressure data to a depth of 500 m was performed. Concurrent with CTD casts, 142 water samples were collected for later analyses for chlorophyll and nutrients at depths of 3 m, 80 m, 100 m, 125 m and 150 m. In addition, 8 water samples were collected for later carbonate chemistry analyses, and 16 samples were collected for salinity values at select depths. The water samples were processed and stored according to the protocols of Dickson et al. (2007) and were shipped to NOAA's Pacific Marine Environmental Laboratory (PMEL) for post-cruise analysis.

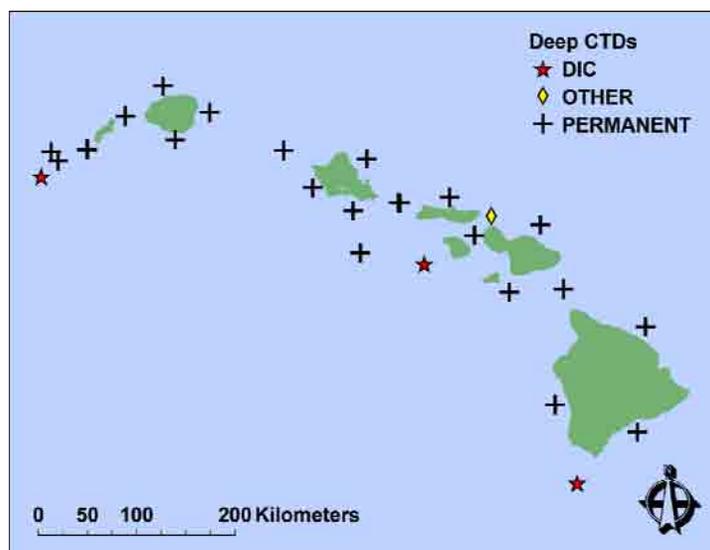


Figure A.1.1.--Shipboard CTD locations visited during the SE-08-10 MHIRAMP cruise for the entire main Hawaiian Islands.

Table A.1.1.--Shipboard CTD casts.*

CAST TYPE			TOTAL
PERMANENT	DIC	OTHER	
25	3	1	29

Table A.1.2.--Shipboard water samples.*

SAMPLE TYPE			
CHL	NUT	DIC	SAL
142	142	8	16

* The following list applies to the table above: CHL = chlorophyll-*a*; NUT = nutrients; DIC = dissolved inorganic carbon; SAL = salinity.

A.2. Rapid Ecological Assessment Methods

(Fish: Marc Nadon, Kosta Stamoulis, Marie Ferguson, Kevin O'Brien, Paula Ayotte, Darla White; Coral: Stephanie Schopmeyer, Bernardo Vargas-Ángel; Algae: Cristi Richards; Invertebrates-ARMS: Max Sudnovsky; Ron Hoeke, and Kevin O'Brien)

Every effort was made to revisit long-term monitoring sites first established in 2005–2006 and part of the ongoing RAMP (Table A.2.1). At each site visited in 2008, three 25-m transect lines were laid out by the fish team, separated from each other by ~ 2–3 m. At most sites, transects were laid out at between 3–15 m depth. The fish REA team also conducted additional surveys at haphazardly selected sites (Table A.2.2). The following text in this appendix reveals the REA methods for each specific discipline:

A.2.1. Algae

OBJECTIVES OF STUDY:

- Determine which macroalgal species are present in each island ecosystem and in what quantity;
- Examine how algal diversity and abundance change over time;
- Assess whether changes in algal populations serve as good environmental indicators of reef health;
- Formulate biogeographical hypotheses about algal dispersal and evolution using qualitative and quantitative data from island groups around the Pacific.

The goal of algal surveys is to quantitatively describe the algal community and prepare a comprehensive species list for each site. Working at depths of 3–16 m with teams from other biological disciplines that use other existing rapid assessment protocols, a line-point intercept method for algal assessment has been created that minimizes time in the water yet yields the greatest amount of data possible. A single phycologist (usually teamed with the macroinvertebrate diver during field surveys) collected data using a line-point intercept method and recorded the macroalgal species, algal functional group, coral species, noncoral invertebrate functional group, and substrate type at 20-cm intervals along two 25-m transect lines on a sheet of waterproof paper. Additionally, a roving-diver swim at the end of the dive that covered a 3-m swath on either side of the transect line was used to record specimen not observed along the

transects themselves. One specimen of each species that could not be identified in the field was collected by hand. If samples could be identified in the field, no samples were collected. Algal species inventories and percentage of cover were to be generated from data collected at each site. A high-resolution digital camera mounted on a 0.18-m² photoquadrat frame was also used to create permanent historical records of benthic marine substrates at each site.

Numerous species of algae unknown to science are frequently found around Pacific islands. The possibility of describing new species (and, thus, increasing our understanding of biodiversity) is great. Detailed microscopic analysis and the placement of holotype specimens in internationally accepted herbaria are a necessary part of this process. Additionally, an understanding of algal species ranges and genetic similarity across Pacific islands will enable biogeographic hypotheses to be formulated and provide information for marine dispersal mechanisms useful to biologists in many different disciplines. Ultimately, field-collected algal specimens will be critically analyzed in the laboratory to ensure positive species identification, will be catalogued, and will subsequently be placed in research institutions where they can be accessed by researchers interested in a suite of topics. After identification, provisions will be made to ensure appropriate preservation and curation of each algal specimen, providing a historical record that will be available to future researchers.

A.2.2. Corals

At each site, the first two 25-m transects laid out by the fish team were the focal point of the coral community structure and health surveys. Within each transect, five 2.5-m segments were surveyed (beginning at points: 0-, 5-, 10-, 15-, and 20-m), whereby in each segment, all coral colonies whose center fell within 0.5 m of either side of the transect line were identified to species and 2 planar size metrics collected: maximum diameter and diameter perpendicular to the maximum diameter. In addition, the extent of mortality, both recent and old, was estimated for each colony. Observers paid special attention to identifying as best as possible the extent of the former live colony. When a coral colony exhibited signs of disease or compromised health, additional information was recorded including type of affliction (bleaching, skeletal growth anomaly, white syndrome, tissue loss other than white syndrome, trematodiasis, necrosis, other, pigmentation responses, algal overgrowth, and predation), severity of the affliction (mild, moderate, marked, severe, acute), as well as photographic documentation and sometimes tissue samples. Tissue samples were catalogued and fixed in buffered zinc-formalin solution for further histopathological analyses.

A.2.3. Noncoral Invertebrate Surveys

Quantitative counts and percentage of cover for specific target marine invertebrates were conducted along 2 separate belt transects (1 × 25 m) at 5-m intervals. Size frequency distribution of urchin species were recorded for the first 25 individuals of each species. 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 generally visible (i.e., noncryptic) and easily enumerated during the course of a single 50–60-min dive.

These target species are listed below:

CNIDARIA

Zoanthid—rubber coral

Actiniaria—anemones (*Heteracti*, *Stichodactyla*, *Phymanthus*, etc)

ECHINODERM

Echinoid—sea urchin

Holothuroid—sea cucumber

Asteroid—seastar

MOLLUSCA

Bivalves—spondylid oyster, pearl oyster, tridacnid clam (giant clam)

Large Gastropods—*Charonia* (Triton's Trumpet) and *Lambis* sp. (spider conch)

Coralliophilidae gastropod

Cephalopod—octopus

CRUSTACEA

Hermit crab, lobster, and large crab

Specific in situ methods for each transect

Conduct enumerations at 5-m intervals along the transect line (1 × 25 m):

- Count all species of urchin. Also record test diameter for the first 25 of all species present
- Presence/absence (P/A) for octocoral (*Carijoa*), zoanthid, colonial anemone
- Count cnidarian = anemone (diameter > 7 cm), sea fan
- Count holothuroid = all visible species
- Count asteroid = all visible species
- Count molluscs = bivalves (*Pinctada* and *Tridacna*), large gastropods (*Charonia* and *Lambis*), Coralliophilidae gastropod
- Count Crustacea = large hermit crabs (e.g., *Dardanus* sp. and *Aniculus maximus*), large brachyuran (*Carpilius*, *Etisus*, and *Dromia*), spiny and slipper lobsters, trapezid crab, and small hermit crab

A.2.3. Autonomous Reef Monitoring Systems (ARMS)

ARMS were deployed at selected forereef habitats around the main Hawaiian Islands. ARMS provide a mechanism to quantify marine invertebrates that are not easily identifiable or accountable on the transect lines. They remain on the benthos for 2 years, enabling the recruitment and colonization of lesser known, cryptic marine invertebrates.

A.2.4. Fish

The fish team, composed of 4 divers, conducted belt-transect surveys at preselected sites. Two separate teams, consisting of 2 divers each, were deployed to conduct these surveys. The first team (fish team 1) accompanied the benthic REA team and conducted 3 belt-transect surveys at

each previously visited permanent site. The second team (fish team 2) was deployed on a separate boat and surveyed new, randomly chosen sites. A total of 2 belt-transect surveys were conducted at each new site, and divers took note of substrate type, coral and algal cover, and habitat complexity. Sites were predetermined from satellite imagery and fell into 3 depth categories: shallow (0–6 m), mid (6–18 m), and deep (18–29 m). Surveys were performed using a 25-m line set along a single depth contour. As the line was set, 2 observers swam along either side of the line identifying, counting, and sizing all fishes > 20 cm in total length within an area 25 m long and 4 m wide. The divers then returned along their respective sides of the transect line identifying, counting, and sizing all fishes < 20 cm in total length in a belt 2 m wide and 25 m long. Compass headings and depth of transect lines were recorded for each transect. No collection efforts were made by the fish teams during this survey period.

Table A.2.1.--Established CRED long-term REA monitoring 2005–2006.

SITE ID	Date	Latitude (N)	Longitude (W)	General Location
MOL-1	7/31/2005	21	12.192	-157 15.168 Kawakiunui
MOL-2	8/1/2005	21	7.496	-157 18.193 Kahaiawa Point
MOL-3	8/1/2005	21	4.980	-157 16.027 Kanalukaha Beach
MOL-4	8/1/2005	21	4.827	-157 12.936 Halena
MOL-5	7/29/2006	21	11.164	-157 15.207 Kepuhi Bay; off Sheraton Beach
MOL-6	8/14/2006	21	11.046	-156 55.472 Mokapu Islet, E of Kalaupapa Ridge between Pelekunu Bay and
MOL-7	8/14/2006	21	10.194	-156 52.707 Mokohola Islet
LAN-1	8/2/2005	20	54.814	-157 3.281 Ka`ena Point
LAN-2	8/2/2005	20	52.011	-157 2.608 Ka`apahu
LAN-3	8/2/2005	20	46.520	-156 59.394 Kaumalapau
LAN-3	8/5/2006	20	46.506	-156 59.379 Kaumalapau
LAN-4	8/3/2005	20	46.772	-156 49.247 Huawai Bay
LAN-4	8/4/2006	20	46.799	-156 49.219 Huawai Bay
LAN-5	8/3/2005	20	44.462	-156 52.541 Kapo`ili`ili Bay
LAN-5	8/4/2006	20	44.469	-156 52.545 Kapo`ili`ili Bay
LAN-6	8/3/2005	20	44.019	-156 55.299 Kaumalapau
LAN-6	8/5/2006	20	44.022	-156 55.279 Kaumalapau
LAN-7	8/5/2006	20	52.234	-156 50.088 Kainehe Beach
LAN-8	8/4/2006	20	55.429	-156 54.595 Po`aiwa
OAH-1	2/24/2005	21	18.705	-158 7.639 Cape Flattery grounding
OAH-2	7/14/2005	21	33.682	-158 15.695 Ka`ena Point
OAH-3	7/22/2005	21	35.470	-158 12.571 Dillingham
OAH-4	7/22/2005	21	32.024	-158 13.997 Makua
OAH-5	7/22/2005	21	27.593	-158 13.070 Makaha
OAH-6	7/23/2005	21	31.987	-157 49.230 Kualoa
OAH-7	7/23/2005	21	35.552	-157 52.268 Punaluu
OAH-8	7/23/2005	21	41.111	-158 2.805 Waialeale
OAH-9	7/24/2005	21	41.787	-158 2.256 COT outbreak
OAH-10	7/24/2005	21	36.725	-158 6.676 Haleiwa
OAH-11	7/24/2005	21	35.424	-158 9.074 Mokuleia
OAH-12	7/27/2006	21	19.151	-157 39.246 Flat Island
OAH-13	8/7/2006	21	17.184	-158 2.429 Ewa
KAU-1	7/15/2005	22	3.232	-159 18.801 Waipouli
KAU-2	7/15/2005	22	9.919	-159 17.943 Anahola
KAU-2	7/28/2006	22	9.938	-159 17.574 Anahola
KAU-3	7/15/2005	22	13.836	-159 24.320 Kilauea Pt.
KAU-3	7/28/2006	22	13.838	-159 24.326 Kilauea Pt.
KAU-4	7/16/2005	21	57.564	-159 19.700 Nawiliwili

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SITE ID	Date	Latitude (N)	Longitude (W)	General Location
KAU-5	7/16/2005	21	52.136	-159 26.833 Hanapepe
KAU-6	7/16/2005	21	53.380	-159 36.529 Port Allen
KAU-7	7/20/2005	22	13.266	-159 35.502 Haena
KAU-8	7/20/2005	22	10.011	-159 40.810 S of Kalalau Valley
KAU-9	7/20/2005	22	6.752	-159 44.812 Inshore from Mana Reef
KAU-10	7/21/2005	22	0.992	-159 47.641 Missile Range
KAU-11	7/21/2005	21	57.158	-159 42.910 Kekaha
KAU-12	7/21/2005	21	55.821	-159 39.569 Pahala
KAU-13	7/28/2006	22	13.588	-159 33.877 Tunnels area
KAU-14	8/13/2006	22	9.669	-159 43.746 N end Mana Reef
Begin drift	8/13/2006	22	8.700	-159 44.950 S to N, 0.53 km drift dive
End drift	8/13/2006	22	8.952	-159 44.825
KAU-15	8/13/2006	22	8.263	-159 45.680 mid-section Mana Reef
NII-1	7/17/2005	21	57.125	-160 3.761 Poleho
NII-1	8/9/2006	21	57.118	-160 3.744 NE side, S of Kaunuopou Pt.
NII-2	7/17/2005	21	52.519	-160 7.342 Kalaloa Valley
NII-3	7/17/2005	21	49.010	-160 11.130 Kowahi
NII-3	8/9/2006	21	49.001	-160 11.151 SE side, N of Kawaihoa
NII-4	7/19/2005	21	59.439	-160 7.235 Puuokoae
NII-5	7/19/2005	21	54.415	-160 12.647 Puuwai
NII-5	8/11/2006	21	54.415	-160 12.656 W side, Puuwai
NII-6	7/19/2005	21	48.777	-160 15.017 Pahau Point
NII-7	8/9/2006	22	0.408	-160 4.738 N side, W of Kikepa Pt.
NII-8	8/11/2006	21	47.204	-160 13.410 S side, Leahi
NII-9	8/11/2006	21	56.746	-160 9.798 W side, Kaununui
LEH-1	7/18/2005	22	0.987	-160 5.480 SE side
LEH-1	8/12/2006	22	0.987	-160 5.486 SE side
LEH-2	7/18/2005	22	1.302	-160 5.644 Inside caldera
LEH-2	8/12/2006	22	1.294	-160 5.633 inside caldera
LEH-3	7/18/2005	22	1.274	-160 6.093 West side
LEH-3	8/12/2006	22	1.278	-160 6.096 West side
KAL-1	8/10/2006	21	39.310	-160 32.619
KAL-2	8/10/2006	21	39.166	-160 32.713
MAI-1	2/25/2005	20	45.736	-155 58.790 Hana
MAI-2	2/25/2005	20	51.908	-156 9.142 Keanae Pt.
MAI-3	2/26/2005	20	37.436	-156 10.859 Nu'u
MAI-3	8/1/2006	20	37.410	-156 10.692 Nu'u
MAI-4	8/4/2005	20	34.748	-156 24.253 Kamanamana
MAI-5	8/4/2005	20	43.486	-156 27.387 Kaluiahakoko
MAI-6	8/4/2005	20	39.312	-156 26.739 Nahuna
MAI-7	8/5/2005	21	0.471	-156 40.089 NW side W Maui
MAI-8	8/5/2005	20	49.922	-156 38.888 Launiupoko Pt.
MAI-9	8/5/2005	20	47.441	-156 35.025 Ukumehame
MAI-10	7/30/2006	20	59.212	-156 31.613 Hakuhee Pt.
MAI-11	7/30/2006	21	0.131	-156 32.904 Kahakuloa
MAI-12	7/30/2006	21	1.820	-156 35.340 Nakalele Pt.
MAI-13	7/31/2006	20	44.743	-155 58.724 Kauiki Head
MAI-14	7/31/06	20	37.200	-156 8.500 Kailio Pt.
MAI-15	7/31/06	20	39.583	-156 2.466 Puhilele Pt.
MAI-16	8/1/2006	20	35.555	-156 16.781 Alena
MAI-17	8/1/2006	20	34.804	-156 20.578 Auwahi
MAI-18	8/19/2006	20	48.445	-156 2.128 Kalahu Pt.
MAI-19	8/19/2006	20	54.845	-156 12.864 near Waipio Bay
MAI-20	8/19/2006	20	56.878	-156 16.904 Opana Pt.
MOK-1	8/6/2005	20	37.815	-156 29.797 S side

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SITE ID	Date	Latitude (N)	Longitude (W)	General Location
MOK-2	8/6/2005	20	38.014	-156 29.930 W point
MOK-3	8/6/2005	20	37.930	-156 29.815 Inside caldera
HAW-1	2/27/2005	19	48.504	-155 5.275 Onomea Bay
HAW-2	2/27/2005	19	50.539	-155 4.965 Pepe'ekeo
HAW-3	2/27/2005	19	51.836	-155 5.205 Lehuawehi Pt.
HAW-4	2/28/2005	20	14.406	-155 53.680 Puakea Pt.
HAW-5	2/28/2005	20	12.721	-155 54.236 Ha'ena Pt.
HAW-6	2/28/2005	20	11.490	-155 54.217 Maka O Hule Pt.
HAW-7	3/1/2005	19	29.134	-154 49.066 Wai'opae
HAW-8	3/1/2005	19	25.429	-154 52.838 Opihikao
HAW-8	8/17/2006	19	25.438	-154 52.836 Opihikao
HAW-9	3/1/2005	19	23.637	-154 55.643 Kehena
HAW-10	3/2/2005	19	15.195	-155 11.822 Apua
HAW-11	3/2/2005	19	16.032	-155 15.322 Halape
HAW-12	3/3/2005	18	57.925	-155 37.062 Ka'alu'alu Bay
HAW-12	8/16/2006	18	57.930	-155 37.057 Ka'alu'alu Bay
HAW-13	3/3/2005	18	55.328	-155 41.064 Ka Lae Northwest
HAW-14	3/3/2005	18	56.339	-155 41.305 Ka Lae Northwest
HAW-15	3/4/2005	19	8.592	-155 27.908 Kamehame Beach
HAW-15	8/16/2006	19	8.593	-155 27.912 Kamehame Beach
HAW-16	3/4/2005	19	8.029	-155 30.068 Punalu'u
HAW-16	8/16/2006	19	8.031	-155 30.060 Punalu'u
HAW-17	3/4/2005	19	4.527	-155 33.151 Ka'alela
HAW-18	3/5/2005	19	32.849	-154 51.050 Maka Ukiu Pt.
HAW-19	3/5/2005	19	39.771	-154 58.384 Ha'ena
HAW-20	8/2/2006	20	11.452	-155 42.247 Offshore islet S of Polulu Valley
HAW-21	8/2/2006	20	14.829	-155 46.595 Keawa'eli Bay
HAW-22	8/3/2006	18	58.134	-155 43.799 Kalipoa
HAW-23	8/3/2006	19	0.354	-155 47.802 Hosaka Pt./Pohue Bay
HAW-24	8/3/2006	19	2.295	-155 52.954 Kauna Pt.
HAW-25	8/15/2006	19	42.464	-154 59.055 Papua'a Bay, S of Hilo Bay
HAW-26	8/15/2006	19	44.491	-155 1.826 Keokeha Pt., Hilo Bay
HAW-27	8/17/2006	19	19.956	-155 0.591 near Kupapa'u Pt.
HAW-28	8/17/2006	19	17.974	-155 5.037 near Kalae'apuki Pt.
HAW-29	8/18/2006	19	59.942	-155 14.964 Hamakua coast: Laupahoehoe Pt.
HAW-30	8/18/2006	20	3.493	-155 21.964 Hamakua coast: Kuka'iau
HAW-31	8/18/2006	20	5.706	-155 26.777 S of Honoka'a
HAW-32	8/2/2006	20	16.022	-155 50.878 Upolu Point

Table A.2.2.--Long-term REA monitoring sites visited during the SE-08-10 MHIRAMP cruise

SITE ID	Date	Latitude (N)		Longitude (W)		REA Team	Depth (ft)	Depth (ft)
MAI-02	10/17/08	20	51.7880	156	9.0790	BENTHIC, FISH	33	42
MAI-19	10/17/08	20	54.8560	156	12.8710	BENTHIC, FISH	36	46
MAI-20	10/17/08	20	56.8620	156	16.8840	BENTHIC, FISH	36	50
MAI-50	10/17/08	20	51.9480	156	9.5680	FISH	60	75
MAI-51	10/17/08	20	52.4560	156	10.4220	FISH	8	15
MAI-52	10/17/08	20	56.1170	156	15.2260	FISH	8	15
MAI-53	10/17/08	20	56.3000	156	16.1590	FISH	60	75
MAI-06	10/18/08	20	39.3250	156	26.6940	BENTHIC, FISH	27	32
MAI-58	10/18/08	20	43.1220	156	26.9150	FISH	6	13
MAI-54	10/18/08	20	35.5960	156	26.1220	FISH	72	78
MAI-55	10/18/08	20	38.3040	156	27.1110	FISH	15	20
MAI-56	10/18/08	20	39.3680	156	26.6900	FISH	10	18
MAI-57	10/18/08	20	42.5180	156	27.3470	FISH	60	70
LAN-08	10/19/08	20	55.3820	156	54.5620	BENTHIC, FISH	42	53
LAN-07	10/19/08	20	52.2240	156	50.0930	BENTHIC, FISH	41	47
LAN-04	10/19/08	20	46.7990	156	49.2230	BENTHIC, FISH	46	52
LAN-54	10/19/08	20	49.7540	156	48.4230	FISH	10	16
LAN-50	10/19/08	20	55.1110	156	53.3910	FISH	65	68
LAN-51	10/19/08	20	54.8430	156	53.2130	FISH	13	16
LAN-52	10/19/08	20	53.3940	156	51.4960	FISH	14	18
LAN-53	10/19/08	20	47.5870	156	48.5710	FISH	60	63
LAN-05	10/20/08	20	44.4820	156	52.5690	BENTHIC, FISH	36	42
LAN-06	10/20/08	20	44.0370	156	55.2990	BENTHIC, FISH	34	40
LAN-03	10/20/08	20	46.4980	156	59.3970	BENTHIC, FISH	35	43
LAN-59	10/20/08	20	50.1190	156	59.8800	FISH	10	18
LAN-55	10/20/08	20	43.9920	156	54.5100	FISH	60	70
LAN-56	10/20/08	20	44.0567	156	57.0250	FISH	16	20
LAN-57	10/20/08	20	44.2600	156	58.1000	FISH	14	19
LAN-58	10/20/08	20	47.4220	156	59.4920	FISH	63	76
MOL-09	10/21/08	21	10.2280	156	50.6240	BENTHIC, FISH	46	41
MOL-07	10/21/08	21	10.1930	156	52.7010	BENTHIC, FISH	40	45
MOL-06	10/21/08	21	11.0190	156	55.4700	BENTHIC, FISH	45	52
MOL-54	10/21/08	21	10.1850	156	55.9460	FISH	10	18
MOL-50	10/21/08	21	10.5350	156	49.4590	FISH	73	77
MOL-51	10/21/08	21	9.9600	156	52.4420	FISH	13	21
MOL-52	10/21/08	21	10.0220	156	53.5690	FISH	14	18
MOL-53	10/21/08	21	10.3270	156	54.8470	FISH	75	82
MAI-21	10/22/08	20	56.1840	156	29.2120	BENTHIC, FISH	30	36
MAI-10	10/22/08	20	59.1900	156	31.6090	BENTHIC, FISH	35	44
MAI-12	10/22/08	21	1.8330	156	35.3990	BENTHIC, FISH	36	47
MAI-61	10/22/08	21	1.7180	156	36.3050	FISH	11	18
MAI-62	10/22/08	20	56.6410	156	29.5660	FISH	65	70
MAI-11	10/22/08	21	0.1370	156	32.8990	FISH	25	45
MAI-59	10/22/08	21	1.8380	156	35.6370	FISH	6	18
MAI-60	10/22/08	21	1.6570	156	37.0210	FISH	60	65
MAI-07	10/23/08	21	0.4460	156	40.0630	BENTHIC, FISH	32	42
MAI-22	10/23/08	20	54.6050	156	41.7380	BENTHIC, FISH	37	43
MAI-08	10/23/08	20	49.9300	156	38.8860	BENTHIC, FISH	28	36
MAI-67	10/23/08	20	48.9300	156	37.7900	FISH	10	14
MAI-63	10/23/08	20	58.6880	156	41.1360	FISH	63	72
MAI-64	10/23/08	20	51.2350	156	39.9080	FISH	9	15

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SITE ID	Date	Latitude (N)		Longitude (W)		REA Team	Depth (ft)	Depth (ft)
MAI-65	10/23/08	20	48.3170	156	36.1800	FISH	9	15
MAI-66	10/23/08	20	47.4940	156	34.6120	FISH	9	15
MAI-68	10/23/08	20	46.4290	156	32.1900	FISH	58	67
MOL-05	10/24/08	21	11.1620	157	15.2020	BENTHIC, FISH	33	42
MOL-02	10/24/08	21	7.4830	157	18.1910	BENTHIC, FISH	35	40
MOL-03	10/24/08	21	4.9660	157	16.0160	BENTHIC, FISH	36	43
MOL-58	10/24/08	21	4.9580	157	14.1260	FISH	10	18
MOL-59	10/24/08	21	9.0750	157	17.7300	FISH	70	79
MOL-55	10/24/08	21	5.1250	157	15.5470	FISH	10	14
MOL56	10/24/08	21	4.9310	157	13.5310	FISH	10	14
MOL-57	10/24/08	21	4.6580	157	14.9230	FISH	60	65
HAW-32	10/26/08	20	16.0300	155	50.8810	BENTHIC, FISH	26	35
HAW-21	10/26/08	20	14.8160	155	46.6090	BENTHIC, FISH	41	53
HAW-20	10/26/08	20	11.5430	155	42.2030	BENTHIC, FISH	34	43
HAW-54	10/26/08	20	10.5910	155	40.5730	FISH	10	18
HAW-50	10/26/08	20	16.2720	155	51.3850	FISH	68	79
HAW-51	10/26/08	20	15.6500	155	49.5520	FISH	18	18
HAW-52	10/26/08	20	13.1700	155	43.9720	FISH	11	16
HAW-53	10/26/08	20	11.9880	155	42.6080	FISH	63	71
HAW-29	10/27/08	19	59.9490	155	14.9690	BENTHIC, FISH	36	45
HAW-30	10/27/08	20	3.5080	155	21.9820	BENTHIC, FISH	43	51
HAW-31	10/27/08	20	5.7020	155	26.7910	BENTHIC, FISH	37	43
HAW-60	10/27/08	20	6.2550	155	28.5190	FISH	13	24
HAW-55	10/27/08	20	1.1480	155	16.6210	FISH	60	75
HAW-56	10/27/08	20	1.9740	155	19.0810	FISH	12	18
HAW-57	10/27/08	20	4.2020	155	23.8020	FISH	12	18
HAW-58	10/27/08	20	5.5050	155	26.3530	FISH	12	18
HAW-59	10/27/08	20	6.1860	155	27.9550	FISH	70	81
HAW-25	10/28/08	19	42.4620	154	59.0560	BENTHIC, FISH	36	42
HAW-26	10/28/08	19	44.4880	155	1.8170	BENTHIC, FISH	31	44
HAW-01	10/28/08	19	48.5230	155	5.3760	BENTHIC, FISH	36	42
HAW-65	10/28/08	19	44.0390	155	1.1330	FISH	34	12
HAW-61	10/28/08	19	40.9430	154	58.6540	FISH	80	95
HAW-62	10/28/08	19	43.9070	154	59.9910	FISH	10	14
HAW-63	10/28/08	19	47.3490	155	5.3550	FISH	10	17
HAW-64	10/28/08	19	49.5150	155	4.9800	FISH	65	76
HAW-08	10/29/08	19	25.4280	154	52.8380	BENTHIC, FISH	34	40
HAW-09	10/29/08	19	23.6270	154	55.6380	BENTHIC, FISH	38	44
HAW-33	10/29/08	19	20.3860	154	59.3690	BENTHIC, FISH	39	47
HAW-66	10/29/08	19	24.4900	154	54.0380	FISH	68	75
HAW-67	10/29/08	19	22.4060	154	56.7440	FISH	64	77
HAW-68	10/29/08	19	20.5710	154	58.9230	FISH	65	73
HAW-28	10/30/08	19	17.9860	155	5.0450	BENTHIC, FISH	28	39
HAW-10	10/30/08	19	15.1950	155	11.8170	BENTHIC, FISH	36	44
HAW-11	10/30/08	19	16.0340	155	15.3300	BENTHIC, FISH	26	35
HAW-74	10/30/08	19	15.9150	155	16.7830	FISH	9	18
HAW-75	10/30/08	19	15.7100	155	17.5400	FISH	70	80
HAW-69	10/30/08	19	16.4210	155	7.6430	FISH	68	70
HAW-70	10/30/08	19	15.6060	155	13.5910	FISH	60	70
HAW-71	10/30/08	19	15.9100	155	14.1380	FISH	10	14
HAW-72	10/30/08	19	15.9360	155	16.8350	FISH	10	20
HAW-16	10/31/08	19	8.0290	155	30.0640	BENTHIC, FISH	30	39

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SITE ID	Date	Latitude (N)		Longitude (W)		REA Team	Depth (ft)	Depth (ft)
HAW-80	10/31/08	19	6.6840	155	31.3750	FISH	16	21
HAW-17	10/31/08	19	4.5280	155	33.1590	BENTHIC, FISH	35	42
HAW-12	10/31/08	18	57.9250	155	37.0920	BENTHIC, FISH	35	40
HAW-76	10/31/08	19	7.3770	155	30.4580	FISH	80	90
HAW-77	10/31/08	19	5.0590	155	32.9860	FISH	15	20
HAW-78	10/31/08	18	56.7070	155	37.5580	FISH	62	77
HAW-34	11/01/08	19	4.4900	155	54.0610	BENTHIC, FISH	40	55
HAW-24	11/01/08	19	2.2950	155	52.9540	BENTHIC, FISH	49	57
HAW-23	11/01/08	19	0.3740	155	47.7780	FISH	40	55
HAW-81	11/01/08	19	4.7960	155	54.4480	FISH	71	75
HAW-82	11/01/08	19	1.5840	155	51.7600	FISH	8	17
HAW-83	11/01/08	18	59.7120	155	46.9780	FISH	70	77
HAW-14	11/02/08	18	56.3390	155	41.2910	BENTHIC, FISH	35	40
HAW-22	11/02/08	18	58.1140	155	43.8510	BENTHIC	40	55
HAW-13	11/02/08	18	55.3220	155	41.0690	FISH	35	43
HAW-23	11/02/08	19	0.3740	155	47.7780	BENTHIC	46	52
HAW-88	11/02/08	18	58.8440	155	45.6690	FISH	16	12
HAW-84	11/02/08	18	54.8790	155	41.0240	FISH	80	95
HAW-85	11/02/08	18	56.7070	155	41.7670	FISH	10	18
HAW-86	11/02/08	18	57.5120	155	42.7760	FISH	8	17
HAW-87	11/02/08	18	58.5410	155	45.2680	FISH	8	16
HAW-89	11/02/08	18	59.1930	155	46.2800	FISH	80	90
MAI-01	11/03/08	20	45.7390	155	58.7990	BENTHIC, FISH	35	45
MAI-13	11/03/08	20	44.7340	155	58.8790	BENTHIC, FISH	36	50
MAI-14	11/03/08	20	39.5820	156	2.4660	BENTHIC, FISH	36	43
MAI-69	11/03/08	20	40.9830	156	0.9600	FISH	10	18
KAU-15	11/05/08	22	8.2700	159	45.6674	BENTHIC, FISH	50	55
KAU-14	11/05/08	22	9.7630	159	43.7480	BENTHIC, FISH	48	56
KAU-08	11/05/08	22	10.0060	159	40.8030	BENTHIC, FISH	38	42
KAU-55	11/05/08	22	12.1620	159	36.5920	FISH	19	33
KAU-50	11/05/08	22	7.0970	159	46.8140	FISH	75	80
KAU-51	11/05/08	22	8.0120	159	44.0220	FISH	10	18
KAU-52	11/05/08	22	9.5640	159	42.3850	FISH	10	18
KAU-53	11/05/08	22	11.5560	159	37.9010	FISH	10	25
KAU-54	11/05/08	22	12.6000	159	36.9740	FISH	60	75
KAU-13	11/06/08	22	13.5830	159	33.8590	BENTHIC, FISH	18	27
KAU-03	11/06/08	22	13.8330	159	24.3200	BENTHIC, FISH	27	30
KAU-02	11/06/08	22	9.8520	159	17.9360	BENTHIC, FISH	42	45
KAU-61	11/06/08	22	8.3640	159	17.4110	FISH	8	16
KAU-56	11/06/08	22	14.6980	159	32.9180	FISH	72	81
KAU-57	11/06/08	22	12.8140	159	31.0110	FISH	7	12
KAU-58	11/06/08	22	13.0380	159	22.7700	FISH	8	12
KAU-59	11/06/08	22	10.9210	159	18.2460	FISH	65	68
KAU-05	11/07/08	21	52.1270	159	26.8420	BENTHIC, FISH	18	28
KAU-06	11/07/08	21	53.3860	159	36.5420	BENTHIC, FISH	40	52
KAU-12	11/07/08	21	55.8270	159	39.5650	BENTHIC, FISH	40	44
KAU-66	11/07/08	21	57.0950	159	41.1320	FISH	8	16
KAU-62	11/07/08	21	52.1490	159	27.6380	FISH	62	67
KAU-63	11/07/08	21	53.4020	159	33.8970	FISH	10	19
KAU-64	11/07/08	21	55.0520	159	38.3670	FISH	14	18
NII-04	11/08/08	21	59.4230	160	7.4900	BENTHIC, FISH	42	54
NII-09	11/08/08	21	56.7460	160	9.8110	BENTHIC, FISH	44	52

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SITE ID	Date	Latitude (N)		Longitude (W)		REA Team	Depth (ft)	Depth (ft)
NII-53	11/08/08	21	55.6610	160	10.8120	FISH	14	19
NII-50	11/08/08	22	0.2600	160	6.9030	FISH	75	82
NII-51	11/08/08	21	56.1810	160	9.8980	FISH	9	15
NII-52	11/08/08	21	56.1020	160	12.1840	FISH	70	85
LEH-01	11/09/08	22	0.9750	160	5.4810	BENTHIC, FISH	38	46
LEH-02	11/09/08	22	1.3060	160	5.6490	BENTHIC, FISH	43	49
NII-07	11/09/08	22	0.4130	160	4.7500	BENTHIC, FISH	49	55
NII-54	11/09/08	22	0.0000	160	3.4570	FISH	75	88
NII-55	11/09/08	22	0.4020	160	5.5560	FISH	3	15
LEH-50	11/09/08	22	0.8720	160	5.7980	FISH	10	18
LEH-51	11/09/08	22	1.7570	160	5.9050	FISH	75	90
NII-06	11/10/08	21	48.7710	160	15.0350	BENTHIC, FISH	53	58
NII-05	11/10/08	21	54.4150	160	12.6530	BENTHIC, FISH	35	46
NII-60	11/10/08	21	55.3710	160	12.1780	FISH	45	55
NII-56	11/10/08	21	49.8460	160	15.1400	FISH	76	69
NII-57	11/10/08	21	52.5910	160	14.0150	FISH	15	18
NII-58	11/10/08	21	54.5980	160	12.3190	FISH	14	19
NII-59	11/10/08	21	56.2580	160	12.1450	FISH	70	75
OAH-03	11/12/08	21	35.4740	158	12.5570	BENTHIC, FISH	50	67
OAH-02	11/12/08	21	33.6860	158	15.6900	BENTHIC, FISH	25	37
OAH-04	11/12/08	21	32.0190	158	13.9950	BENTHIC, FISH	30	46
OAH-54	11/12/08	21	30.6670	158	13.8280	REA-FISH	10	18
OAH-50	11/12/08	21	35.5270	158	11.2320	REA-FISH	75	85
OAH-51	11/12/08	21	34.4770	158	17.5930	REA-FISH	60	71
OAH-52	11/12/08	21	34.3240	158	16.6370	REA-FISH	11	18
OAH-53	11/12/08	21	28.7530	158	13.9310	REA-FISH	60	75
OAH-14	11/13/08	21	24.7330	157	42.5880	BENTHIC, FISH	35	47
OAH-15	11/13/08	21	22.8780	157	41.2050	BENTHIC, FISH	40	46
OAH-12	11/13/08	21	19.1718	157	39.2346	BENTHIC, FISH	50	39
OAH-59	11/13/08	21	17.9330	157	38.8910	REA-FISH	60	75
OAH-55	11/13/08	21	21.7080	157	40.5300	REA-FISH	70	70
OAH-56	11/13/08	21	23.5190	157	42.0200	REA-FISH	4	8
OAH-57	11/13/08	21	19.6180	157	39.5870	REA-FISH	6	12

A.3. Towed-diver Survey Methods

(Kevin Lino, Benjamin Richards, Edmund Coccagna, Jason Helyer, and Jacob Asher)

Shallow-water habitats around each island, bank, or reef were surveyed using pairs of divers towed 60 m behind a 5.8-m SAFE boat launch. In each towed-diver buddy team, one diver was tasked with quantifying the benthos while the other quantified fish populations. Each towed-diver survey lasts 50 min, broken into ten 5-min segments, and covers ~ 2 km. A global positioning system (GPS) track of the survey track was recorded at 5-s intervals using a Garmin GPSMap 76 GPS unit. A custom algorithm was used to calculate the track of the divers based on the track, speed, and course of the boat and depth of the diver. Each towboard was equipped with an SBE 39 precision temperature and depth recorder, which was also recorded at 5-s intervals. At the end of each day, data were downloaded, processed, and presented in ArcGIS. This data can be displayed in conjunction with IKONOS satellite imagery, NOAA chart data, or other spatial data layers.

A.3.1 Benthic Towed-diver Methods

The benthic towboard was equipped with a downward high-resolution digital still camera with dual strobes. The downward-looking camera was maintained 1–2 m off the bottom and was programmed to photograph benthic substrate at 15–s intervals, creating a permanent visual record to evaluate and track potential changes in the benthos between subsequent cruises. The diver on the benthic towboard also observed and recorded habitat composition (habitat complexity, prevalent habitats and substrate types, hard coral, stressed hard, soft coral, macroalgae, coralline algae, sand, and rubble), tallied conspicuous macroinvertebrates (crown-of-thorns seastar, boring and free sea urchins, sea cucumbers, and giant clams) along a 10-m swath in ten 5-min segments. Additional fields, including prevalent coral and algae genera (when applicable/time permitting) were also tracked. At the end of each day, the data were transcribed from field data sheets into a centralized Microsoft (MS) Access database.

A.3.2 Fish Towed-diver Methods

The fish towboard was equipped with a forward-looking digital video camera, creating a visual archive of the survey track that can be used to evaluate stochastic changes in the reef environment, particularly following episodic events like coral bleaching and vessel grounding. The diver on the fish towboard recorded, to the lowest possible taxon, all fish > 50 cm in total length along a 10-m swath in each time segment. Fishes were recorded in terms of species and length in centimeters. Species of particular concern observed outside the survey swath were classified as presence/absence data and are recorded separately from the quantitative swath data. At the end of each day, the data were transcribed from field data sheets into a centralized MS Access database. Biomass values were calculated using species-specific length-weight parameters and are normalized by area (i.e., kg/100 m²).

A.5. References

Dickson AG, Sabine CL, Christian JR (eds, 2007) Guide to best practices for ocean CO₂ measurements. PICES Special Publication 3, 191 pp.

Appendix B: Five Fathom Pinnacle

B.1. Oceanography and Water Quality

At Five Fathom Pinnacle, 1 subsurface temperature recorder (STR) was recovered and 1 deployed. A new ecological acoustic recorder (EAR) deployment was established at the same position.

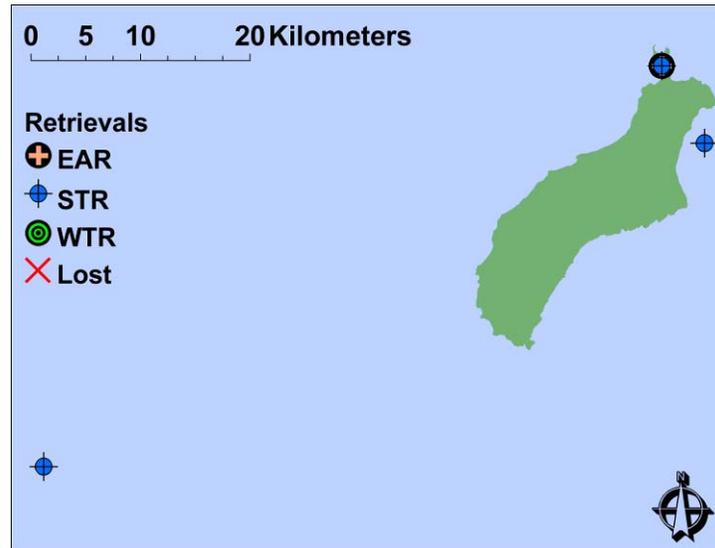


Figure B.1.1.--Retrieved moored oceanographic instrumentation map for Five Fathom Pinnacle and Ni`ihau.



Figure B.1.2.--Deployed moored oceanographic instrumentation map for Five Fathom Pinnacle and Ni`ihau.

Table B.1.1.--Moored oceanographic instrumentation for Five Fathom Pinnacle.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
STR	Retrieval	39390381815	21.68671	-160.60315	11/11/2008	16.46
STR	Deployment	39301590840	21.68678	-160.60318	11/11/2008	18.29
EAR	Deployment	930031391	21.68678	-160.60318	11/11/2008	18.29

Water Quality

At the 30-m isobath, 1 shallow-water conductivity, temperature, and depth (CTD) cast was conducted using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. A.1.3). A total of 4 discrete water samples were collected concurrently with shallow-water CTD casts at 1 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m and 30 m and will be analyzed later for nutrient and chlorophyll contents. Nutrient and chlorophyll samples were processed and stored according to protocol and were sent out for analysis when the cruise returned.

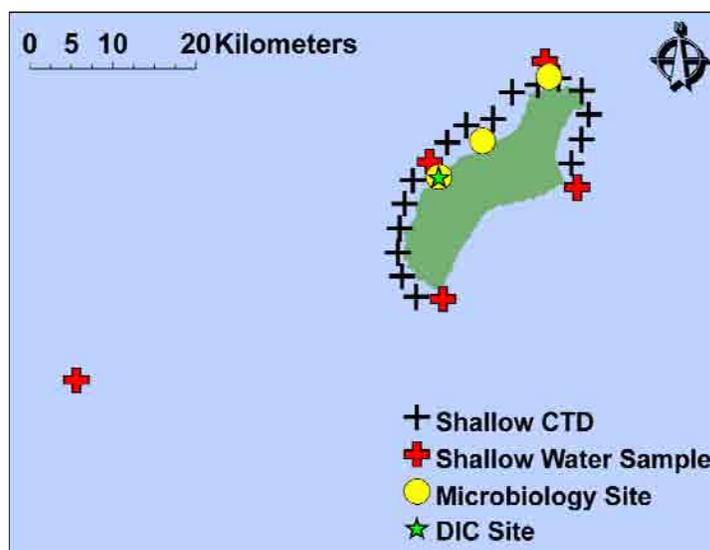


Figure B.1.3.--Shallow-water CTD and water sampling locations in the vicinity of Five Fathom Pinnacle and around Ni'ihau.

Appendix C: Hawai`i

C.1. Oceanography and Water Quality

A total of 3 subsurface temperature recorders (STRs) were recovered and 6 deployed around Hawai`i. A total of 2 new ecological acoustic recorder (EAR) deployments were established.



Figure C.1.1.--Retrieved moored oceanographic instrumentation map for Hawai`i.



Figure C.1.2.--Deployed moored oceanographic instrumentation map for Hawai`i.

Table C.1.1.--Moored oceanographic instrumentation table for Hawai`i.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
STR	Deployment	39390381723	20.19120	-155.90350	10/26/2008	9.75
STR	Retrieval	39331791194	20.19120	-155.90350	10/26/2008	9.75
STR	Deployment	39510234392	19.39413	-154.92417	10/29/2008	15.85
EAR	Deployment	930046127	19.39413	-154.92417	10/29/2008	15.85
STR	Deployment	39368591659	19.39413	-154.92417	10/29/2008	11.89
STR	Lost	1660	19.39413	-154.92417	10/29/2008	10.06
STR	Deployment	39368591657	19.13292	-155.50222	10/31/2008	14.33
STR	Retrieval	39390381813	19.13292	-155.50222	10/31/2008	14.94
STR	Deployment	39510234396	18.92254	-155.68431	11/01/2008	14.02
STR	Retrieval	39331791153	18.92254	-155.68431	11/01/2008	14.02
STR	Deployment	39301590831	19.07380	-155.90161	11/01/2008	17.68
EAR	Deployment	930046088	19.07380	-155.90161	11/01/2008	17.68

Water Quality

A total of 89 shallow-water conductivity, temperature, and depth (CTD) casts were conducted at the 30-m isobath around Hawai`i using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. C.1.3.). Additionally 8 “static,” (nonprofiling mode) shallow-water CTD casts were conducted in conjunction with the benthic seawater carbonate chemistry sampling. A total of 7 shallow-water CTD casts were taken for use with microbial water samples.

A total of 206 discrete water samples (including 1 duplicate) were collected concurrently with shallow-water CTD casts at 3 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m and will later be analyzed for nutrient, chlorophyll, and carbonate chemistry (dissolved inorganic carbon (DIC) and total alkalinity (A_T)) content (carbonate chemistry samples were only collected at the depths of 1 m and 10 m). Nutrient, chlorophyll, and carbonate chemistry samples were processed and stored according to protocol and were sent out for analysis when the cruise returned. In addition to the standard water sampling that accompanies some of the shallow-water CTD sites, benthic seawater carbonate chemistry samples were collected at 8 sites around Hawai`i over various benthic habitat types (primarily coral cover). Each of the benthic sites yielded 4 carbonate chemistry water samples, 2 from the bottom, 1 from the mid depth of the water column and 1 from the just beneath the surface. All benthic carbonate chemistry data will be processed following the cruise. Twenty-eight of the discrete water samples were processed for microbial analysis.

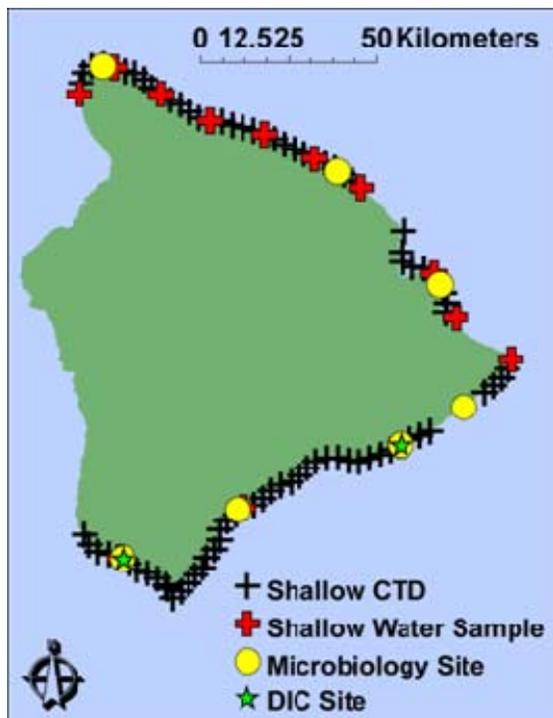


Figure C.1.3.--Shallow-water CTD and water sampling locations around Hawai`i during the SE-08-10 MHIRAMP cruise.

C.2. Rapid Ecological Assessment (REA) Site Descriptions

A total of 62 REA surveys were conducted around forereefs of Hawai`i between October 26 and November 2, 2008. At 23 sites, full REA surveys (benthic and fish) were conducted at historical stations, and 39 additional and randomly chosen sites were surveyed only by fish scientists. Site locations are plotted in Figure C.2.1, and physical and biological characteristics for each site are described below.

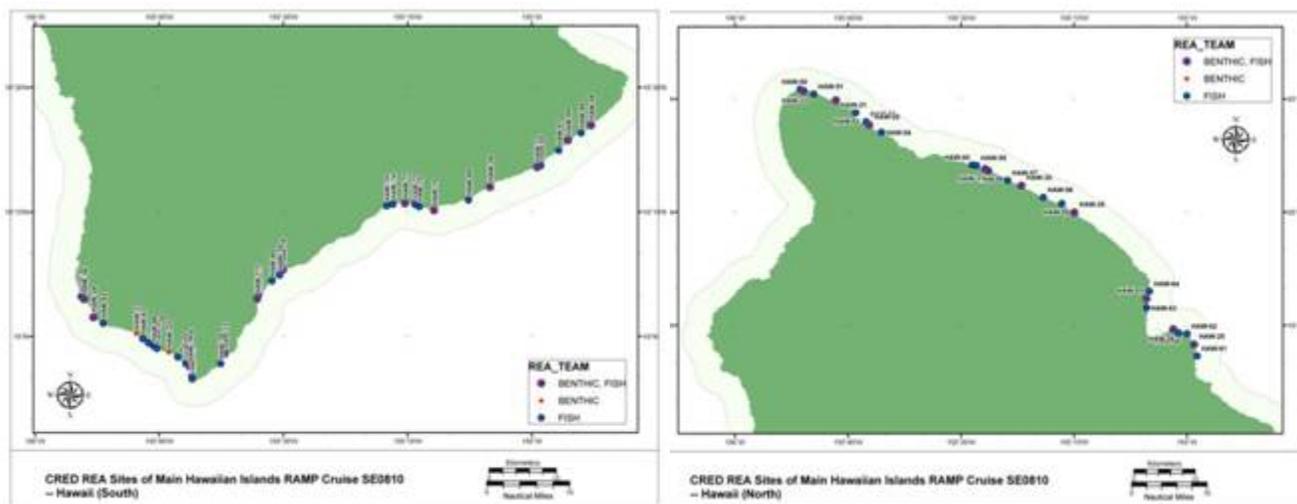


Figure C.2.1.--Locations of 2008 REA sites on Hawai`i.

REA Site Descriptions

HAW-21

10/26/2008

N 20° 14.816'

W 155° 46.609'

Forereef

Depth: 14.0–15.5 m



Survey Notes: Original global positioning system (GPS) point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Rocky outcroppings; sand channels

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (58.4%) with scattered encrusting colonies of *Porites lobata*, *Pocillopora meandrina*, and *Montipora capitata*. There was low macroalgal cover (11.2%) with *Portieria hornemannii* (6.4%) being the most prominent. Overall coral cover was also low (12.0%).

Coral: Coral cover was dominated by large colonies of *Porites lobata* (59.0%) and *Montipora capitata* (25.0%). Only 3 scleractinian species were documented within belt transects. Overall, coral health was good with 2.6% of colonies being affected by either bleaching or algal interactions.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, species of *Neomeris* and *Laurencia*, *Gibsmithia hawaiiensis*, *Haloplegma duperreyi*, and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include *Halimeda velasquezii*.

Inverts: Overall invertebrate diversity was low at this site. Abundance of organisms recorded was also very low, with only 25 individuals of all species recorded on the transect. Of those, trapezid crabs and *Echinostrephus* sp. urchins were the most numerous.

Fish: Fish diversity was moderate. Schools of large *Acanthurus olivaceus* were observed. A particularly large *Parapeneus cyclostomus* was seen (~ 40 cm).

HAW-20

10/26/2008

N 20° 11.543'

W 155° 42.203'

Pinnacle Wall

Depth: 9.4–11.9 m



Survey Notes: Original GPS point moved to the lee of the pinnacle due to rough conditions at original site.

Habitat: Site located at base of pinnacle wall.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (32.0%), crustose coralline red algae (17.6%), and *Lobophora variegata* (22.8%). Overall coral cover was low (1.6%).

Coral: Although this pinnacle wall site had very low percent coral cover, relatively high species diversity was found. A total of 6 genera (5 scleractinian and 1 anthozoan) were documented. *Porites lobata* (45.7%) was the most common species observed. Other documented species included *Psammocora haimeana* (17.0%), *Leptoseris incrassata* (13.5%) and *Montipora capitata* (9.1%). Coral health was very good with only 1 colony displaying discoloration other than bleaching (1.2%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Amansia glomerata*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Liagora*.

Inverts: Overall invertebrate diversity was low at this site. Zoanthids were by far the most numerous organisms, followed by *Tripneustes* urchins. Aside from high zoanthid counts, overall abundance was very low.

Fish: Fish diversity was moderate. Some large fish were observed (e.g., *Caranx melampygius*, *Sufflamen fraenatum*). Notable sightings include *Ostracion meleagrif*.

HAW-32

10/26/2008

N 20° 16.030'

W 155° 50.881'

Boulders

Depth: 8.2–10.1 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (54.0%) and crustose coralline red algae (16.0%). Overall coral cover was moderate (23.2%) and macroalgal cover was low (2.8%).

Coral: Moderate coral cover was found scattered on top of large boulders found at this site. Colonies of *Porites lobata* (39.9%) and *Pocillopora meandrina* (22.6%) were most common. Additionally, colonies of *Montipora capitata* (15.0%) and *M. patula* (14.0%) were frequently documented along the transect. Various types of compromised coral health conditions were observed on 3.8% of colonies surveyed including bleaching, predation, and algal and fungal interactions.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, *Gibsmithia dotyi*, *Styopodium flabelliforme*, and

Portieria hornemannii. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Laurencia*, *Caulerpa taxifolia*, *Haloplegma duperreyi*, and *Caulerpella ambigua*.

Inverts: Invertebrate diversity at this site was low-moderate. Zoanthids were numerous, as were urchins of the genus *Echinometra*. Of note was the presence of several *Protospalythoa* polyps.

Fish: Fish diversity was moderate. Large groups of fairly big kyphosids were observed. Other large fish observed include *Scarus rubroviolaceus*. Notable sightings include *Aphareus furca* and *Aprion virescens*.

HAW-29

10/27/2008

N 19° 59.949'

W 155° 14.969'

Boulders

Depth: 12.2–12.8 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders on sand bottom

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (45.6%) and scattered coral colonies of *Montipora capitata*, *M. patula*, *Pocillopora meandrina*, and *Porites lobata* (22.4%). Overall macroalgal cover was relatively low (11.2%), as well as crustose coralline red algal cover (9.2%).

Coral: Belt transect surveys revealed relatively low coral cover with colonies of *Porites lobata* (32.7%) and *Montipora patula* (22.6%) being most common. Additionally, colonies *M. capitata* (15.3%), *Pocillopora meandrina* (10.3%), and *M. flabellata* (10.2%) were frequently documented. A total of 6 genera (5 scleractinian and 1 anthozoan) were represented at this forereef site. Evidence of compromised coral health conditions were observed on 3.9% of colonies surveyed with discolorations other than bleaching (2.6%) being the most common.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, species of *Neomeris* and *Padina*, *Amansia glomerata*, *Acanthophora pacifica*, *Halimeda opuntia*, and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include species of *Galaxaura*, *Caulerpa taxifolia*, and *Halimeda velasquezii*.

Inverts: This boulder habitat had a high Zoanthid presence, as well as a high number of trapezid crabs. The dominant urchin at this site was the *Echinostrephus aciculatus*.

Fish: Fish diversity and abundance at this site was moderate. One large ulua entered the transect to be counted then made a quick exit. Moderate-sized fishes seen included Acanthurids (*Acanthurus dussumieri*, *A. olivaceus*, *Naso literatus*) and wrasses (*Bodianus bilunulatus*). The most abundant fish counted was the diminutive *Chromis vanderbilti*.

HAW-30

10/27/2008

N 20° 03.508'

W 155° 21.982'

Boulders

Depth: 10.7–14.6 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders

Benthic Cover: Benthos was dominated by encrusting coral colonies, including *Montipora capitata*, *M. patula*, *Pocillopora meandrina*, and *Porites lobata* (50.4%), and turf algae colonized on pavement (39.2%). Overall macroalgal cover was low (4.4%), as was crustose coralline red algal cover (6.0%).

Coral: High coral cover was observed at this forereef site was comprised mostly of *Montipora patula* (53.8%) and *M. capitata* (16.5%) colonies. Only 6.0% of colonies were observed to show signs of compromised coral health conditions, including algal interactions, discolorations other than bleaching and pink line syndrome.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, *Caulerpa taxifolia*, a species of *Padina*, and *Acanthophora pacifica*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, and *Amansia glomerata*.

Inverts: Overall biodiversity of invertebrates was low at this site. The Echinoids recorded were *Echinostrephus aciculatus* and *Echinometra mathaei*. A high number of trapezid crabs were also recorded.

Fish: Fish diversity and abundances at this site were moderate, with moderate-sized fishes including Acanthurids, Mullids, Lutjanids, and Lethrinids. Small fishes were numerous, including *Thalassoma duperrey*, *Paracirrhites arcatus*, and of course, *Chromis vanderbilti*.

HAW-31

10/27/2008

N 20° 05.702'

W 155° 26.791'

Boulders

Depth: 9.8–12.5 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (58.0%) with scattered colonies of *Montipora capitata*, *M. patula*, *M. flabellata*, *Pocillopora meandrina*, and *Porites lobata* (21.6%). Overall macroalgal cover was low (6.8%) and there was moderate crustose coralline red algal cover (13.6%).

Coral: Colonies of *Porites lobata* (34.4%) and *Montipora capitata* (34.0%) were commonly found along the belt transect at this site consisting of large boulders. A total of 6 genera (5 scleractinian and 1 anthozoan) were represented. Evidence of compromised coral health conditions was documented, including algal interactions (2.4%), discolorations other than bleaching (1.2%), and bleaching (0.6%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, *Amansia glomerata*, and *Haloplegma duperreyi*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Padina*.

Inverts: At this forereef habitat a high number of trapezid crabs were recorded, as well as high numbers of Zoanthid colonies. Echinoids recorded in higher numbers were *Echinostrephus aciculatus* and *Echinometra mathaei*.

Fish: Fish diversity at this site was relatively high. *Chromis vanderbilti* was the only fish recorded in appreciable numbers, while *Thalassoma duperrey*, *Acanthurus nigrofuscus*, *A. leucopareis*, and *Paracirrhites arcatus* were common. Large fishes seen on transect included *Caranx melampygus*, *Naso unicornis*, and *Chlorurus perspicillatus*.

HAW-01

10/28/2008

N 19° 48.523'

W 155° 05.376'

Forereef

Depth: 10.9–12.8 m



Survey Notes: Original GPS point used and updated to reflect dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by corals, including *Pocillopora meandrina*, *Porites lobata*, and *Montipora capitata* (38.5%), turf algae colonized on pavement, dead coral and rubble (37.0%). Overall crustose coralline red algal cover was moderate (14.0%), as was macroalgal cover (9.5%).

Coral: Large colonies of *Porites lobata* (45.1%) and *Pocillopora meandrina* (25.4%) dominated this forereef site with moderate coral cover. Colonies of *Palythoa* sp. (15.8%) and *Montipora flabellata* (11.8%) were also commonly found along the belt transect. Cases of compromised coral health conditions included algal interactions (5.3%), skeletal growth anomalies (1.1%), predation (1.1%), and discolorations other than bleaching (1.1%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris* and *Halimeda opuntia*.

Inverts: Zoanths were the overwhelmingly dominant feature of this site, recruiting on the relatively fresh bare basalt. One notable feature was the distinct lack of any echinoderms on the transect. Additionally, trapezied crabs were found in many of the pocillopora heads.

Fish: This site was characterized as having abundant fish with good diversity and moderately high richness. Smaller fishes were most abundant, with notable aggregations of larger herbivores including *Zebrasoma flavescens* and *Ctenochaetus hawaiiensis*. Medium-sized fishes included *Oxycheilinus unifasciatus*, *Aphareus furca*, *Cephalopholis argus*, *Lutjanus kasmira*, *Parupeneus insularis* and *P. cyclostomus*, *Acanthurus blochii*, and *Scarus rubroviolaceus*. Also, one *Novaculichthys taeniourus* was observed.

HAW-25

10/28/2008

N 19° 42.462'

W 154° 59.058'

Forereef

Depth: 10.9–12.8 m



Survey Notes: Original GPS point used. New GPS position was not recorded to reflect dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by corals, including *Pocillopora meandrina*, *Porites lobata*, and *Montipora capitata* (38.5%), turf algae colonized on pavement, dead coral and rubble (37.0%). Overall crustose coralline red algal cover was moderate (14.0%), as was macroalgal cover (9.5%).

Coral: Moderate coral cover was mostly comprised of *Pocillopora meandrina* (45.2%) and *Porites lobata* (41.9%). A total of 5 genera (4 scleractinian and 1 anthozoan) were represented within the belt transect. Several cases of compromised coral health conditions were observed along the transect, including algal interactions (1.6%) and predation (1.3%). Evidence of bleaching (0.7%), skeletal growth anomalies (0.7%), and discolorations other than bleaching were also documented.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris* and *Halimeda opuntia*.

Inverts: Zoanths were particularly abundant at this site, as was the ubiquitous *Echinometra mathaei*. Hermit crabs were recorded relatively frequently, as were the *Pocillopora*-dwelling trapezid crabs.

Fish: This site was characterized as having abundant fishes with good diversity and moderately high richness. Smaller fishes were most abundant, with notable aggregations of larger herbivores including *Zebrasoma flavescens* and *Ctenochaetus hawaiiensis*. Medium sized fishes included *Oxycheilinus unifasciatus*, *Aphareus furca*, *Cephalopholis argus*, *Lutjanus kasmira*, *Parupeneus*

insularis and *P. cyclostomus*, *Acanthurus blochii*, and *Scarus rubroviolaceus*. Also, one *Novaculichthys taeniourus* was seen.

HAW-26

10/28/2008

N 19° 44.488'

W 155° 01.817'

Forereef

Depth: 9.5–13.4 m



Survey Notes: Original GPS point used and updated to reflect dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by corals, including *Pocillopora meandrina*, *Porites lobata*, and *Montipora capitata* (38.5%), turf algae colonized on pavement, dead coral and rubble (37.0%). Overall crustose coralline red algal cover was moderate (14.0%), as was macroalgal cover (9.5%).

Coral: Colonies of *Porites lobata* (57.7%) and *Pocillopora meandrina* (20.3%) were most commonly found at this forereef site with moderate coral cover. Colonies from the genera *Montipora* accounted for 19.8% of the coral documented. Examples of compromised coral health conditions included algal interactions (2.7%), discolorations other than bleaching (1.4%), and predation (0.5%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris* and *Halimeda opuntia*.

Inverts: Zoanths were particularly abundant at this site, as was the ubiquitous *Echinometra mathaei*. Lesser numbers of *Echinothrix* sp. and *Tripnustes* sp. were also present. Trapezid crabs were found in many of the *Pocillopora* heads.

Fish: This site was characterized as having abundant fishes with good diversity and moderately high richness. Smaller fishes were most abundant, with notable aggregations of larger herbivores including *Zebrasoma flavescens* and *Ctenochaetus hawaiiensis*. Medium-sized fishes included *Oxycheilinus unifasciatus*, *Aphareus furca*, *Cephalopholis argus*, *Lutjanus kasmira*, *Parupeneus insularis* and *P. cyclostomus*, *Acanthurus blochii*, and *Scarus rubroviolaceus*. Also, one *Novaculichthys taeniourus* was seen.

HAW-08

10/29/2008

N 19° 25.428'

W 154° 52.838'

Boulders

Depth: 9.1–11.3 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement and dead coral (44.8%), scattered colonies of coral (22.8%), including *Pocillopora meandrina*, *Montipora capitata*, and *Porites lobata*, and crustose coralline red algae (20.4%). Overall macroalgal cover was low (9.6%).

Coral: Most common coral species identified at this forereef site included *Porites lobata* (53.2%) and *Pocillopora meandrina* (22.8%). Colonies of *Montipora capitata* (10.0%) and *M. patula* (7.9%) were also present. Overall coral health was good with only 3.8% of colonies displaying symptoms of predation (1.9%), algal interactions (1.3%) and bleaching (0.6%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, and *Dictyota ceylanica*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Peyssonnelia*, *Portieria hornemannii*, *Styopodium flabelliforme* and *Amansia glomerata*.

Inverts: The urchin *Echinometra mathaei* was found at this site in overwhelming numbers. Also present was *Echinothrix calamaris* and the occasional *Echinostrephus* sp. In addition, *Linckia multifora* and *Trapezia* sp. were recorded. Overall species diversity seemed low.

Fish: This site had a good fish diversity. Many large fishes were observed (*Sphyrna barracuda*, *Parupeneus insularis*, etc.). A large *Aprion virescens* and a few *Naso unicornis* were also recorded. Notable sightings include *Novaculichthys taenorius*.

HAW-09

10/29/2008

N 19° 23.627'

W 154° 55.638'

Forereef

Depth: 12.8–14.6 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by crustose coralline red algae (49.6%), turf algae colonized on pavement and dead coral (19.2%), scattered colonies of coral (15.6%), including *Pocillopora meandrina* and *Porites lobata*, and *Lobophora variegata* (12.8%). Other than *L. variegata*, overall macroalgal cover was low (0.4%).

Coral: A total of 6 genera were represented at this forereef site (5 scleractinian species and 1 zoanthid species). Colonies of *Pocillopora meandrina* (46.3%), *Porites lobata* (28.0%), and *Palythoa* sp. (14.4%) were commonly present along the belt transect. Overall coral health was excellent with 2 colonies (0.5% each) showing signs of predation and algal interaction.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, and *Dictyota ceylanica*. Additional algae documented by the Roving Diver survey include a species of *Peyssonnelia*, *Halimeda distorta*, and *H. velasquezii*.

Inverts: The urchin *Echinometra mathaei* was present at this site in large numbers, as was *Tripneustes gratilla*. Numerous zooanthids were also found inhabiting the bare basalt substrate. *Linckia multifora* were particularly abundant. Overall diversity seemed moderate.

Fish: Fish diversity was relatively high at this site. Many juvenile *Melichthys niger* were observed. Large fishes were moderately abundant (*Acanthurus olivaceus*, *Naso lituratus*). Notable sightings include *Acanthurus triostegus* and *Chaetodon auriga*.

HAW-33

10/29/2008

N 19° 20.386'

W 154° 59.369'

Boulders and rubble

Depth: 11.6–14.9 m



Survey Notes: New site created in 2008 because original site to be surveyed, HAW-27, was inaccessible due to a lava flow.

Habitat: Boulders and rubble

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (48.4%), scattered colonies of coral (30.0%), including *Pocillopora meandrina* and *Porites lobata*, and crustose coralline red algae (13.6%). Overall macroalgal cover was low (4.8%).

Coral: While colonies of *Pocillopora meandrina* (79.2%) dominated this new 2008 site, other small colonies of *Porites lobata* (8.4%), *Montipora capitata* (6.6%), and *M. patula* (4.7%) were commonly found scattered on and between boulders and rubble. Only 1 case of predation was observed.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Acanthophora pacifica*, and a species of *Martensia*. Additional algae documented by the Roving Diver survey include *Caulerppella ambigua* and *Halimeda velasquezii*.

Inverts: Overall invertebrate diversity was low at this site. The relatively fresh basalt substrate did not seem old enough to have large assemblages of any species. Present in moderate numbers were trapezid crabs, inhabiting the spaces between arms of *Pocillopora* heads, and the occasional Zooanthid, recruited on the basalt.

Fish: Fish diversity was moderate. Many large fish were observed (*Scarus rubroviolaceus*, *Acanthurus dussumieri*, *Bodianus bilunulatus*). Notable sightings include *Acanthurus lineolatus* and *Oplegnathus punctatus*.

HAW-28

10/30/2008

N 19° 17.986'

W 155° 05.045'

Rubble

Depth: 9.8–11.6 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Rubble

Benthic Cover: Benthos was dominated by turf algae colonized on rubble (82.0%) with a low percent cover of macroalgae (14.8%), coral (0.8%), and crustose coralline red algae (0.4%).

Coral: Low coral cover was comprised of small colonies of *Pocillopora* sp. (84.8%) and *Porites lobata* (15.2%). There was no evidence of compromised coral health conditions.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, and species of *Wrangelia* and *Padina*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*.

Inverts: The very fresh basalt/gravel substrate at this site made for sparse invertebrate counts. Overall species diversity was very low. Echinoderms were the most numerous, with a relatively high number of *Echinothrix calamaris* recorded on the transect. A handful of zooanthids were present, along with one *Spondylus* clam. Of note was the presence of several individuals of *Aiptasia pulchella*, the glass anemone.

Fish: Fish were relatively depauperate at this site, although towards the end of the last transect diversity and abundances increased slightly. Medium-sized fish included *Caranx melampygus*, *Naso unicornis*, *Acanthurus dussumieri*, *Bodianus bilunulatus*, *Lutjanus fulvus*, and *L. kasmira*. The most common small fish seen was the ever popular *Chromis vanderbilti*. An unusual sighting was that of the tilefish *Ptereleotris heteroptera*, and off transect, a single *C. orthogrammus*.

HAW-10

10/30/2008

N 19° 15.195'

W 155° 11.817'

Boulders

Depth: 12.2–13.4 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (44.8%) colonies of *Pocillopora meandrina*, and *Porites lobata* (27.6%), and crustose coralline red algae (20.8%). Overall macroalgal cover was low (5.6%).

Coral: Moderate coral cover was dominated by *Pocillopora meandrina* (63.7%) and *Porites lobata* (18.0%) colonies. A total of 4 scleractinian genera and 1 anthozoan genus were represented along the belt transect including *Montipora*, *Psammocora*, and *Palythoa*.

Discoloration other than bleaching and 1 case of algal interaction (0.6% each) were recorded as evidence of compromised coral health conditions.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris* and *Dictyota ceylanica*.

Inverts: Invertebrate diversity was moderate at this site. The urchin *Echinometra mathaei* was very abundant, as was *Echinothrix calamaris*. The sea-star *Linckia multifora* was a steady presence along the transect, as were zooanthids.

Fish: Site HAW-10 was chock-full of fish; *Kyphosus* spp. winning for highest numbers of medium-sized fish, although *Melichthys niger* made a good showing as well. Also seen were *Ctenochaetus hawaiiensis*, *Aphareus furca*, *Lutjanus kasmira*, *Bodianus bilunulatus*, *Cantherhines dumerilii*, *Chlorurus perspicillatus*, *Myripristis amaena*, *M. berndti*, and *Acanthurus dusumieri*. *Chromis vanderbilti* was again the dominant small fish, with *C. strigosus* coming in second.

HAW-11

10/30/2008

N 19° 16.034'

W 155° 15.330'

Boulders

Depth: 7.9–10.7 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (54.4%), scattered colonies of *Pocillopora meandrina*, *Porites lobata*, and *P. evermanni* (20.0%), and crustose coralline red algae (18.0%). Overall macroalgal cover was low (7.6%).

Coral: Coral cover at this forereef site consisted of relatively large colonies of *Porites lobata* (48.1%), *Pocillopora meandrina* (28.0%), and *Montipora capitata* (21.0%). A total of 3 scleractinian genera were represented along the belt transect. Overall coral health was good with a few documented cases of algal interactions (2.3%), predation (2.3%) and bleaching (0.6%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota friabilis*, and *Halimeda distorta*. Additional algae documented by the Roving Diver survey include species of *Neomeris*, *Martensia*, *Dictyota*, and *Peyssonnelia*, and *Turbinaria ornata*.

Inverts: Invertebrate diversity was low-moderate at this site. The urchin *Echinometra mathaei* was numerous, along with the sea start *Linckia multifora*. Many trapezid crabs were found inhabiting the spaces between arms of *Pocillopora* heads. Of note was the presence of one pearl oyster and one *Streptopinna saccata*, the baggy pen shell.

Fish: This site was notable for the high number of yellow tangs (*Zebrasoma flavescens*) and kole (*Ctenochaetus strigosus*). *Acanthurus blochii*, *Scarus rubroviolaceus*, *Myripristis berndti*, *Parupeneus insularis*, and *Naso literatus*, while not as numerous, contributed to the biomass.

HAW-12

10/31/2008

N 18° 57.930'

W 155° 37.056'

Forereef

Depth: 12.8–14.2 m



Survey Notes: Original GPS point used

Habitat: Spur and Groove- small sand channels between rocky outcroppings

Benthic Cover: No quantitative method used to calculate benthic cover. Visual surveys estimate benthos to be composed mainly of turf algae on rock and dead coral, coral, and sand.

Coral: Although an line-point intercept survey was not conducted at this site, belt transect surveys yielded percent coral composition based on colony size. Colonies of *Porites compressa* (37.4%), *P. lobata* (26.2%), and *Montipora patula* (23.4%) were prevalent. Overall, 12.0% of coral colonies were documented to have compromised health conditions with half of those colonies displaying signs of predation. Evidence of *Porites* trematodiasis (2.0%), algal interactions (2.0%), bleaching (1.3%) and discolorations other than bleaching (0.7%) were also found.

Algae: No algal data collected during this dive.

Inverts: Invertebrate surveys were not conducted at this site. Invert divers utilized dive time to make an attempt at ARMS installation. Substrate was found unsuitable for driving stakes, and all ARMS were returned to the boat.

Fish: Fish diversity was relatively high at this site. Small and medium fishes were abundant (small fish more so than medium). Abundant small species included *Ctenochaetus strigosus*, *Acanthurus nigrofuscus* and *Zebrasoma flavescens*. Abundant medium species included schools of *A. olivaceous*, *Lutjanus kasmira* and *Naso literatus*.

HAW-16

10/31/2008

N 19° 08.034'

W 155° 30.060'

Forereef

Depth: 9.4–10.4 m



Survey Notes: Original GPS point used and not updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by corals, including *Pocillopora meandrina*, *Porites lobata*, *Montipora capitata*, *M. patula* and *M. flabellata* (44.4%) and turf algae colonized on pavement and dead coral (35.6%). Overall macroalgal cover was moderate (10.0%) and crustose coralline red algal cover was low (5.6%).

Coral: Belt transects were not conducted in 2008.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, nongeniculate branched coralline red algae, *Haloplegma duperreyi*, *Lobophora variegata*, *Acanthophora pacifica*, *Portieria hornemannii*, and *Amansia glomerata*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Dictyota*, *Dictyota ceylanica*, *Halimeda opuntia*, and *Dotyella hawaiiensis*.

Inverts: Overall invertebrate diversity seemed low at this site. While zooanthids were numerous, and *Echinometra mathaei* abundant, there lacked the presence of many other species to round out the count. Of note was the record of one *Actinopyge obesa* on the transect.

Fish: Fish diversity was relatively moderate at this site. Small fishes were more abundant than medium-sized fishes, while large fishes were not observed in the immediate area. Medium fishes observed were primarily small schools of *Acanthurus olivaceus*, *A. dussumieri* and *Naso literatus*. Notable sightings include *Apolemicthys arcuatus*.

HAW-17

10/31/2008

N 19° 04.530'

W 155° 33.150'

Forereef

Depth: 10.4–12.2 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by corals, including *Pocillopora meandrina*, *Porites lobata*, *Montipora capitata*, and *M. flabellata* (50.8%), crustose coralline red algae (23.6%), and turf algae colonized on pavement and dead coral (15.6%). Overall macroalgal cover was low (2.8%).

Coral: High coral cover was found at this forereef site. Large colonies of *Montipora flabellata* (30.1%) and *Porites lobata* (28.8%) covered most of the belt transect while colonies of *M. patula* (13.8%), *Pocillopora meandrina* (13.5%), *M. capitata* (10.3%) and *Palythoa* sp. (3.4%) were also documented. Only 3.7% of all colonies were found to display signs of compromised coral health conditions such as discolorations other than bleaching, algal interactions, and skeletal growth anomalies.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Halimeda distorta*, and *Amansia glomerata*. Additional algae documented by the Roving Diver survey include species of *Peyssonnelia* and *Halymenia*, *Dictyota ceylanica*, *Acanthophora pacifica*, and *Portieria hornemannii*.

Inverts: The unique feature of this site was the presence of higher numbers of *Spondylus* clams. These could be found clinging to the roofs of caves or overhangs. Of course, the ubiquitous zooanthids were numerous, as were trapezid crabs. Overall invertebrate diversity seemed low.

Fish: Fish diversity was relatively high at this site. Both small and medium fishes were abundant (small fish more so than medium). Medium-sized fish species included *Acanthurus dussumieri*, *Naso lituratus*, *Scarus rubroviolaceus* and *Lutjanus kasmira*. Small-sized fish species consisted primarily of *A. nigrofuscus*, *Thalassoma duperrey*, *Chromis vanderbilti* and *Halichoeres ornatissimus*.

HAW-34

11/01/2008

N 19° 04.034'
W 155° 54.061'

Forereef

Depth: 12.2–15.2 m



Survey Notes: New site created in 2008 near the site of deployment of an Oceanographic EAR. The site had a pinnacle at the end of the transect lines (heading ~ 120°).

Habitat: Forereef with sand/rubble channels

Benthic Cover: Benthos was dominated by turf algae colonized on pavement and rubble (49.6%) and corals, including *Porites compressa*, *P. lobata*, and *Montipora capitata* (36.4%). Overall crustose coralline red algal cover was moderate (9.6%), and macroalgal cover was low (2.8%).

Coral: This new forereef site was dominated by species of the *Porites* genera, *lobata* (75.6%) and *compressa* (20.9%). Small colonies of *Montipora capitata*, *Pocillopora meandrina* and *M. patula* were found to cover 3.5% of the benthos. Only 2.2% of colonies were observed to show signs of compromised coral health conditions (bleaching and algal interactions).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, and *Caulerpa racemosa*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Halimeda opuntia*, and *Ventricaria ventricosa*.

Inverts: No invertebrate surveys were conducted during this dive.

Fish: This site had moderate species richness, diversity, and fish abundance. While smaller fishes were most abundant, larger fishes (particularly herbivores) had good presence. The most abundant fishes surveyed include *Ctenochaetus strigosus*, *Chromis agilis*, and *Zebrasoma flavescens*; the former and the latter were largely young-of-the-year. There was a good recruitment of many species to this site. Medium-sized fish species included *Sargocentron tiare*, *Cephalopolis argus*, *Acanthurus olivaceus*, *Naso lituratus*, *Scarus rubroviolaceus*, and *Chlorurus sordidus*. Rare species included *Centropyge loricula*, and *C. fisheri*.

HAW-24

11/01/2008

N 19° 02.298'

W 155° 52.956'

Forereef

Depth: 15.2–17.4 m



Survey Notes: Original GPS point used and was not updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by corals, including *Pocillopora meandrina*, *Porites lobata*, and *Montipora capitata* (38.5%), turf algae colonized on pavement, dead coral and rubble (37.0%). Overall crustose coralline red algal cover was moderate (14.0%), as was macroalgal cover (9.5%).

Coral: Moderately high coral cover was composed of large *Porites lobata* (50.0%) and *Pocillopora meandrina* (32.6%) colonies and scattered colonies of *Montipora capitata* (6.6%), *M. patula* (6.3%), and *P. compressa* (3.1%). There were no cases of compromised coral health conditions documented within the belt transect.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris* and *Halimeda opuntia*.

Inverts: A total of 3 ARMS were installed at this site. No invertebrate surveys were conducted.

Fish: This site was characterized as having abundant fishes with good diversity and moderately high richness. Smaller fishes were most abundant, with notable aggregations of larger herbivores including *Zebrasoma flavescens* and *Ctenochaetus hawaiiensis*. Medium-sized fishes included *Oxycheilinus unifasciatus*, *Aphareus furca*, *Cephalopolis argus*, *Lutjanus kasmira*, *Parupeneus insularis* and *P. cyclostomus*, *Acanthurus blochii*, and *Scarus rubroviolaceus*. Also, one *Novaculichthys taeniourus* was seen.

HAW-14

11/02/2008

N 18° 56.339'

W 155° 41.291'

Forereef

Depth: 12.4–13.5 m



Survey Notes: Original GPS point used to locate site; new GPS point recorded in 2008 to reflect location of dive buoys marking transect lines

Habitat: Forereef

Benthic Cover: No quantitative methods used to determine benthic cover. Visual surveys estimate dominant coral cover.

Coral: Although an line-point intercept survey was not conducted at this site, belt transect surveys yielded percent coral composition based on colony size. Colonies of *Porites lobata* (55.8%) dominated the site, while colonies of *Pocillopora meandrina* (18.5%) and *Montipora capitata* (12.7%) were also abundant. A total of 7 genera (6 scleractinian and 1 anthozoan) were documented along the belt transect. Overall, coral health was very good with only 2.1% of colonies being affected by algal interactions (0.9), predation (0.4%), discolorations other than bleaching (0.4%), and bleaching (0.4%).

Algae: No algal data collected during this dive.

Inverts: A total of 3 ARMS were installed at this site by the O-team. Invert surveys yielded high counts of the urchin *Echinometra mathaei*. Trapezid and Paguroid crabs were also relatively abundant. Overall species diversity was moderate.

Fish: Fishes at this site were relatively abundant and diverse, with small fishes ruling the day. These little guys included *Chromis agilis*, numerous juvenile *Ctenochaetus strigosus*, and the ever-present *C. vanderbilti* with the occasional juvernile *Chaetodon multicinctis* adding to the cuteness quotient. *Zebrasoma flavescens* were also out in force. Interesting sightings off transect sightings included *Hemitaurichthys thompsoni*, *H. polylepis*, and *C. ephippium*.

HAW-22

11/02/2008

N 22° 58.114'

W 155° 43.851'

Forereef

Depth: 15.2–16.8 m



Survey Notes: Original GPS point used; new GPS point marked to reflect position of dive buoy at beginning of transect lines

Habitat: Forereef

Benthic Cover: No quantitative surveys were conducted at this site to determine benthic cover. Visual surveys estimate benthos to be composed of coral cover, turf algae, rubble and rock.

Coral: Although a line-point intercept survey was not conducted at this site, belt transect surveys yielded percent coral composition based on colony size. The most common species were 2 species of *Porites*, *compressa* (51.7%) and *lobata* (26.4%). A total of 7 genera (6 scleractinian and 1 anthozoan) were documented along belt transects. Overall, coral health was good with 4 colonies displaying symptoms of discolorations other than bleaching.

Algae: No algal data collected during this dive.

Inverts: A total of 3 ARMs were installed at this site by the O-team. Invert surveys yielded high counts of the urchin *Echinometra mathaei*, along with scattered individuals of 5 other urchin species. Overall species diversity seemed low-moderate.

Fish: Fish diversity and abundances were fairly high at this site. Moderate-sized fishes ranged from *Scombroides lysan* high in the water column, *Melichthys vidua*, *Naso literatus*, *N. brevirostris*, and *Aphareus furca* cruising throughout, and *Cephalopholis argus* and *Myripristis kuntee* hiding in the coral. Clouds of the smaller *Chromis vanderbilti*, intermixed with *C. agilis* floated above the reef, and *Ctenochaetus strigosus* again were ubiquitous.

HAW-23

11/02/2008

N 19° 00.374'
W 155° 47.778'

Forereef

Depth: 14.9–16.5 m



Survey Notes: Original GPS point used to locate site; new GPS point marked to reflect position of dive buoys at beginning of transect lines

Habitat: Forereef

Benthic Cover: No quantitative method was conducted at this site to determine benthic cover. Visual surveys estimate benthos to be dominated by coral cover.

Coral: Although a line-point intercept survey was not conducted at this site, belt transect surveys yielded percent coral composition based on colony size. Colonies of *Porites compressa* (56.4%) and *P. lobata* (40.5%) dominated coral cover. No cases of compromised coral health conditions were documented at this site.

Algae: No algal data collected during this dive.

Inverts: The urchin *Tripneustes gratilla* was recorded here in unusually high numbers. *Echinometra mathaei* and trapezid crabs were present in usual numbers. Overall species diversity was low.

Fish: Fish diversity and richness was moderate to high, with abundant smaller fishes, including many young-of-the-year. *Chromis agilis* and *Ctenochaetus strigosus* were numerous, and *Centropyge potteri* numbers were relatively high. Medium-sized fishes included *Cephalopholis*

argus, *Aphareus furca*, *Sargocentron tiare*, *Naso lituratus*, *Scarus rubroviolaceus*, *Chlorurus sordidus*, and *Lutjanus kasmira*. Also, a *Caranx melampygu*s was sighted.

Independent Fish Sites

HAW-13

11/2/2008

W 155° 41.069

N 18° 55.322

Forereef

Depth: 12-13 m



General site description

Acanthurids were common at this site, including *Ctenochaetus strigosus*, *C. hawaiiensis*, *Naso literatus*, *Acanthurus olivaceus*, *A. nigrofuscus*, *A. dussumieri*, *A. nigroris*, *A. thompsoni* and *Zebrasoma flavescens*. The most abundant fish, however, were the smaller *Chromis vanderbilti*. *C. verater* were also very common, but only off transect. Of great interest off transect were sightings of the angelfishes, *Centropyge loricula* and *Apolemichthys arcuatus*

HAW-50

10/26/2008

W 155° 51.385

N 20° 16.272

Forereef

Depth: 23-23 m



General site description

This site is located on the northeast shore of Hawai`i. It was established by the Fish REA team as a new sampling location in the deep forereef stratum. This site consisted of all pavement substrate formed as tables with med/large boulders creating med/high complexity. Coral cover was low to moderate. Fish diversity was high and small; medium and large fishes were all relatively common (*Acanthurus dussumieri*, *A. olivaceus*, *Scarus rubroviolaceus*, *Monotaxis granducolis*, *Naso literatus*, *Lutjanus kasmira* and *fulvus* (off transect), *Chromis vanderbilti* and several wrasse species). Notable sightings include *Aprion virescens*.

HAW-51

10/26/2008

W 155° 49.552

N 20° 15.650

Forereef

Depth: 6-6 m



General site description

This site is located on the northeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of medium to large boulders. Coral cover was low and complexity moderate to high. Fish diversity was moderate and small fishes were abundant (several wrasse species including *Thalassoma duperrey* and *Haliichoeres ornatissimus*).

HAW-52

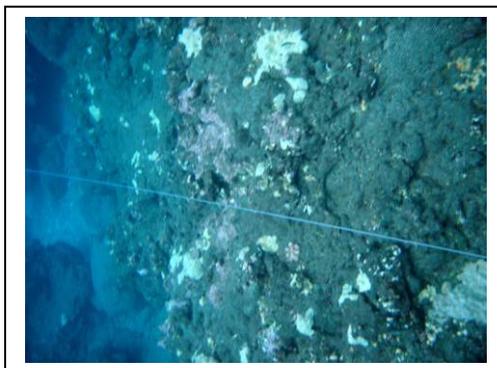
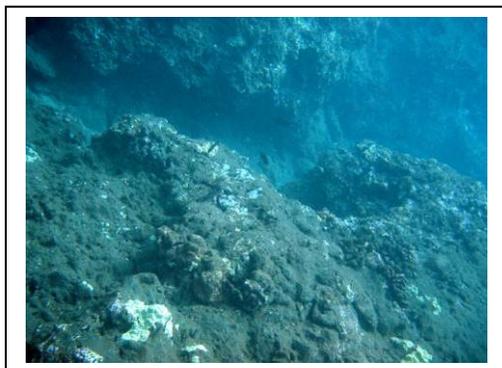
10/26/2008

W 155° 43.972

N 20° 13.170

Forereef

Depth: 4-4 m



General site description

This site is located on the northeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of pavement and boulders. Coral cover was very low and complexity was low to moderate. The few corals seen comprised small patches of encrusting *Porites lobata*, *Montipora capitata*, small heads of *Pocillopora meandrina* and *Pavona duerdeni* surrounded by mostly sand, silt, and turf algae. Fish diversity and abundance were low with *Chromis vanderbilti* being most common. No large fishes were counted on the transect, although medium-sized *Bodianus bilunulatus* and *Kyphosus* spp. were seen.

HAW-53

10/26/2008

W 155° 42.608

N 20° 11.988

Forereef

Depth: 19-20 m



General site description

This site is located on the northeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site was a pinnacle that started in ~ 23 m of water and rose up to less than 1 m below the surface. Complexity was high, while coral cover was low (approx. 15%) with *Porites lobata*, small heads of *Pocillopora meandrina*, zoanths, wire coral, crustose coralline algae, turf, bryozoans, encrusting sponges, and silt making up the rocky substrate. A few large fishes were counted (*Bodianus bilunulatus* and *Kyphosus* spp.), while smaller fishes (*Chromis vanderbilti*, *Thalassoma duperrey* and *Chromis agilis*) were relatively abundant. Of interest, a bicolor anthias and a viper moray eel were recorded on transect, while off transect a single eagle ray (*Aetobatus narinari*) and a Hawaiian anthias (*Pseudanthias hawaiiensis*) were spotted. Also seen off transect were the surgeons *Naso hexacanthus*, *N. brevirostris* and schooling *Acanthurus leucopareis*, and numerous soldierfish (*Myripristis berndti*).

HAW-54

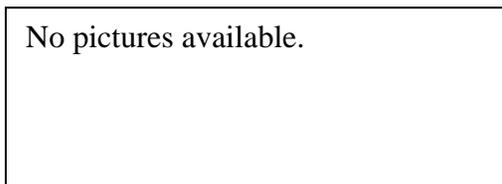
10/26/2008

W 155° 40.573

N 20° 10.591

Forereef

Depth: 5-5 m



General site description

This site is located on the northeast shore of Hawai`i (North Kohala), located in front of a nice waterfall. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site was located on an area of large boulders. Coral cover was low and complexity moderate. Fish diversity was moderate and large fishes were relatively common (*Lutjanus fulvus* and *L. kasmira*, *Scarus rubroviolaceus*). Notable sightings include *Thalassoma ballieui*.

HAW-55

10/27/2008

W 155° 16.621

N 20° 01.148

Forereef

Depth: 21-21 m



General site description

This site is located on the northeast shore of Hawai`i (Hamakua Coast, north of Hilo). It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of large boulders resting over sand. Coral cover was moderate and complexity was also moderate. Fish diversity and abundance were moderate. Spinner dolphins were observed on the safety stop.

HAW-56

10/27/2008

W 155° 19.081

N 20° 01.974

Forereef

Depth: 3-3 m

No picture available.

General site description

This site is located on the northeast shore of Hawai`i (Hamakua Coast, north of Hilo). It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of large boulders. Coral cover was low and complexity was moderate. Fish diversity and abundance were moderate.

HAW-57

10/27/2008

W 155° 23.802

N 20° 04.202

Forereef

Depth: 5-5 m



General site description

This site is located on the northeast shore of Hawai`i (Hamakua Coast, north of Hilo). It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of large boulders. Coral cover was low and complexity was moderate. Fish diversity and abundance were moderate.

HAW-58

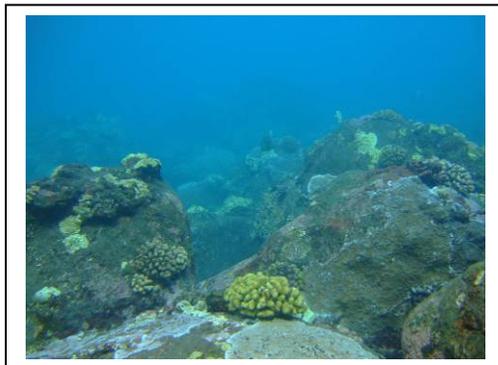
10/27/2008

W 155° 26.353

N 20° 05.505

Forereef

Depth: 4-4 m



General site description

This site is located on the northeast shore of Hawai`i (Hamakua Coast, north of Hilo). It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of large boulders. Coral cover was low and complexity was moderate. Fish diversity and abundance were moderate.

HAW-59

10/27/2008

W 155° 27.955

N 20° 06.186

Forereef

Depth: 23-23 m

No pictures available.

General site description

This site is located on the northeast shore of Hawai`i (Hamakua Coast, north of Hilo). It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of large boulders resting over sand. There was some interesting structure around the site (very narrow ridge, benches, etc.). Coral cover was moderate and complexity was also moderate. Fish diversity and abundance were moderate. Notable sightings include *Sphyraena barracuda*.

HAW-60

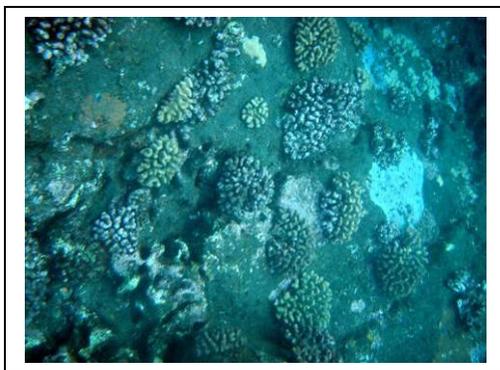
10/27/2008

W 155° 28.519

N 20° 06.255

Forereef

Depth: 6-6 m



General site description

This site is located on the northeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. Coral cover here was low (~ 20%), while complexity was very high, with large boulders and large, flat rocky outcroppings creating an amphitheater-like structure. *Pocillopora meandrina* heads dotted the boulders, with *Montipora capitata* and *M. flabellata* encrusting small areas. Large fishes included kyphosids, parrotfish, and surgeonfish; smaller fishes (*Chromis vanderbilti* and *Plectroglyphidodon imparipenis*) were most abundant. Off-transect, large schools of *Acanthurus leucopareis* were seen swirling about in the surge.

HAW-61

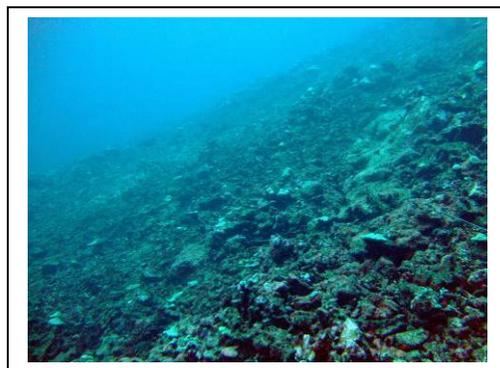
10/28/2008

W 154° 58.654

N 19° 40.943

Forereef

Depth: 25-25 m



General site description

This site is located on the east, southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site consisted of mostly coral rubble covered with coralline algae and some medium boulders. The reef sloped at a 45 degree angle. Coral cover was low and complexity was low. Fish diversity was high with abundant small and medium fish (surgeonfish, parrotfish, several wrasse species and chromis). Of note, schools of *Lutjanus kasmira*, *Scarus rubroviolaceus* and *Ancanthurus olivaceous* were present in the immediate area. Also, *Aprion virescens* were seen off transect.

HAW-62

10/28/2008

W 154° 59.991
N 19° 43.907

Forereef

Depth: 4-4 m



General site description

This site is located on the east, southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of mostly pavement habitat with large boulders. Coral cover was low and complexity was high. Fish diversity was high with abundant small and medium fish. Noteworthy species included schools of *Kuhlia sandvicensis*, *Acanthurus leucoparis* and *A. achilles*.

HAW-63

10/28/2008

W 155° 05.355
N 19° 47.349

Forereef

Depth: 4-4 m



General site description

This site is located on the east, southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of primarily medium boulders with pavement tables intermixed. Coral cover was low and complexity was moderate. Fish diversity was moderate with abundant small and medium fishes (surgeonfish, several wrasse and damsel species).

HAW-64

10/28/2008

W 155° 04.980
N 19° 49.515

Forereef

Depth: 25-25 m



General site description

This site is located on the east, southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site consisted of medium and large boulders with sand intermixed. Coral cover was low and complexity was moderate. Fish diversity was moderate with abundant small and medium fishes, and more medium-sized fishes than small-sized fishes. *Acanthurus olivaceus* density seemed to dominate the immediate area.

HAW-65

10/28/2008

W 155° 01.133

N 19° 44.039

Forereef

Depth: 4-5 m



General site description

This site is located on the eastern shore of Hawai`i in front of Leleiwi Beach Park in the Keaukaha area of Hilo. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This area is characterized by high complexity rocky outcropping amid small patches of sandy areas. Coral cover was low to moderate, consisting of *Porites lobata*, *Pocillopora meandrina*, *Montipora flabellata*, and crustose coralline algae. Fish diversity and abundances were relatively moderate. *Thalassoma duperrey* were ubiquitous, as were *Acanthurus nigrofuscus*, and *Chromis vanderbilti*.

HAW-66

10/29/2008

W 154° 54.038

N 19° 24.490

Forereef

Depth: 21-21 m



General site description

This site is located on the southeastern shore of Hawai`i, in the district of Puna. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The substrate consisted of areas with high complexity (basalt precipices and rough boulders) separated by a gentle slope consisting of hard bottom, *Pocillopora*, rubble and sand. Fishes were abundant in complex areas, and diversity was good. Medium-sized fishes included *Acanthurus olivaceus*, *A. dussumieri*, *A. nigroris*, *Monotaxis grandoculis*, *Parupeneus cyclostomus*, *P. multifasciatus*, and *P. insularis*. Less common species included *Hemitaurichthys polylepis*,

Centropyge fisheri, *Pseudojuloides cerasinus*, *Xanthichthys auromarginatus*, and *Pervagor aspricaudus*.

HAW-67

10/29/2008

W 154° 56.744

N 19° 22.406

Forereef

Depth: 21-21 m



General site description

This site is located on the southeastern shore of Hawai'i, ~ 1.6 km south of Kahena Beach in the district of Puna. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The reef here gently sloped to a sandy, rubble bottom; the area surveyed had low to moderate coral cover consisting of *Porites lobata*, *Pocillopora meandrina*, and small patches of zoanthids interspersed among medium- and large-sized boulders, rubble, and sand. Fish richness and diversity was relatively high, though abundances were low to moderate. The fish most commonly recorded was the arc-eyed hawkfish, *Paracirrhites arcatus*. Several large fishes were recorded, including *Bodianus bilunulatus*, *Acanthurus dussumieri*, and *Scarus rubroviolaceus*. Of interest, a Tinker's butterflyfish (*Chaetodon tinkeri*) was seen on transect. Off transect, a single leatherback (*Scomberoides lysan*) checked out the divers.

HAW-68

10/29/2008

W 154° 58.923

N 19° 20.571

Forereef

Depth: 20-20 m



General site description

This site is located on the southeastern shore of Hawai'i Island, in the district of Puna. It was just off the northern point of a small secluded black sand beach in the Kalapana/Royal Gardens subdivision. The site was within 1.6 km of the current lava flow into the ocean, and had poor visibility with a strong sulfur component. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The substrate was hardbottom with rubble and sedimentation, and some boulders. Coral and algae were sparse, mostly encrusting types and *Pocillopora* spp. The fish community consisted primarily of smaller species, with a few larger

species present, such as *Acanthurus olivaceus*, *Scarus rubroviolaceus*, *Naso lituratus*, and *Parupeneus multifasciatus*.

HAW-69

10/30/2008

W 155° 07.643

N 19° 16.421

Forereef

Depth: 21-21 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site consisted of mostly medium and large boulders intermixed with coral rubble. The reef sloped at a 35-45 degree angle. Coral cover was low and complexity was moderate. Fish diversity was high with abundant small and medium fishes. Noteworthy species included schools of *Naso hexacanus* and *Acanthurus dussumieri* as well as *Chaetodon tinkeri*, *Centropyge fisheri* and *Pseudanthias bicolor*. Planktivores were also abundant including *Chromis verater*, *Abudefduf abdominalis*, *Melichthys niger*, *C. ovalis* and *C. vanderbilti*.

HAW-70

10/30/2008

W 155° 13.591

N 19° 15.606

Forereef

Depth: 19-19 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site consisted of mostly medium and large boulders. The reef sloped at a 45 degree angle. Coral cover was moderate and complexity was high. Fish diversity was high with abundant small and medium fishes (surgeonfish, parrotfish, several wrasse, damsel and chromis species). Abundant species included *Zebrasoma flavescens*, *Chromis agilis* and *Ctenochaetus strigosus*.

HAW-71

10/30/2008

W 155° 14.138

N 19° 15.910

Forereef

Depth: 4-4 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of mostly large boulders and pavement, ledge reef habitat. Coral cover was moderate-high and complexity was moderate-high. Fish diversity was high with abundant small and medium fishes (surgeonfish, parrotfish, several wrasse, damsel and chromis species). Noteworthy species observed included the Golden nenu (all-yellow phase for *Kyphosus bigibbus*).

HAW-72

10/30/2008

W 155° 16.835

N 19° 15.936

Forereef

Depth: 5-5 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of mostly pavement, ledge reef habitat intermixed with medium/large boulders as well as drop-offs and ravines. Coral cover was moderate and complexity was high. Fish diversity was high with abundant small and medium fishes (surgeonfish, parrotfish, several wrasse, damsel and chromis species). Abundant species included *Melichtys niger*, *Zebrasoma flavescens*, *Ctenochaetus strigosus*, *Chromis vanderbilti* and *Acanthurus nigrofuscus*.

HAW-74

10/30/2008

W 155° 16.783

N 19° 15.915

Forereef

Depth: 4-4 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of pavement and small rocky outcroppings, with moderate complexity and low coral cover, mostly *Pocillopora meandrina* (alive and dead), *Porites lobata*, *Montipora capitata* and *M. flabellata*. Fish diversity and abundances were moderate with *Thalassoma duperrey*, *Acanthurus nigrofuscus*, *Zebrasoma flavescens*, and *Chromis vanderbilti* being most common.

HAW-75

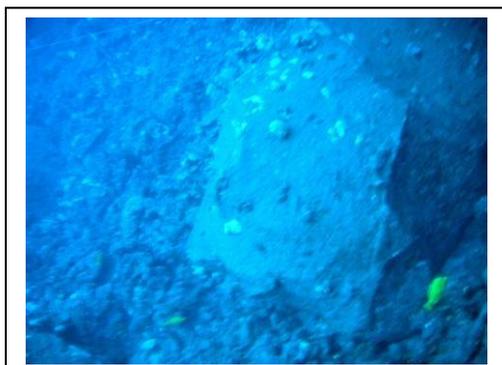
10/30/2008

W 155° 17.540

N 19° 15.710

Forereef

Depth: 22-22 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This low to moderately complex site consisted of pavement, medium and large boulders, and rubble in sand and silt. Coral cover was low, comprising *Porites compressa*, *P. lobata*, and *Pocillopora meandrina*. Fish diversity was relatively moderate, and abundant species included *Lutjanus kasmira*, *Zebrasoma flavescens*, *Chromis agilis* and *Ctenochaetus strigosus*. The very shy *Centropyge fisheri* was spotted darting into coral crevices on transect, and a rare sighting of the triggerfish *Balistes polylepis* off transect added interest to the dive.

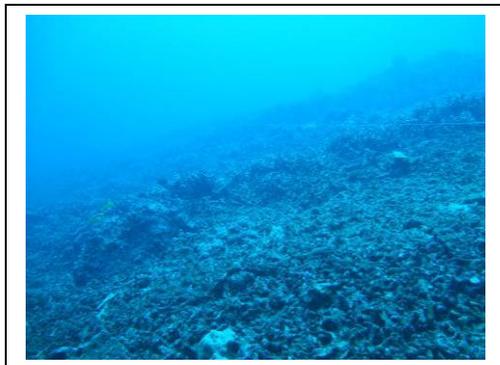
HAW-76

10/31/2008

W 155° 30.458
N 19° 07.377

Forereef

Depth: 23-23 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site is located south of a small village. The first transect was located in a rubblely area between 2 large spur formations. The 2nd transect went over a spur with higher coral cover. Complexity was medium; coral was moderate. A school of juvenile *Lutjanus kasmira* was observed. Notable sightings include *Chromis leucura* and *Centropyge fisheri*.

HAW-77

10/31/2008

W 155° 32.986
N 19° 05.059

Forereef

Depth: 5-5 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was located in a protected small harbor due to rough sea conditions elsewhere. A couple of old anchors were seen. Coral cover and complexity was high. Notable sightings include *Canthigaster amboinensis*.

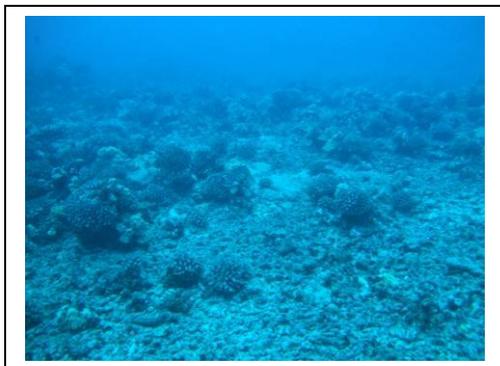
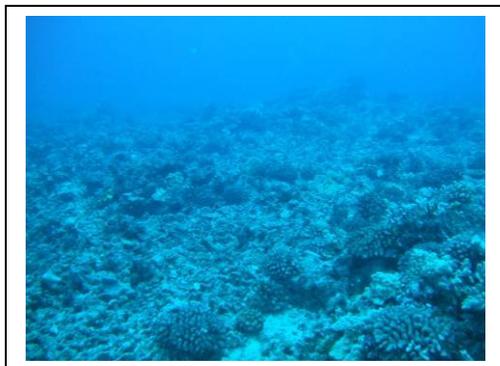
HAW-78

10/31/2008

W 155° 37.558
N 18° 56.707

Forereef

Depth: 20-20 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site is located south of a green sand beach. This site had nice, moderate coral cover with moderate complexity. The site had moderate amount of medium-large fish. No notable sightings.

HAW-80

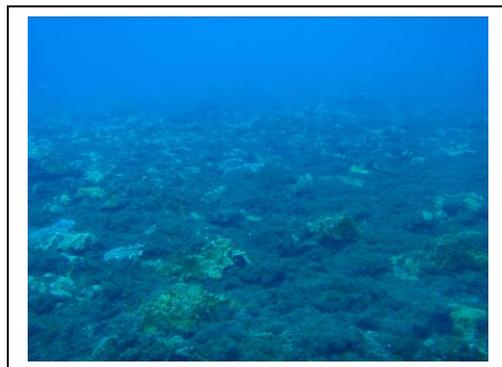
10/31/2008

W 155° 31.375

N 19° 06.684

Forereef

Depth: 5-5 m



General site description

This site is located on the southeast shore of Hawai`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of mostly pavement covered with turf and coral. Coral cover was moderate and complexity was zero/low. Fish diversity was low/moderate with abundant small fishes (*Acanthurus nigrofuscus* and *Thalassoma duperrey*). Few medium fishes were observed in the immediate area (*Naso literatus* and *Parapuneus multifasciatus*).

HAW-81

11/1/2008

W 155° 54.448

N 19° 04.796

Forereef

Depth: 21-21 m



General site description

This site is located on the southwest shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site consisted of mostly *Porites compressa* and *P. lobata* habitat, intermixed with coral rubble and scattered large boulders. The reef sloped at an approximate 45 degree angle. Coral cover was high and complexity was moderate/high. Fish diversity was high with abundant small and medium-size fishes. Common medium fishes included surgeonfish and parrotfish; *Acanthurus olivaceus*, *Naso literatus*, *Chlorurus sordidus*, *Scarus rubroviolaceus* and *Ctenochaetus hawaiiensis*. Common small fishes included *C. strigosus*, *Chromis agilis* and *Pseudocheilinus evanidus*. Noteworthy species included *Centropyge fisheri*.

HAW-82

11/1/2008

W 155° 51.760

N 19° 01.584

Forereef

Depth: 5-5 m



General site description

This site is located on the southwest shore of Hawai'i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of mostly large/medium boulders and small pinnacles surrounding the area. Coral cover was high and complexity was high. Fish diversity was high with abundant small and medium-size fishes (more small fishes observed than medium). Common small-sized fish species included *Ctenochaetus strigosus*, *Acanthurus nigrofuscus*, *Thalassoma duperrey* and *Chromis vanderbilti*. Common medium-sized fish species included *Naso literatus*, *Acanthurus leucoparis* and *C. hawaiiensis*. Several schools of *Mulloidichthys vanicolensis* were observed off transect.

HAW-83

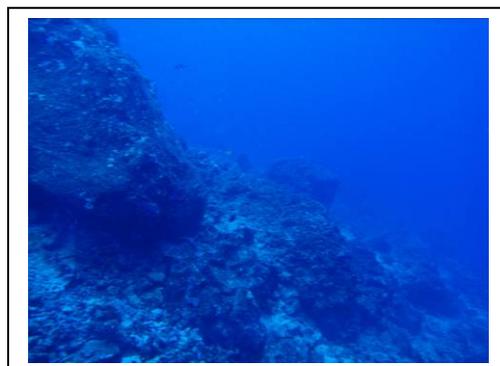
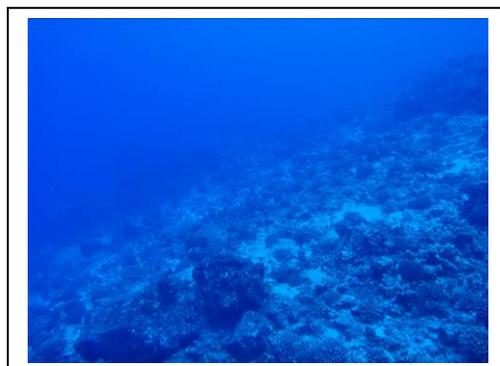
11/1/2008

W 155° 46.978

N 18° 59.712

Forereef

Depth: 21-21 m



General site description

This site is located on the southwest shore of Hawai'i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site consisted of mostly *Porites compressa* and *P. lobata* habitat intermixed with coral rubble and scattered large boulders. The reef sloped at a 45 degree angle. Coral cover was high and complexity was moderate/high. Fish diversity was high with abundant small and medium-size fishes. Common small species included *Chromis agilis*, *Ctenochaetus strigosus* and *Acanthurus nigrofuscus*. Common medium species included schools of *Naso hexacanthus*, *N. brevirostris*, *C. hawaiiensis* and *Aphareus furca*. Parrotfish were also common in the immediate area (primarily *Scarus rubroviolaceus*).

HAW-84

11/2/2008

W 155° 41.024
N 18° 54.879

Forereef

Depth: 26-26 m



General site description

This site is located on the southwest shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site is composed mostly of large boulders resting on pavement along a steep slope. Many fishing lines were around and the bottom was littered with debris. Fish diversity was moderate, with moderate amounts of medium-sized fish. No notable sightings.

HAW-85

11/2/2008

W 155° 41.767
N 18° 56.707

Forereef

Depth: 3-3 m



General site description

This site is located in a small cover on the southwest shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep shallow stratum. The bottom is composed of pavement with small coral heads. Fish diversity is moderate. There was a moderate amount of medium-sized fish. No notable sightings.

HAW-86

11/2/2008

W 155° 42.776
N 18° 57.512

Forereef

Depth: 3-3 m



General site description

This site is located on the southwest shore of Hawai'i. It was established by the REA fish team as a new sampling location in the deep shallow stratum. This site is located next to a small wall. The bottom is composed of walls and boulders. Coral cover was moderate, with high complexity. Fish diversity is moderate. There was a moderate amount of medium-sized fishes. No notable sightings.

HAW-87

11/2/2008

W 155° 45.268

N 18° 58.541

No pictures available.

Forereef

Depth: 3-4 m

General site description

This site is located on the southwest shore of Hawai'i. It was established by the REA fish team as a new sampling location in the deep shallow stratum. This site is located next to a small wall. The bottom is composed of walls and boulders. Coral cover was moderate, with high complexity. Fish diversity is moderate. There was a moderate amount of medium-sized fishes. No notable sightings.

HAW-88

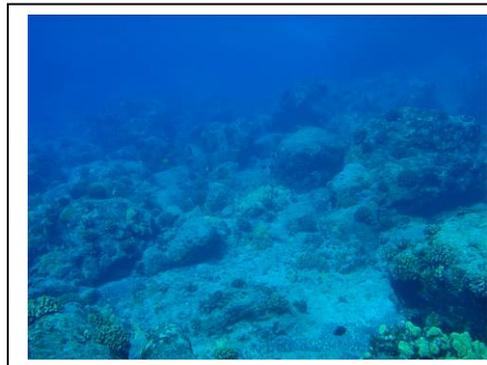
11/2/2008

W 155° 45.669

N 18° 58.844

Forereef

Depth: 4-4 m



General site description

This site is located on the southwest shore of Hawai'i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted of mostly medium and large boulders interlaced with small sand patches, rocks, and cobbles. Coral cover was low and live coral present were *Pocillopora meandrina*, *Porites lobata*, and *Montipora flabellata*. Fish diversity was high; common species included *Ctenochaetus strigosus*, *Acanthurus nigrofuscus*, *Thalassoma duperre*, *Chromis vanderbilti*, *Kyphosus sp.*, and *Chlorurus sordidus*. Species of note seen off transect include *Chaetodon reticulatus* and *Carangoides orthogrammus*.

HAW-89

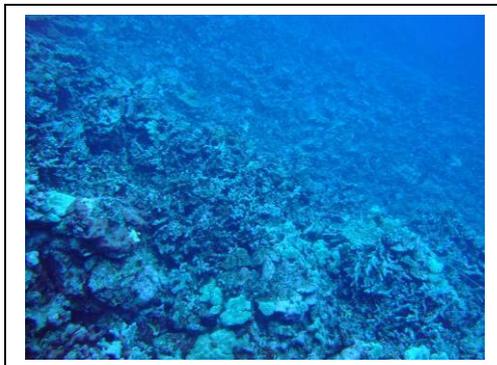
11/2/2008

W 155° 46.280

N 18° 59.193

Forereef

Depth: 25-25 m



General site description

This site is located on the southwest shore of Hawai`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site is composed of a sloping bottom with moderate coral and medium complexity. Fish diversity was moderate, with moderate amounts of medium-sized fish. No notable sightings.

C.3. Benthic Environment

C.3.1 Algae

Benthic communities around the Big Island of Hawai`i were dominated by turf algal and coral functional groups (Table C.3.1.1). Turf algae were the dominant functional group at 13 of the 19 sites surveyed with a percent cover range of 15.6% to 82% (Table C.3.1.1). Coral percent cover exceeded that of other functional groups at 4 of the 19 sites with a percent cover range of 0.8% to 50.8% (Table C.3.1.1). Macroalgae were only a minor component of the benthic communities surrounding the Island of Hawai`i, comprising 2.4% to 37.2% of the benthos (Table C.3.1.1). A combined total of 31 species of macroalgae were observed (8 chlorophytes, 7 ochrophytes, 16 rhodophytes) from the 19 sites surveyed (Tables C.3.1.2 and C.3.1.3). *Lobophora variegata* was documented at all of the survey sites and dominated the macroalgal community at 14 of the 19 sites with a percent cover range of 0.8% to 22.8% (Table C.3.1.3). *Amansia glomerata* was the only other macroalgal species found at a majority of the sites, and it was documented at 10 of the 19 sites. However it was a minor component of the benthos with a percent cover range of 0% to 14.4% (Table C.3.1.3).

Table C.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at the Big Island of Hawai'i.

Site	Macroalgae	Turf Algae	Coralline Red Algae (crustose + upright)	Cyanobacteria	Coral
HAW-01	4.8%	41.6%	6.4%	-	22.8%
HAW-08	9.6%	44.8%	20.4%	-	22.8%
HAW-09	13.2%	19.2%	49.6%	-	15.6%
HAW-10	5.6%	44.8%	20.8%	-	27.6%
HAW-11	7.2%	54.4%	18.0%	-	20.0%
HAW-17	2.4%	15.6%	23.6%	1.2%	50.8%
HAW-20	37.2%	32.0%	17.6%	-	1.6%
HAW-21	11.2%	58.4%	5.6%	-	12.0%
HAW-24	9.5%	37.0%	14.0%	-	38.5%
HAW-25	3.2%	46.4%	7.6%	-	42.8%
HAW-26	7.2%	40.8%	15.6%	-	35.6%
HAW-28	14.8%	82.0%	0.4%	-	0.8%
HAW-29	11.2%	45.6%	9.2%	-	22.4%
HAW-30	4.4%	39.2%	6.0%	-	50.4%
HAW-31	6.8%	58.0%	13.6%	-	21.6%
HAW-32	10.0%	35.6%	5.6%	-	44.4%
HAW-32	2.8%	54.0%	16.0%	0.8%	23.2%
HAW-33	4.8%	48.4%	13.6%	-	30.0%
HAW-34	2.8%	49.6%	9.6%	0.8%	36.4%

Table C.3.1.2.--Additional species recorded at each site at the Big Island of Hawai`i during Roving Diver survey.

Site	Chlorophyta
HAW-29, HAW-32	<i>Caulerpa taxifolia</i>
HAW-32, HAW-33	<i>Caulerpelia ambigua</i>
HAW-09	<i>Halimeda distorta</i>
HAW-16, HAW-24, HAW-26, HAW-34	<i>Halimeda opuntia</i>
HAW-09, HAW-21, HAW-29, HAW-33	<i>Halimeda velasquezii</i>
HAW-08, HAW-10, HAW-11, HAW-16, HAW-20, HAW-24, HAW-28, HAW-30, HAW-31, HAW-32, HAW-34	<i>Neomeris</i> sp.
HAW-34	<i>Ventricaria ventricosa</i>
	Ochrophyta
HAW-10, HAW-16, HAW-17, HAW-25, HAW-26	<i>Dictyota ceylanica</i>
HAW-11, HAW-16, HAW-25	<i>Dictyota</i> sp.
HAW-31	<i>Padina</i> sp.
HAW-08	<i>Styopodium flabelliforme</i>
	Rhodophyta
HAW-01, HAW-17, HAW-25	<i>Acanthophora pacifica</i>
HAW-08, HAW-30	<i>Amansia glomerata</i>
HAW-16	<i>Dotyella hawaiiensis</i>
HAW-29	<i>Galaxaura</i> sp.
HAW-26	<i>Gibsmithia hawaiiensis</i>
HAW-32	<i>Haloplegma duperreyi</i>
HAW-17	<i>Halymenia</i> sp.
HAW-32	<i>Laurencia</i> sp.
HAW-20	<i>Liagora</i> sp.
HAW-11	<i>Martensia</i> sp.
HAW-08, HAW-09 HAW-11, HAW-17 HAW-26	<i>Peyssonnelia</i> sp.
HAW-08, HAW-17	<i>Portieria hornemannii</i>

Table 3.2.3.--Cover of macroalgal species (%) at long-term monitoring sites at the Big Island of Hawai`i.

Site	<i>Caulerpa racemosa</i>	<i>Caulerpa taxifolia</i>	<i>Halimeda distorta</i>	<i>Halimeda opuntia</i>	<i>Neomeris</i> sp	<i>Dictyota ceylanica</i>	<i>Dictyota friabilis</i>	<i>Lobophora variegata</i>	<i>Padina</i> sp	<i>Styopodium flabelliforme</i>	<i>Acanthophora pacifica</i>	<i>Amansia glomerata</i>	<i>Gibsmithia doryi</i>	<i>Gibsmithia hawaiiensis</i>	<i>Haliclrysis coalescens</i>	<i>Haloplegma duperreyi</i>	<i>Laurencia</i> sp	<i>Martensia</i> sp	<i>Poriterra hornemannii</i>	<i>Wrangelia</i> sp
HAW-01	-	-	-	-	-	-	-	0.8%	-	-	-	4.0%	-	-	-	-	-	-	-	-
HAW-08	-	-	-	-	-	0.4%	-	9.2%	-	-	-	-	-	-	-	-	-	-	-	-
HAW-09	-	-	-	-	-	0.4%	-	12.8%	-	-	-	-	-	-	-	-	-	-	-	-
HAW-10	-	-	-	-	-	-	-	5.6%	-	-	-	-	-	-	-	-	-	-	-	-
HAW-11	-	-	0.4%	-	-	-	0.4%	6.8%	-	-	-	-	-	-	-	-	-	-	-	-
HAW-17	-	-	0.4%	-	-	-	-	0.8%	-	-	-	1.2%	-	-	0.4%	-	-	-	-	-
HAW-20	-	-	-	-	-	-	-	22.8%	-	-	-	14.4%	-	-	-	-	-	-	-	-
HAW-21	-	-	-	-	0.4%	-	-	1.2%	-	-	-	0.4%	-	0.4%	-	1.6%	0.8%	-	6.4%	-
HAW-24	-	-	-	-	-	-	-	9.5%	-	-	-	-	-	-	-	-	-	-	-	-
HAW-25	-	-	-	-	-	-	-	2.8%	-	-	-	0.4%	-	-	-	-	-	-	-	-
HAW-26	-	-	-	-	-	-	-	6.0%	-	-	-	0.8%	-	-	-	-	-	-	-	0.4%
HAW-28	-	-	-	-	-	-	-	7.6%	4.4%	-	-	0.4%	-	-	-	-	-	-	-	2.4%
HAW-29	-	-	-	0.4%	0.4%	2.4%	-	2.8%	2.4%	-	0.4%	2.0%	-	-	-	-	-	-	0.4%	-
HAW-30	-	2.0%	-	-	-	0.4%	-	1.2%	0.4%	-	0.4%	-	-	-	-	-	-	-	-	-
HAW-31	-	-	-	-	-	2.4%	-	2.0%	-	-	-	2.0%	-	-	-	0.4%	-	-	-	-
HAW-32	-	-	-	-	-	0.8%	-	0.8%	-	0.4%	-	-	0.4%	-	-	-	-	-	0.4%	-
HAW-32	-	-	-	-	-	-	-	2.0%	-	-	4.0%	1.6%	-	-	-	1.2%	-	-	1.2%	-
HAW-33	-	-	-	-	-	-	-	4.0%	-	-	0.4%	-	-	-	-	-	-	0.4%	-	-
HAW-34	0.4%	-	-	-	-	-	-	2.4%	-	-	-	-	-	-	-	-	-	-	-	-

Sum of totals for each row equal to the percent cover of macroalgae recorded in Table X

C.3.2. Corals

C.3.2.1 Coral Populations

Line-point intercept surveys indicate relatively high coral cover ($27.3 \pm 3.3\%$) at REA sites around Hawai'i in 2008 (Fig. C.3.2.1.1, left). Benthic habitat generally varied between large boulders or rocky outcroppings with sand channels. Species richness varied between sites with 12 genera (11 scleractinian and 1 zoanthid) being represented within belt transect surveys. Coral composition was dominated by *Porites* (50.3%), *Montipora* (25.7%), and *Pocillopora* (20.9%) colonies (Fig. C.3.2.1.1, right). The most common scleractinian species observed included *Porites lobata* (44.0%), *Pocillopora meandrina* (15.5%) and *Montipora capitata* (14.6%; Table C.3.2.1.1).

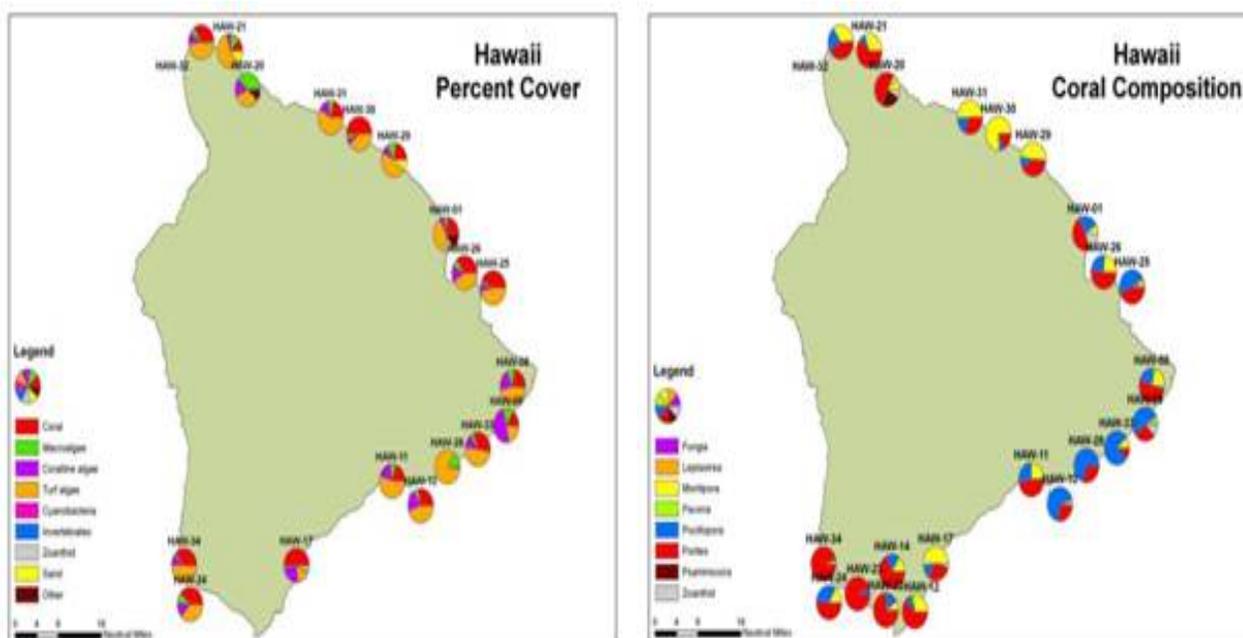


Figure C.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around Hawai'i in 2008.

Table C.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around Hawai'i in 2008.

Taxon Name	No. of Colonies	Relative Abundance
<i>Cyphastrea ocellina</i>	2	0.03
<i>Cyphastrea</i> sp.	4	0.05
<i>Cycloseris</i> sp.	16	0.21
<i>Fungia scutaria</i>	8	0.10
<i>Fungia</i> sp.	4	0.05
<i>Leptastrea bewickensis</i>	11	0.14
<i>Leptoseris/Pachyseris/Gardineroseris/Coeloseris</i>	1	0.01
<i>Leptoseris incrustans</i>	10	0.13
<i>Leptastrea purpurea</i>	4	0.05
<i>Leptastrea transversa</i>	1	0.01
<i>Montipora capitata</i>	1124	14.57
<i>Montipora flabellata</i>	274	3.55
<i>Montipora incrassata</i>	7	0.09
<i>Montipora patula</i>	511	6.63
<i>Palythoa</i> sp.	511	6.63
<i>Pavona</i> sp.	1	0.01
<i>Porites brighami</i>	5	0.06
<i>Porites compressa</i>	211	2.74
<i>Pocillopora damicornis</i>	1	0.01
<i>Pavona duerdeni</i>	18	0.23
<i>Porites evermanni</i>	31	0.40
<i>Psammocora haimeana</i>	19	0.25
<i>Pocillopora ligulata</i>	12	0.16
<i>Porites lobata</i>	3392	43.98
<i>Pavona maldivensis</i>	8	0.10
<i>Pocillopora meandrina</i>	1194	15.48
<i>Pocillopora molokensis</i>	1	0.01
<i>Pocillopora</i> sp.	230	2.98
<i>Porites</i> sp.	21	0.27
<i>Porites rus</i>	1	0.01
<i>Psammocora</i> sp.	1	0.01
<i>Psammocora stellata</i>	2	0.03
<i>Pavona varians</i>	77	1.00

C.3.2.2. Coral Health

During 2008 REA surveys, compromised coral health prevalence was low with only 3.0% of colonies being affected. The occurrence of algal interactions was most common (1.0%). Members of the genera *Porites* (9.8%) and *Montipora* (8.0%) exhibited relatively higher prevalence (Fig. C.3.2.2.1). *Montipora* colonies were found to be affected by algal infections (2.4%) and bleaching (2.1%) while colonies of *Porites* were more common to have fungal infections (3.4%) and algal interactions (2.7%). Higher prevalence was typically found along the northeast coast of the island at sites, such as HAW-01 and HAW-30.

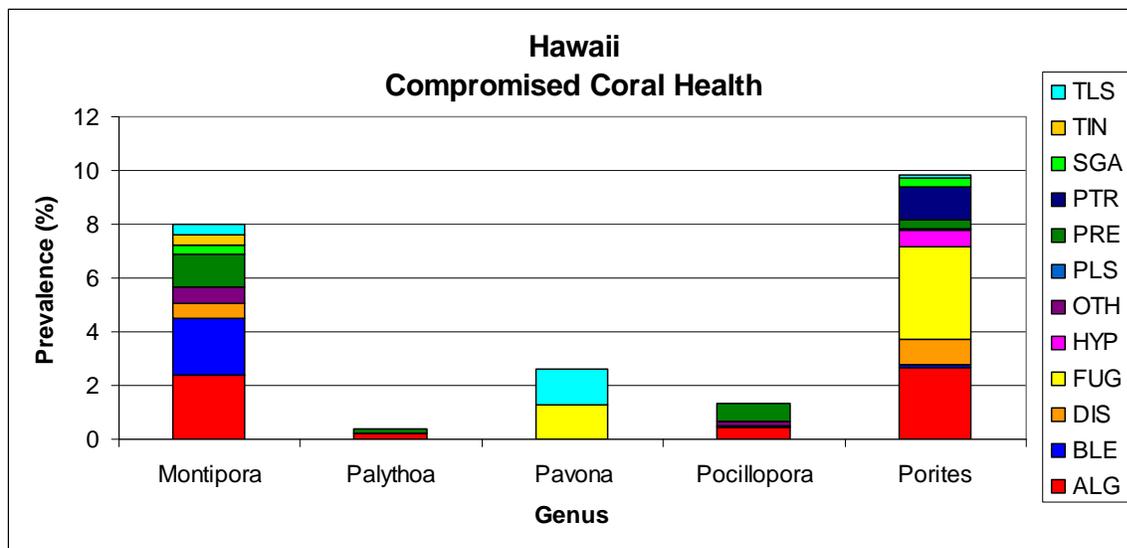


Figure C.3.2.2.1.--Prevalence of compromised coral health by taxon at Hawai`i in 2008.

Percent mortality of colonies surveyed during 2008 was moderate (24.5%; Fig. C.3.2.2.2). Along the belt transects, *Pavona* (10.9%) and *Porites* (8.1%) colonies were found to exhibit signs of partial mortality. Throughout forereef sites, *Pocillopora* and *Montipora* colonies had 3.0 and 2.5% partial mortality, respectively. Other genera, such as *Psammocora*, *Leptastrea* and *Fungia* were found to be healthy with 100% live tissue.

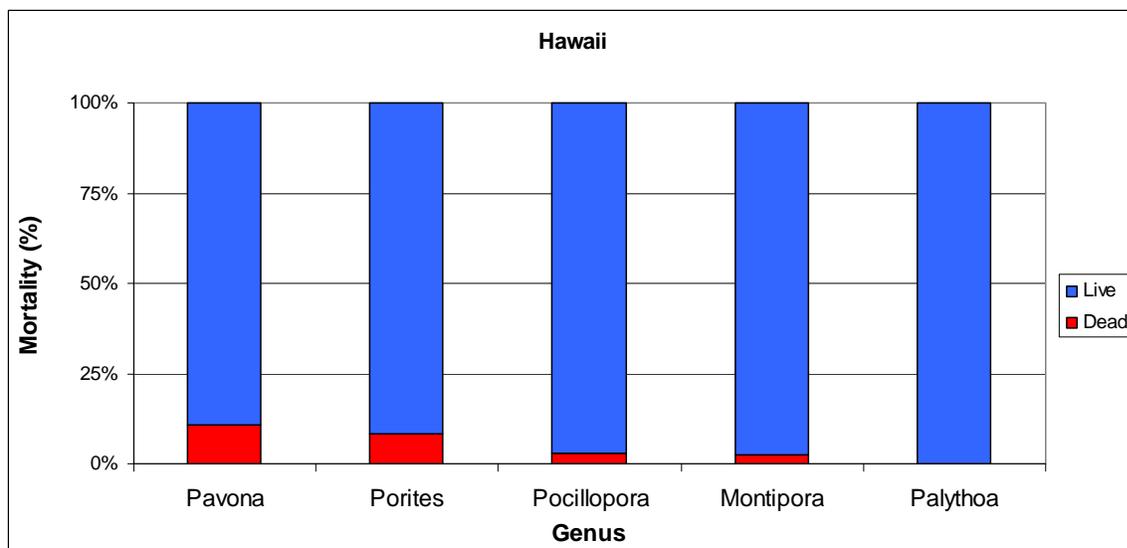


Figure C.3.2.2.2.--Mean percent live versus dead tissue for various coral genera at Hawai`i in 2008.

C.3.3. Noncoral Invertebrate Surveys

A total of 4721 individuals of benthic invertebrate target species or taxa group were enumerated from 38 belt transects at 19 sites. Noncryptic invertebrates were dominated by the echinoids *chinometra mathaei* and *Echinothrix* sp. Zoanthids were also very numerous and were present at

every site (with the exception of HAW-11). Densities of *Echinometra mathaei* were highest at HAW-08 followed by HAW-10 and HAW-11 (3.56, 1.91, and 1.72/m² respectively). *Echinothrix* sp. densities were highest at HAW-28, HAW-09, and HAW-08 (0.75, 0.22, and 0.15/ m² respectively). Trapezid crabs were very numerous, with the highest densities recorded at HAW-33, HAW-10, and HAW-31. (0.57, 0.54, and 0.45/m² respectively). One pearl oyster, *Pinctada margaritifera* was seen at HAW-11.

C.3.3.1. Urchin Measurements

Figure C.3.3.1.1 reveals the average test diameter of urchins from the genera *Echinometra*, *Echinothrix*, *Tripneustes*, and *Echinostrephus* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented.

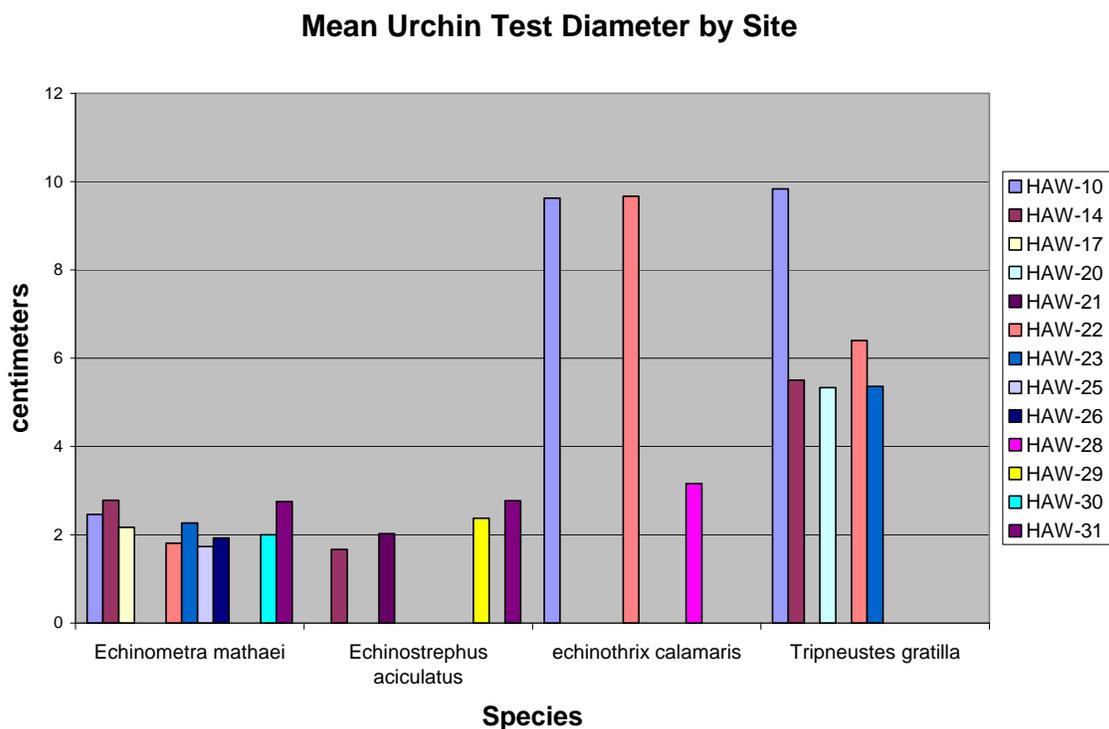


Figure C.3.3.1.1.--Mean test size of urchins by site.

C.3.3.2. ARMS Deployment

HAW-24

Deployed 3 ARMS

19° 02.293' N; 155° 52.953' W

01-NOV-2008

HAW-14

Deployed 3 ARMS ~ 12.2 m,

18.93908473° N; 155.68830125° W (Decimal degrees)

02-NOV-2008

HAW-22

Deployed 3 ARMS ~ 15.2 m,

18.96859682° N, 155.73073195° W

02-NOV-2008

C.3.4 Towed-diver Benthic Surveys

A total of 41 towed-diver surveys were conducted off the coast of Hawai`i in 2008. Surveys were focused around the northeast region (17 tows) and volcano coast (10 tows) with additional tows conducted in both the southeast (6 tows) and southwest regions (8 tows, Fig. C.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.

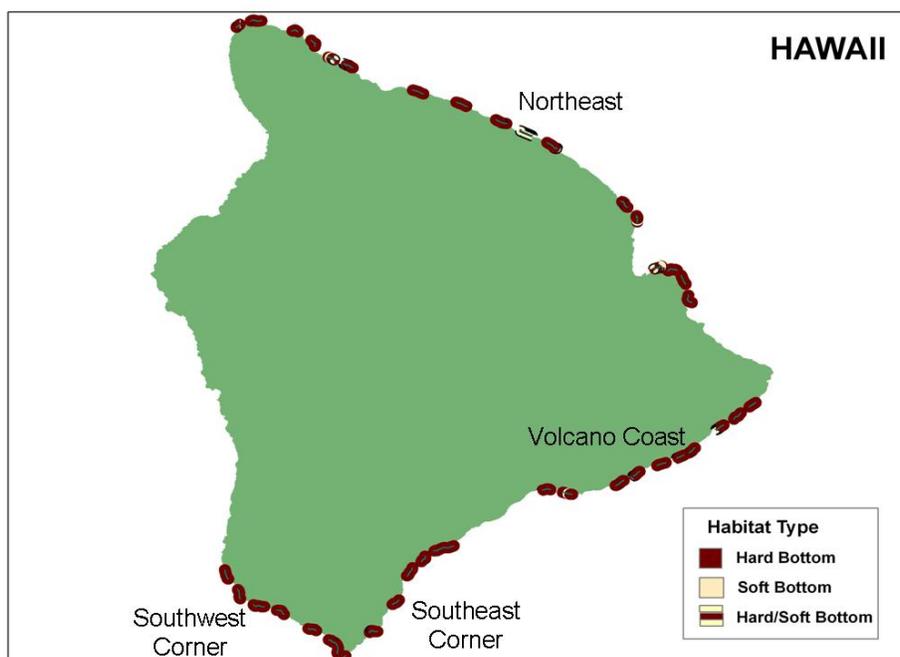


Figure C.3.4.1.--Locations of 41 towed-diver surveys around Hawai`i in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Habitat types varied considerably both within tows and between regions, although the majority of habitat was hard bottom. Habitat within the northeast region consisted primarily of rock boulders with scattered bedrock outcroppings. The volcano coast was also heavily dominated by rock boulders while the southeast and southwest corners were composed of a mix of rock boulders and continuous reef. Due to limited area coverage with regards to the island as a whole, island averages are not presented. Instead, means (percent cover) and total (invertebrate counts) values are presented for each region. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in the Table C.3.4.1 and Figure C.3.4.2.

The highest coral cover was observed in the southeast and southwest regions (mean: 30 and 24%, respectively). The lowest coral cover was observed along the volcano coast where percent cover was extremely low at the 2 tows adjacent to the lava outfall. Corals in this area were mostly

small (less than 10 cm) *Pocillopora meandrina* and *Porites lobata* colonies. Stressed coral was fairly low in all regions except for a localized spike near Hilo Bay. Coral cover was relatively high consisting mostly of *Porites lobata* and *Montipora capitata*. About 20–30% of *Porites* colonies had either growth anomalies or predation marks while growth anomalies were also fairly common in *Montipora* colonies.

Macroalgae was extremely low for all regions while coralline algae were moderate averaging between 12 and 23% for all regions. The most common macroinvertebrate in all regions was the boring urchin. Crown-of-thorns seastars (COTS) were most abundant in the Northeast region with 142 individuals observed.

Table C.3.4.1.--Overall Benthic Habitat Composition.

Region	Hard Coral	Stress Coral	Macro-algae	Coralline Algae	COTs	Free Urchins	Boring Urchins	Sea Cucumbers
Northeast	13	3	1	12	142	305	1726	154
Southeast	30	3	1	20	9	874	1492	22
Southwest	24	2	1	23	12	968	2577	139
Volcano coast	11	3	1	16	19	980	3527	53

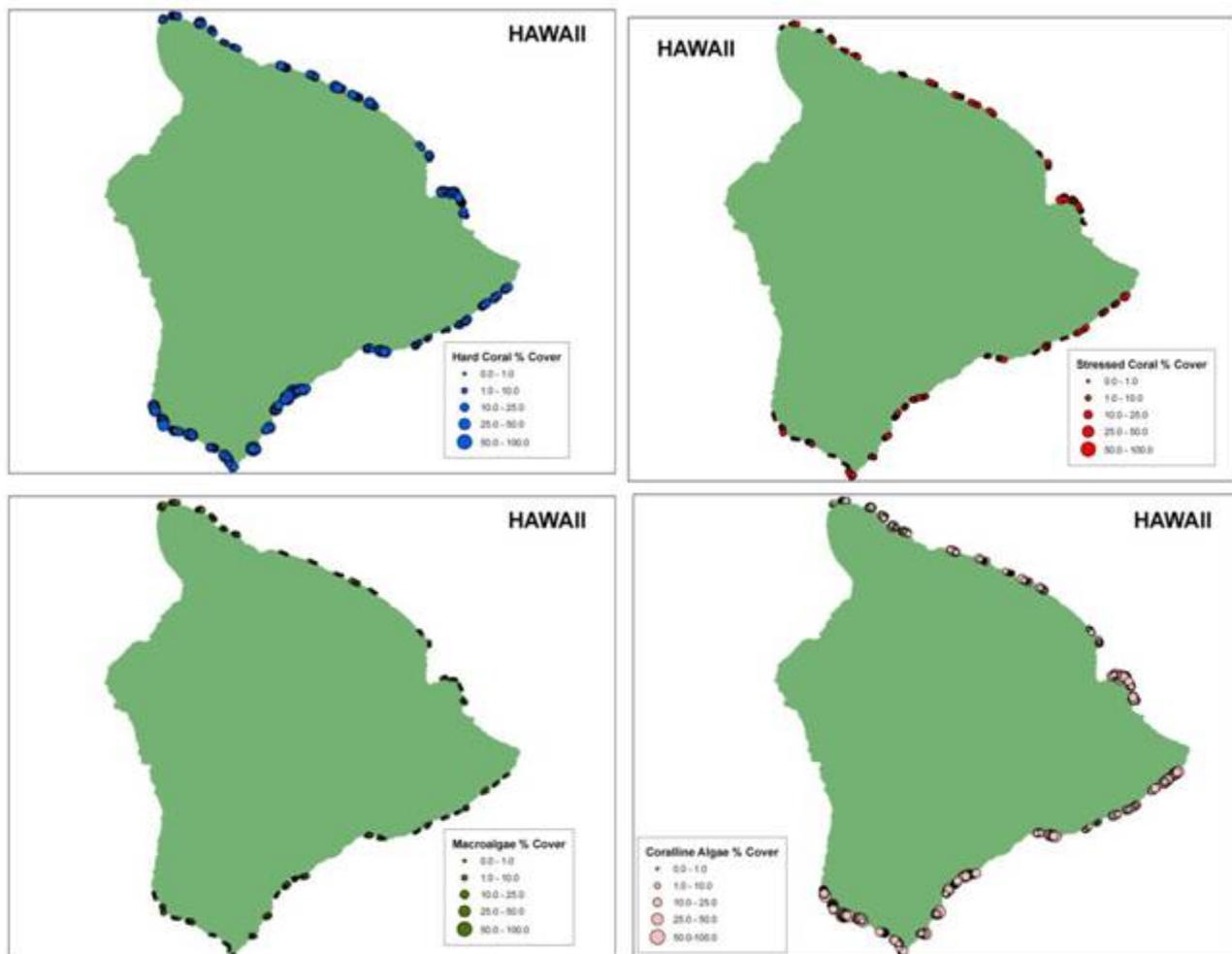


Figure C.3.4.2.--Clockwise: hard coral cover, stressed coral cover, coralline algal cover, and macroalgal cover.

C.4 Fish

C.4.1 REA Fish Surveys

Belt transect data

During the survey period, belt transect surveys were conducted at 62 sites around Hawai`i. Surgeonfish were the largest contributor to total biomass with 2.50 kg 100 m⁻². Parrotfish were the second largest contributor to total biomass with 0.49 kg 100 m⁻², followed by snappers at 0.32 kg 100 m⁻² (Fig. C.4.1.1)

Overall Observations

A total of 171 fish species were observed by all divers during the survey period. The average total fish biomass around Hawai`i during the survey period was 5.38 kg 100 m⁻² for the belt transect surveys (Table C.4.1.1).

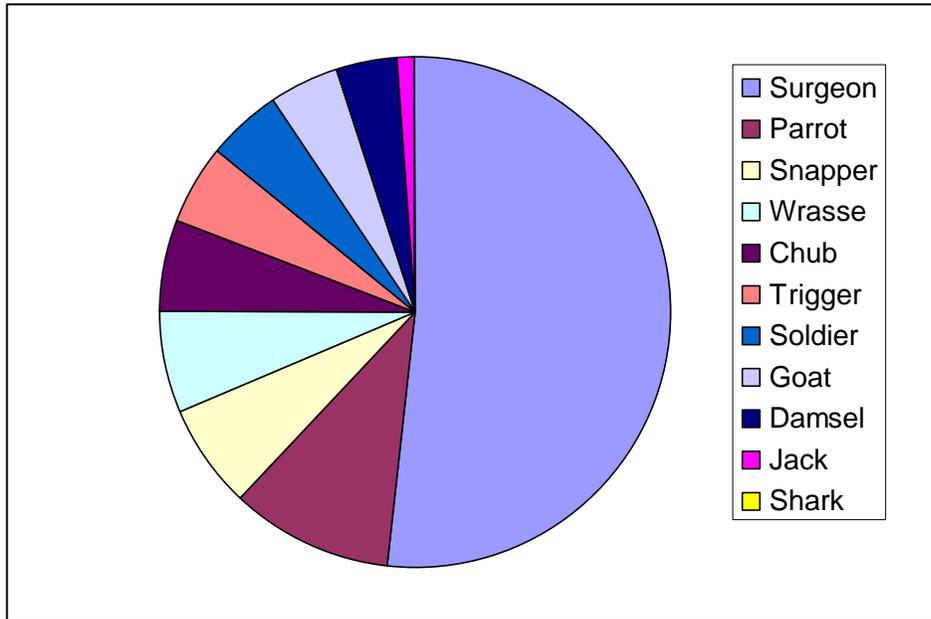


Figure H.4.1.1.--Total fish biomass composition by family.

SE-08-10 Cruise Report

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	HAW-50	8.35	0.00	0.21	0.10	0.00	2.61	0.00	2.46	0.00	1.79	0.00	0.38
Deep	HAW-53	2.32	0.00	0.17	0.00	0.00	0.22	0.00	0.13	0.00	0.43	0.24	0.90
Deep	HAW-55	9.98	0.24	0.05	0.36	0.22	0.00	0.00	0.73	1.13	6.02	0.22	0.67
Deep	HAW-59	10.28	0.00	0.17	0.22	0.00	0.00	0.00	2.58	0.11	5.99	0.00	0.77
Deep	HAW-61	2.90	0.00	0.02	0.86	0.00	0.00	0.00	0.00	0.00	1.31	0.00	0.42
Deep	HAW-64	5.73	0.00	0.01	0.23	0.00	0.00	0.00	0.00	0.11	4.51	0.44	0.32
Deep	HAW-66	7.01	0.00	0.17	0.03	0.00	0.00	0.00	0.00	0.00	5.10	0.81	0.30
Deep	HAW-67	9.37	0.00	0.04	0.88	0.00	0.33	0.00	1.09	0.74	4.71	0.43	0.50
Deep	HAW-68	5.84	0.00	0.22	0.09	0.00	1.71	0.00	0.00	0.00	2.03	1.02	0.07
Deep	HAW-69	8.25	0.00	0.12	0.17	0.00	1.91	0.00	0.18	0.00	5.12	0.50	0.04
Deep	HAW-70	6.06	0.92	0.05	0.16	0.00	1.70	0.00	0.05	0.45	1.57	0.12	0.46
Deep	HAW-75	7.69	0.00	0.06	0.61	0.00	0.00	0.00	3.99	0.21	1.83	0.17	0.17
Deep	HAW-76	3.40	0.00	0.09	0.00	0.00	0.28	0.00	0.00	0.00	2.34	0.25	0.16
Deep	HAW-78	2.47	0.00	0.03	0.11	0.00	0.05	0.00	0.00	0.00	1.49	0.27	0.42
Deep	HAW-81	4.31	0.00	0.15	0.14	0.00	0.69	0.00	0.23	0.65	1.48	0.11	0.24
Deep	HAW-83	4.64	0.00	0.11	0.43	0.00	0.11	0.00	0.00	0.06	3.15	0.09	0.23
Deep	HAW-84	2.62	0.00	0.15	0.13	0.00	0.05	0.00	0.17	0.00	1.35	0.37	0.15
Deep	HAW-89	4.22	0.00	0.08	0.10	0.00	0.84	0.00	0.05	0.86	0.74	0.00	0.13
Mid	HAW-01	6.82	0.00	1.01	0.12	0.00	0.53	0.00	0.75	0.81	2.74	0.11	0.44
Mid	HAW-08	5.91	0.00	0.09	0.23	0.00	0.22	0.00	0.34	0.00	3.79	0.10	0.19
Mid	HAW-09	3.78	0.00	0.09	0.00	0.00	0.57	0.00	0.08	0.00	2.09	0.62	0.10
Mid	HAW-10	18.51	6.48	0.22	0.17	0.00	1.85	0.00	1.74	1.01	3.53	1.53	0.43
Mid	HAW-11	11.88	0.38	0.14	0.32	0.00	1.70	0.00	0.50	1.58	5.09	0.59	0.16
Mid	HAW-12	4.81	0.00	0.10	0.13	0.00	0.71	0.00	0.02	0.00	2.93	0.02	0.07
Mid	HAW-13	6.34	0.14	0.37	0.17	0.00	0.11	0.00	0.00	0.38	3.70	0.21	0.21
Mid	HAW-14	7.06	0.65	0.20	0.14	0.00	1.80	0.00	0.18	1.01	1.90	0.53	0.24
Mid	HAW-16	5.91	0.00	0.27	0.09	0.00	0.00	0.00	0.33	0.00	4.70	0.10	0.20
Mid	HAW-17	2.58	0.00	0.16	0.00	0.00	0.28	0.00	0.07	0.05	1.42	0.01	0.10
Mid	HAW-20	0.97	0.00	0.27	0.01	0.12	0.00	0.00	0.05	0.13	0.05	0.09	0.16
Mid	HAW-21	3.01	0.00	0.19	0.13	0.00	0.65	0.00	0.00	0.00	1.08	0.08	0.17
Mid	HAW-22	5.03	0.00	0.43	0.00	0.09	0.82	0.00	0.08	1.14	1.43	0.34	0.17
Mid	HAW-23	3.93	0.00	0.12	0.12	0.00	0.62	0.00	0.13	1.33	0.91	0.18	0.25

SE-08-10 Cruise Report

Depth	Site	Total	Chub	Damselfish	Goatfish	Jack	Parrot	Shark	Snapper	Soldier	Surge wrasse	Trigger	Wrasse
Mid	HAW-24	5.14	0.00	0.27	0.66	0.00	0.00	0.00	0.43	0.13	2.74	0.26	0.32
Mid	HAW-25	12.78	0.00	0.15	0.05	0.00	0.64	0.00	0.09	0.00	10.56	0.36	0.32
Mid	HAW-26	8.27	0.00	0.18	0.28	0.00	0.45	0.00	0.00	0.00	6.53	0.03	0.14
Mid	HAW-28	4.71	0.00	0.03	0.04	0.39	0.76	0.00	0.79	0.00	1.75	0.32	0.54
Mid	HAW-29	4.64	0.00	0.22	0.08	1.77	0.00	0.00	0.07	0.00	1.69	0.20	0.40
Mid	HAW-30	5.94	0.45	0.37	0.19	0.00	0.12	0.00	0.68	0.48	2.37	0.20	0.23
Mid	HAW-31	6.66	0.91	0.25	0.26	0.86	0.64	0.00	0.16	0.06	1.82	0.04	0.46
Mid	HAW-32	2.98	0.82	0.04	0.00	0.00	0.31	0.00	0.14	0.00	1.09	0.11	0.19
Mid	HAW-33	7.11	0.00	0.18	0.00	0.00	2.14	0.00	0.31	0.19	2.91	0.72	0.15
Mid	HAW-34	2.07	0.00	0.04	0.00	0.00	0.46	0.00	0.06	0.05	0.87	0.14	0.11
Shallow	HAW-51	1.42	0.00	0.16	0.07	0.00	0.00	0.00	0.17	0.06	0.48	0.00	0.38
Shallow	HAW-52	0.55	0.00	0.16	0.06	0.00	0.03	0.00	0.00	0.00	0.11	0.00	0.19
Shallow	HAW-54	2.67	0.00	0.10	0.14	0.00	0.89	0.00	0.72	0.00	0.27	0.00	0.42
Shallow	HAW-56	2.38	0.30	0.13	0.11	0.00	0.03	0.00	0.00	0.09	0.74	0.43	0.30
Shallow	HAW-57	4.81	1.10	0.15	0.07	0.00	0.33	0.00	0.00	0.33	2.09	0.14	0.27
Shallow	HAW-58	2.92	1.77	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.17	0.42
Shallow	HAW-60	6.33	1.59	0.62	0.16	0.00	0.51	0.00	0.13	0.00	2.90	0.03	0.15
Shallow	HAW-62	3.57	0.09	0.30	0.00	0.00	0.09	0.00	0.00	0.06	1.27	0.09	0.87
Shallow	HAW-63	1.71	0.00	0.24	0.09	0.00	0.00	0.00	0.00	0.00	0.68	0.27	0.42
Shallow	HAW-65	4.86	0.00	0.14	0.00	0.00	0.10	0.00	0.00	0.00	1.89	0.19	0.40
Shallow	HAW-71	7.70	0.41	0.14	2.63	0.00	0.00	0.00	0.00	0.22	3.32	0.38	0.20
Shallow	HAW-72	7.84	0.00	0.23	0.30	0.00	0.00	0.00	0.11	0.52	1.65	0.44	0.51
Shallow	HAW-74	6.28	0.28	0.13	0.08	0.00	0.00	0.00	0.09	0.00	4.50	0.46	0.35
Shallow	HAW-77	1.90	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00	0.35
Shallow	HAW-80	0.95	0.00	0.07	0.11	0.00	0.00	0.00	0.00	0.00	0.23	0.16	0.18
Shallow	HAW-82	7.98	0.53	0.46	1.51	0.00	0.90	0.00	0.07	0.26	2.99	0.20	0.51
Shallow	HAW-85	1.31	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.04	0.15
Shallow	HAW-86	6.91	0.00	0.24	0.08	0.00	0.25	0.00	0.05	0.39	5.59	0.05	0.11
Shallow	HAW-87	3.48	0.00	0.15	0.05	0.00	0.57	0.00	0.00	0.00	2.17	0.00	0.34
Shallow	HAW-88	5.89	0.24	0.19	0.10	0.00	0.79	0.00	0.02	0.00	3.26	0.00	0.39
	Total	5.38	0.28	0.18	0.22	0.06	0.49	0.00	0.32	0.23	2.50	0.24	0.31

C.4.2 Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED towed-diver team completed 41 surveys around the island of Hawai`i covering 91 km (91 ha) of ocean floor (Table C.4.2.1). Mean survey length was 2.2 km with a maximum length of 2.9 km and a minimum of 0.8 km. Mean survey depth was 13.9 m with a maximum depth of 16.6 m and a minimum of 11.7 m. Mean temperature on these surveys was 25.6 °C with a maximum temperature of 26.2 °C and a minimum of 25.3 °C.

Table C.4.2.1.--Survey statistics for towed-diver sampling during SE-08-10.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

Three hundred twenty-three individual large-bodied reef fish (> 50 cm in total length) of 24 different species and 17 different families were encountered at Hawai`i Island (Table C.4.2.2). Overall numeric density for this class of reef fishes was 0.036 #/100 m² (3.556 #/ha) with a biomass density of 0.16 kg/100 m² (0.016 t/ha). Numeric and biomass density were both dominated by *Scarus rubroviolaceus*.

The most prevalent families in terms of numeric density were Scarids (41%), Aulostomids (8%), and Lutjanids (3%) (Fig. C.4.2.1). Biomass was dominated by Scarids (41%), Sphyrnids (29%), and Chanids (12%) (Fig. C.4.2.2).

Surveys have not been conducted along the western coast of Hawai`i Island making a discussion of geographic distributions difficult at this time. However, excluding the western coast, biomass of this class of reef fishes appears to be similar along the northeast and southeast coasts (Fig. C.4.2.3). Areas of high biomass are found at the northern and southern tips of the island. *Chanos chanos* were encountered in both of these areas while *Sphyrna lewini* was encountered only at the southern tip.

Table C.4.2.2.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed around Hawai'i from towed-diver surveys during the SE-08-10 MHIRAMP cruise.

Species	#	#/100m2	#/ha	Biomass (kg)	kg/100m2	t/ha
Aetobatus_narinari	3	0.000	0.033	32.05721609	0.004	0.000
Aprion_virescens	10	0.001	0.110	57.47727083	0.006	0.001
Aulostomus_chinensis	26	0.003	0.286	6.553441639	0.001	0.000
Bodianus_bilunulatus	3	0.000	0.033	5.475	0.001	0.000
Caranx_ignobilis	1	0.000	0.011	15.11846806	0.002	0.000
Caranx_melampygus	7	0.001	0.077	14.85564047	0.002	0.000
Cephalopholis_argus	1	0.000	0.011	2.355036083	0.000	0.000
Chanos_chanos	9	0.001	0.099	179.1280847	0.020	0.002
Chlorurus_perspicillatus	39	0.004	0.429	102.3065304	0.011	0.001
Diodon_hystrix	2	0.000	0.022	6.124221566	0.001	0.000
Fistularia_commersonii	6	0.001	0.066	4.034357226	0.000	0.000
Gymnothorax_flavimarginatu	3	0.000	0.033	11.50583628	0.001	0.000
Gymnothorax_javanicus	1	0.000	0.011	7.701927621	0.001	0.000
Gymnothorax_meleagris	1	0.000	0.011	2.7951	0.000	0.000
Gymnothorax_undulatus	2	0.000	0.022	3.2	0.000	0.000
Monotaxis_grandoculis	2	0.000	0.022	6.261523222	0.001	0.000
Naso_hexacanthus	5	0.001	0.055	10.60577503	0.001	0.000
Naso_unicornis	1	0.000	0.011	2.567473762	0.000	0.000
Oplegnathus_punctatus	3	0.000	0.033	7.6125	0.001	0.000
Scarus_rubroviolaceus	192	0.021	2.114	509.2034896	0.056	0.006
Seriola_dumerili	1	0.000	0.011	14.41782246	0.002	0.000
Sphyraena_barracuda	1	0.000	0.011	11.2355914	0.001	0.000
Sphyraena_qenie	1	0.000	0.011	5.6	0.001	0.000
Sphyrna_lewini	3	0.000	0.033	437.8414298	0.048	0.005
Grand Total	323	0.036	3.556	1456.034	0.160	0.016
# of Species	24					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Hawaii Island During 2008 CRED Towed-Diver Surveys

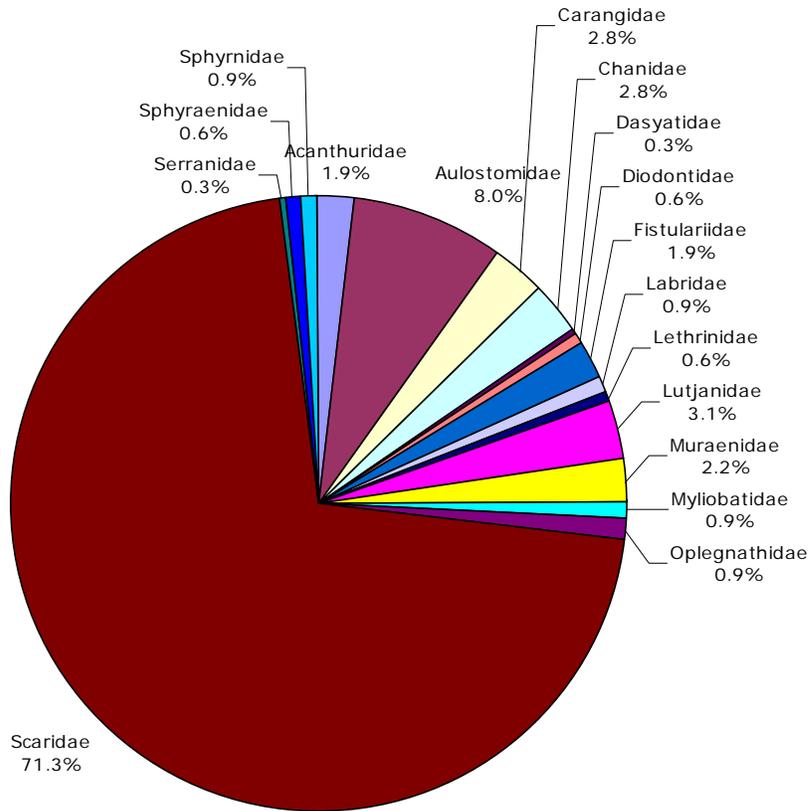


Figure C.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Hawaii Island During 2008 CRED Towed-Diver Surveys

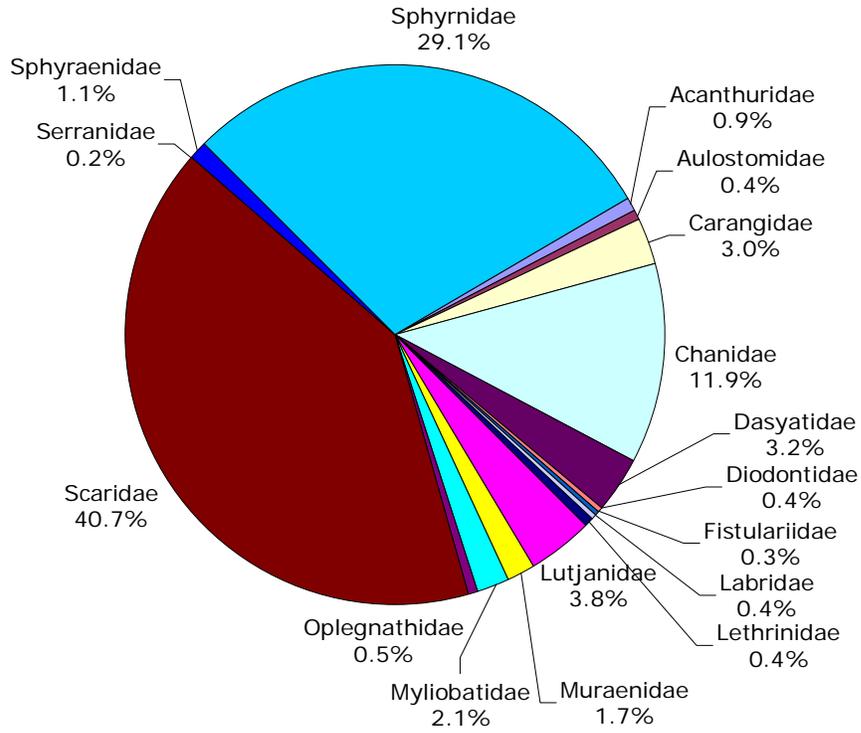


Figure C.4.2.2. Biomass density by family.

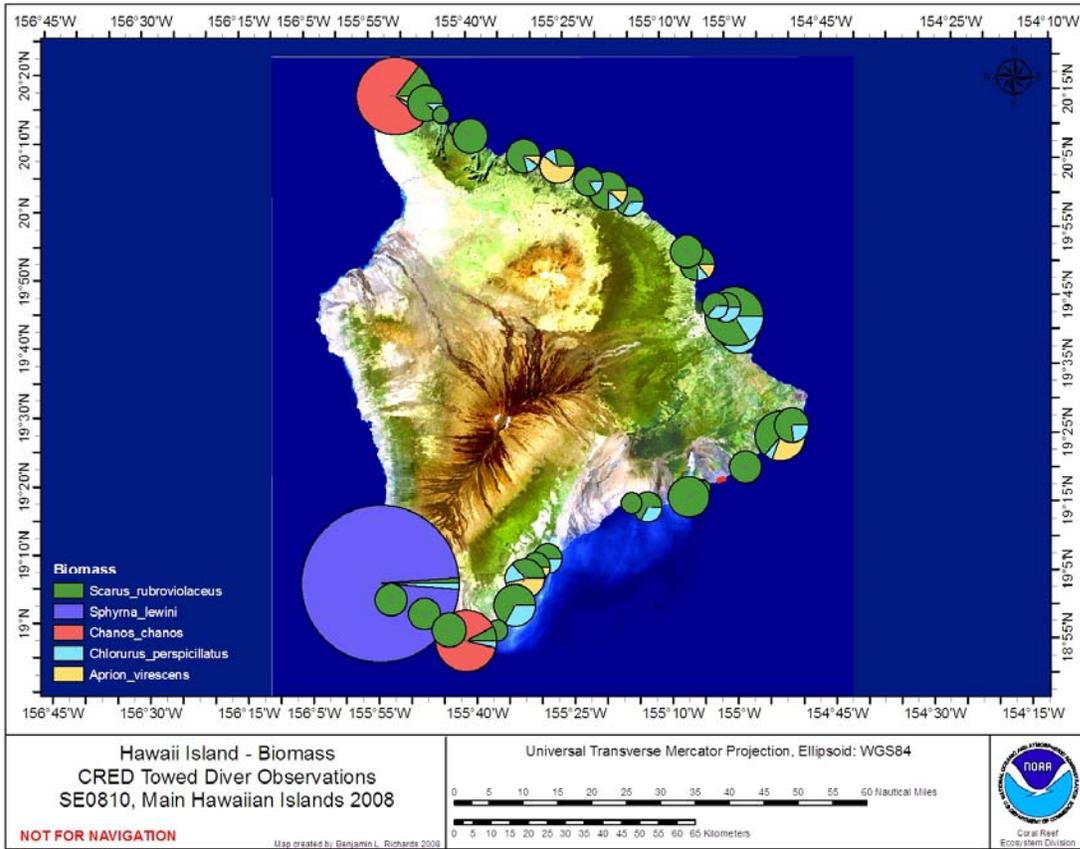


Figure C.4.2.3.--Geographic distribution of biomass around Hawai`i Island. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.

Appendix D: Kaua`i

D.1. Oceanography and Water Quality

One subsurface temperature recorder (STR) was recovered and 2 deployed at Kaua`i. A new ecological acoustic recorder (EAR) deployment was established as well.

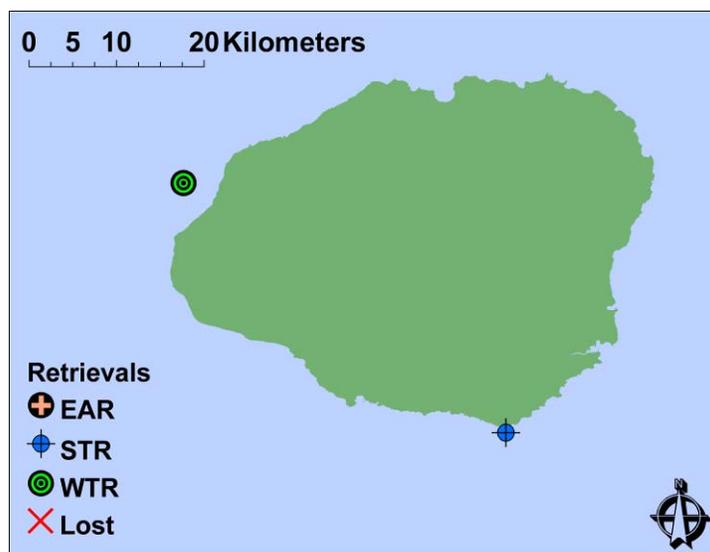


Figure D.1.1.--Retrieved moored oceanographic instrumentation map at Kaua`i.

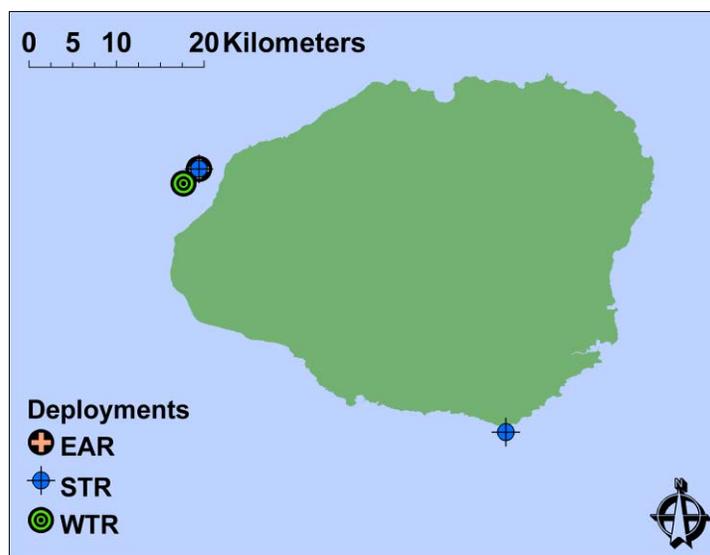


Figure D.1.2.--Deployed moored oceanographic instrumentation map at Kaua`i.

Table D.1.1.--Moored Oceanographic instrumentation table for Kaua`i.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
EAR	Deployment	930028790	22.13802	-159.76133	11/05/2008	18.29
STR	Deployment	39510234487	22.13802	-159.76133	11/06/2008	18.29
WTR	Deployment	26P368591029	22.12336	-159.77701	11/05/2008	26.82
WTR	Retrieval	26331790385	22.12336	-159.77701	11/05/2008	26.82
STR	Deployment	39240220359	21.86885	-159.44754	11/07/2008	6.71
STR	Deployment	39390381816	21.86885	-159.44754	11/07/2008	6.71

Water Quality

A total of 39 shallow-water conductivity, temperature and depth (CTD) casts were conducted at the 30-m isobath around Kaua`i using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. D.1.3). A total of 3 shallow-water CTD casts were taken for use with microbial water samples.

A total of 66 discrete water samples (including 1 duplicate) were collected concurrently with shallow-water CTD casts at 3 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m and will later be analyzed for nutrient and chlorophyll. Nutrient and chlorophyll samples were processed and stored according to protocol and were sent out for analysis when the cruise returned. Twelve of the discrete water samples were processed for microbial analysis.

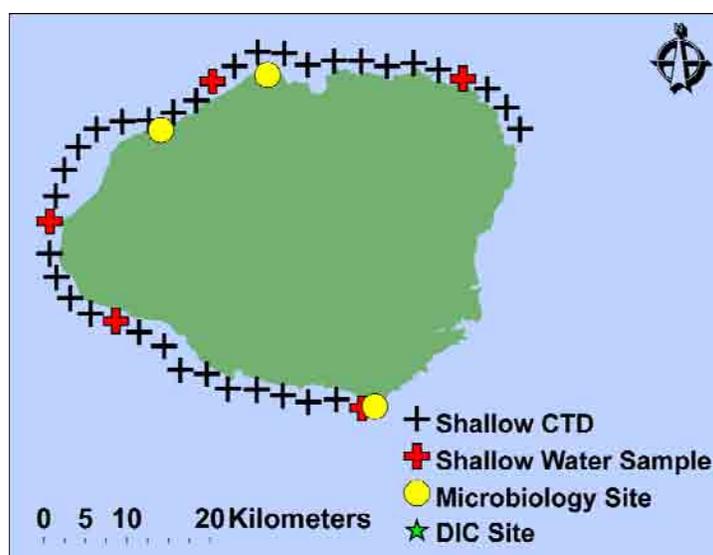


Figure D.1.3.--Shallow-water CTD and water sampling locations around Kaua`i.

D.2. Rapid Ecological Assessment (REA) Site Descriptions

KAU-15

11/05/2008

N 22° 08.270'

W 159° 45.667'

Pavement

Depth: 15.2–16.5 m

Conditons: good



Survey Notes: Original global positioning system (GPS) point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (44.8%), scattered colonies of *Montipora capitata*, *M. patula*, *Pocillopora meandrina*, and *Porites lobata* (27.6%), and macroalgae (25.2%). *Halimeda discoidea* was the dominant species of macroalgae found at the site (6.0%). Overall crustose coralline red algal cover was low (1.6%).

Coral: Moderate coral cover was documented at this forereef site with colonies of *Montipora patula* (49.9%), *M. capitata* (23.0%), and *Pocillopora meandrina* (16.2%) being the most common species observed. A total of 4 scleractinian genera were recorded within the belt transect. Overall coral health was very good. Evidence of compromised health states included one skeletal growth anomaly (0.3%) and one “other” (0.3%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Halimeda discoidea*, species of *Martensia*, *Padina*, *Wrangelia*, and *Peyssonnelia*, and *Gibsmithia hawaiiensis*. Additional algae documented by the Roving Diver survey include species of *Neomeris*, *Laurencia*, and *Galaxaura*, *Dictyota ceylanica*, *Haloplegma duperreyi*, *Portieria hornemannii*, *Codium arabicum*, *Plocamium sandvicense*, and *Dotyella hawaiiensis*.

Inverts: Invertebrate diversity at this site was very low. Urchins were not common, with the most frequently recorded genus being *Echinostrephus*. Of note was the sighting of one stomatopod. Hermit and trapezid crabs were the most abundant organisms at this site. **Fish:** Fish diversity and abundance, were relatively low at this site. The few moderate-sized fishes counted included *Acanthurus olivaceus*, *Sufflamen frenatus*, and *Melichthys niger*. The most abundant fish were the tilefish, *Ptereleotris heteroptera*. Seen off transect were uku, *Aprion virescens*.

KAU-14

11/05/2008

N 22° 09.763'

W 159° 43.748'

Pavement

Depth: 15.2–15.9 m

Conditions: good



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (56.0%), and macroalgae (28.0%) with scattered colonies of coral, including *Montipora capitata*, *Pocillopora meandrina*, and *Porites lobata* (7.2%). Overall crustose coralline red algal cover was low (6.4%).

Coral: Low coral cover was documented at this forereef site with colonies of *Pocillopora meandrina* (28.3%), *Montipora patula* (21.6%), *M. capitata* (19.9%), and *P. eydouxi* (17.6%) commonly observed. Only 3 scleractinian genera were recorded within the belt transect. Overall

coral health was good with a few cases of discolorations other than bleaching (1.2%), algal interactions (0.6%) and predation (0.6%) present.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Portieria hornemannii*, and a species of *Martensia*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Laurencia*, *Dictyota ceylanica*, *Dotyella hawaiiensis*, *Ventricaria ventricosa*, and *Caulerpella ambigua*.

Inverts: A total of 2 autonomous reef monitoring systems (ARMS) were installed at this site in 54 ft of water (lat. 22° 09.679'N ; long. 159° 43.763'W). Bottom-time restrictions prevented all 3 from being installed. Substrate was very hard carbonate pavement.

Fish: Fish diversity and abundance, were relatively low at this site. The few moderate-sized fishes counted included *Acanthurus olivaceus*, *Sufflamen frenatus*, and *Melichthys niger*. The most abundant fish were the tilefish, *Ptereleotris heteroptera*. Seen off transect were uku, *Aprion virescens*.

KAU-08

11/05/2008

N 22° 10.006'

W 159° 40.803'

Forereef

Depth: 11.6–12.5 m

Conditons: good



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (46.0%), macroalgae (24.8%), and scattered colonies of coral, including *Montipora capitata*, *Pocillopora meandrina*, and *Porites lobata* (16.8%). Overall crustose coralline red algal cover was low (9.6%).

Coral: This forereef site was characterized by large colonies of *Porites lobata* (47.6%), *Montipora capitata* (23.7%), and *M. patula* (23.2%). A total of 4 genera (3 scleractinian and 1 anthozoan) were represented within the belt transect. Coral health was excellent with no evidence of compromised coral health conditions.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Codium arabicum*, *Dictyota ceylanica*, *Haloplegma duperreyi*, and a species of *Martensia*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Laurencia*, *Gibsmithia hawaiiensis*, and *Acanthophora pacifica*.

Inverts: A total of 2 ARMS were installed at this site in 12.5 m of water (long. 22° 10.012'N; long. 159° 40.813'W). Bottom-time restrictions prevented all 3 from being installed. Substrate was very hard carbonate pavement. ARMS deployed at site.

Fish: This site is characterized as having moderate to low species of richness and abundance, with some notably large herbivores present, including *Acanthurus dussumieri*, *Naso unicornis*,

and a 'harem' of large *Scarus rubroviolaceus*. A school of young *Lutjanus kasmira* investigated the divers, and numerous *Ptereleotris heteroptera* were noted. Other common fishes at this site included *Paracirrhites arcatus*, *Coris venusta*, *Thalassoma duperrey*, and *Chromis vanderbilti*. Notable carnivores at this site were *Carangoides ferdau*, *Aprion virescens*, *Monotaxis grandoculis*, and *Bodianus bilunulatus*.

KAU-02

11/06/2008

N 22° 09.936'

W 159° 17.574'

Pavement

Depth: 12.8–13.7 m

Conditions: Surge ~ 2 m



Survey Notes: Original GPS point was at ~ 18-m depth. Site position moved inshore to an appropriate depth and GPS waypoint updated to reflect the change of position.

Habitat: Pavement.

Benthic Cover: Benthos was dominated by macroalgae (52.4%) and turf algae colonized on pavement (35.2%). Crustose coralline red algal cover was moderately low (10.4%). Overall coral cover was low (1.6%) and included colonies of *Montipora capitata*, *Pocillopora meandrina*, and *Porites lobata*.

Coral: Low coral cover was characterized by colonies of *Pocillopora meandrina* (40.4%), *Porites lobata* (20.4%), and *Montipora patula* (15.4%). A total of 4 genera (3 scleractinian and 1 anthozoan) were represented within the belt transect. One colony was found to display compromised coral health conditions (algal interaction- 0.8%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Halimeda discoidea*, *Haloplegma duperreyi*, *Asparagopsis taxiformis*, *Portieria hornemannii* and *Dictyosphaeria versluysii*. *Martensia fragilis*. Additional algae documented by the Roving Diver survey include species of *Neomeris*, *Padina*, and *Peyssonnelia*, and *Dotyella hawaiiensis*.

Inverts: A total of 2 ARMS were installed at this site in ~ 13.7 m of water. The exceedingly hard substrate made for lengthy installations, allowing time for only 2 units to be mounted on the bottom. No invertebrate surveys were conducted.

Fish: Fish diversity and abundance were moderate. The most abundant medium fish were surgeons (e.g., *Acanthurus olivaceus*, *Acanthurus nigrofuscus*). Notable sightings include *Abudefduf vaiigiensis* and *Coris flavovittata*.

KAU-03

11/06/2008

N 22° 13.833'

W 159° 24.320'

Pavement

Depth: 8.2–9.4 m

Conditions: Surge ~ 3 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines. Site located in close proximity to cliffs with possibility for high wave energy.

Habitat: Pavement.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (55.2%) and macroalgae (24.4%), with scattered colonies of coral, including *Montipora patula*, *M. capitata*, *Pocillopora meandrina*, and *Porites lobata* (13.6%). Overall crustose coralline red algal cover was low (6.8%).

Coral: This site was characterized with relatively low coral cover comprised of *Montipora patula* (47.6%), *Porites lobata* (24.2%), *M. flabellata* (16.0%), and *Pocillopora meandrina* (13.3%). A total of 4 genera (3 scleractinian and 1 anthozoan) were found within the belt transect. Overall coral health was very good with only 1 case of algal interaction documented.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Halimeda velasquezii*, and *Martensia fragilis*. Additional algae documented by the Roving Diver survey include species of *Neomeris*, *Padina*, and *Galaxaura*, *Dictyota ceylanica*, *Caulerpa taxifolia*, *Ventricaria ventricosa*, *Halimeda discoidea*, and *Halichrysis coalescens*.

Inverts: Invertebrate diversity was low at this site. Extremely surge conditions were not conducive to detecting sedentary cryptic invertebrates. Echinostrephus and Echinometra spp. urchins were the most numerous organisms recorded. Spondylus clams were noted on several of the transect segment.

Fish: Fish diversity and abundance were moderate. The most abundant medium-sized fishes were surgeons (e.g., *Acanthurus olivaceus*, *Acanthurus nigrofuscus*). Notable sightings include *Canthigaster amboinensis* and *Heteropriacanthus cruentatus*.

KAU-13

11/06/2008

N 22° 13.583'

W 159° 33.859'

Boulder Ridge

Depth: 7.3–8.2 m

Conditons: Surge ~ 3 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulder ridge.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (36.0%) and scattered colonies of coral, including *Montipora patula*, *M. flabellata*, *Pocillopora meandrina*, and *Porites lobata* (28.4%). Overall crustose coralline red algal cover was moderate (13.6%), as was percent macroalgal cover (14.4%).

Coral: Moderate coral cover was found at this site. Colonies of *Montipora patula* (66.4%) and *M. capitata* (10.0%) were most common. A total of 5 genera (4 scleractinian and 1 anthozoan) were documented along the belt transect. Overall coral health was good. Only 6 colonies were observed to exhibit compromised coral health states including 3 observations of algal interaction and 3 cases of predation (1.1% each).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Dictyota ceylanica*, *Caulerpa taxifolia*, and *Halichrysis coalescens*. Additional algae documented by the Roving Diver survey include a species of *Peyssonnelia* and *Plocamium sandvicense*.

Inverts: Invertebrate diversity was low at this site. Extremely surgy conditions here were not conducive to detecting sedentary cryptic invertebrates. Zooanthids were numerous, as were *Protospalythoa* spp. Only a handful of urchins were recorded.

Fish: Fish diversity and abundance were moderate. The most abundant medium-sized fishes were surgeons (e.g., *Acanthurus olivaceus*, *Acanthurus nigrofuscus*). Notable sightings include *Canthigaster amboinensis* and *Heteropriacanthus cruentatus*.

KAU-05

11/07/2008

N 21° 52.127'

W 159° 26.842'

Pavement/Boulders

Depth: 6.7–7.9 m



Conditions: Surge ~ 2 m, Visibility ~ 6 m

Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement/boulder patch among sand flats

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (52.8%) with scattered colonies of coral, including *Montipora patula*, *M. capitata*, *Pocillopora meandrina*, and *Porites lobata* (8.8%). Overall crustose coralline red algal cover was low (10.4%), as was macroalgal cover (9.6%). Sand covered 18.0% of the substrate.

Coral: Low coral cover was documented at this forereef site with large colonies of *Porites lobata* (48.2%), *Montipora patula* (27.6%), and *Pocillopora meandrina* (20.0%) being the most common species observed. A total of 4 scleractinian genera were recorded within the belt transect. Overall coral health was good with 2 colonies displaying algal interactions (2.8%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, a species of *Laurencia*, and *Martensia fragilis*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Acanthophora pacifica*, and *Amansia glomerata*.

Inverts: This site was fairly depauperate, probably due to the shallow sand-blasted character of the substrate. Zooanthids were present, as were the ubiquitous *Echinometra mathaei*. Of special note was the presence of one octopus, one *Panulirus lobster*, and one *Stichopus* sea cucumber.

Fish: Fish diversity and abundances were low at this site. Smaller fishes were most common, with *Thalassoma duperrey* and *Chromis vanderbilti* being counted most often. The largest fish species recorded was the surgeonfish *Acanthurus olivaceus*.

KAU-06

11/07/2008

N 21° 53.386'

W 159° 36.542'

Pavement

Depth: 11.9–15.8 m

Conditions: Moderate current



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (52.8%), macroalgae (18.0%), and crustose coralline red algae (16.0%) with scattered colonies of coral, including *Montipora capitata*, *M. patula*, *Pocillopora meandrina*, and *Porites lobata* (9.6%).

Coral: Relatively low coral cover was documented at this forereef site with large colonies of *Porites lobata* (50.1%), *Pocillopora meandrina* (24.3%), and *Montipora capitata* (19.9%) being the most common species observed. A total of 5 genera (4 scleractinian and 1 anthozoan) were recorded within the belt transect. Overall coral health was good with 2.3% of colonies displaying

compromised health states such as algal interactions (1.1%), *Porites trematodiasis* (0.5%), and barnacle infestation (0.5%).

Algae: Algae documented by the line-point intercept survey include nongeniculate coralline red algae, crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Martensia fragilis*, and *Dotyella hawaiiensis*. Additional algae documented by the Roving Diver survey include species of *Peyssonnelia* and *Neomeris*, *Dictyota ceylanica*, *Halymenia formosa*, *Acanthophora pacifica*, *Portieria hornemannii*, and *Gibsmithia hawaiiensis*.

Inverts: A total of 2 ARMS were installed at this site in ~ 12.2 m of water (lat. 21° 53.379'N ; long. 159° 36.545'W). The exceedingly hard pavement substrate made for lengthy installations, allowing time for only 2 units to be mounted on the bottom. No invertebrate surveys were conducted here.

Fish: Fish diversity and abundance were moderate at this site. Smaller fishes were most common, with *Dascyllus albisella*, *Chromis vanderbilti*, and small *Parupeneus multifasciatus* being counted most often. More of the action occurred off transect, where schools of *Myripristis berndti*, *Apogon kallopterus*, *Sargocentron xantherythrum* were seen milling about under a low ledge.

KAU-12

11/07/2008

N 21° 55.827'

W 159° 39.565'

Pavement

Depth: 12.2–13.4 m

Conditions: Visibility
~ 6 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (62.8%), and macroalgae (22.8%) with scattered colonies of coral, including *Montipora capitata*, *Pocillopora meandrina*, and *Porites lobata* (10.8%). Overall crustose coralline red algal cover was low (1.6%).

Coral: Relatively low coral cover was documented at this foreereef site with large colonies of *Porites lobata* (76.1%) and *Montipora capitata* (10.6%) being the most common species observed. A total of 4 scleractinian genera were recorded within the belt transect. Overall coral health was good with 1.6% of colonies displaying compromised health states such as fungal (1.1%) and algal interactions (0.5%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Amansia glomerata*, *Martensia fragilis*, *Dotyella hawaiiensis*, and species of *Padina*, *Galaxaura*, *Jania*, *Neomeris*, and *Wrangelia*. Additional algae documented by the Roving Diver survey include a species of *Peyssonnelia*, *Dictyota ceylanica*, *Halimeda velasquezii*, *H. discoidea*, and *Halymenia formosa*.

Inverts: A total of 2 ARMS were installed at this site in ~ 17.4 m of water. The extremely poor visibility and difficult substrate made for lengthy installations, allowing time for only 2 units to be mounted on the bottom. No invertebrate surveys were conducted here.

Fish: This site had low very fish diversity and abundances, although a sizable gang of ta'ape (*Lutjanus kasmira*) stalked the divers throughout the dive. Again, the areas off transect were more interesting, with sightings of the bandit angelfish *Apolomichthys arcuatus* and the aptly-named bicolor anthias, *Pseudanthias bicolor*.

D.3. Benthic Environment

D.3.1. Algae

Benthic communities around Kaua'i were dominated by turf and macroalgal functional groups (Table D.3.1.1). Turf algae were documented with the highest percent cover at 8 of the 9 sites surveyed. Macroalgae percent cover exceeded that of other functional groups at 1 of the 9 sites and was the second most prominent functional group at 5 of the 9 survey sites (Table A). A combined total of 26 species of macroalgae were observed (8 chlorophytes, 3 ochrophytes, 15 rhodophytes) from the 9 sites surveyed (Tables B, C). *Lobophora variegata* was ubiquitous across all survey sites and dominated the macroalgal community at 3 of the sites with a percent cover range of 0.8% to 7.2% (Table C). *Martensia* sp. occurred in low percent coverage at 5 of the 9 survey sites and was the dominant genera encountered at site KAU-03, with a percent cover of 3.2% (Table C). *Halimeda discoidea* was the most prevalent macroalgal species at sites KAU-02 and KAU-15 with a percent cover of 13.2% and 6.0%, respectively (Table C); however it was only present at 3 of the survey sites.

Table D.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at Kaua'i.

Site	Macroalgae	Turf Algae	Coralline Red Algae (crustose + upright)	Cyanobacteria	Coral
KAU-02	52.4%	35.2%	10.4%	-	1.6%
KAU-03	24.4%	55.2%	6.8%	-	13.6%
KAU-05	9.6%	52.8%	10.4%	0.4%	8.8%
KAU-06	18.0%	52.8%	16.0%	0.8%	9.6%
KAU-08	24.8%	46.0%	9.6%	-	16.8%
KAU-12	22.8%	62.8%	1.6%	0.4%	10.8%
KAU-13	14.4%	36.0%	13.6%	-	28.4%
KAU-14	28.0%	56.0%	6.4%	-	7.2%
KAU-15	25.2%	44.8%	1.6%	-	27.6%

Table D.3.1.2.--Additional species recorded at each site at Kaua'i during roving diver survey.

Site	Chlorophyta
KAU-03	<i>Caulerpa taxifolia</i>
KAU-14	<i>Caulerpella ambigua</i>
KAU-15	<i>Codium arabicum</i>
KAU-03 KAU-12	<i>Halimeda discoidea</i>
KAU-12	<i>Halimeda velasquezii</i>
KAU-02 KAU-03 KAU-05 KAU-06 KAU-08 KAU-14 KAU-15	<i>Neomeris</i> sp.
KAU-03 KAU-14	<i>Ventricaria ventricosa</i>
	Ochrophyta
KAU-03 KAU-06 KAU-12 KAU-14 KAU-15	<i>Dictyota ceylanica</i>
KAU-02 KAU-03	<i>Padina</i> sp.
	Rhodophyta
KAU-05 KAU-06 KAU-08	<i>Acanthophora pacifica</i>
KAU-05	<i>Amansia glomerata</i>
KAU-02 KAU-14 KAU-15	<i>Dotyella hawaiiensis</i>
KAU-03 KAU-15	<i>Galaxaura</i> sp.
KAU-06 KAU-08	<i>Gibsmithia hawaiiensis</i>
KAU-15	<i>Haloplegma duperreyi</i>
KAU-03	<i>Halichrysis coalescens</i>
KAU-06 KAU-12	<i>Halymenia formosa</i>
KAU-08 KAU-14 KAU-15	<i>Laurencia</i> sp.
KAU-02 KAU-06 KAU-12 KAU-13	<i>Peyssonnelia</i> sp.
KAU-13 KAU-15	<i>Plocamium sandvicense</i>
KAU-06 KAU-15	<i>Portieria hornemannii</i>

Table D.3.1.3.--Percent cover of macroalgal species at long-term monitoring sites at Kaua'i. Sum totals for each row equal the percent cover of macroalgae recorded in Table D.3.1.1.

Site	<i>Caulerpa taxifolia</i>	<i>Codium arabicum</i>	<i>Dictyosphaeria versluisii</i>	<i>Halimeda discoidea</i>	<i>Halimeda velasquezii</i>	<i>Neomeris</i> sp.	<i>Dictyota ceylanica</i>	<i>Lobophora variegata</i>	<i>Padina</i> sp.	<i>Asparagopsis taxiformis</i>	<i>Galaxaura</i> sp.	<i>Haloplegma dupeireyi</i>	<i>Jania</i> sp.	<i>Laurencia</i> sp.	<i>Martensia</i> sp.	<i>Peyssonnelia</i> sp.	<i>Portieria hornemannii</i>
KAU-02	-	-	0.4%	13.2%	-	-	-	5.2%	-	0.4%	-	3.2%	-	-	0.8%	-	1.2%
KAU-03	-	-	-	-	0.4%	-	-	2.4%	-	-	-	-	-	-	3.2%	-	-
KAU-05	-	-	-	-	-	-	-	3.2%	-	-	-	-	-	3.2%	-	-	-
KAU-06	-	-	-	0.4%	-	-	-	1.6%	-	-	-	-	-	-	-	-	-
KAU-08	-	0.4%	-	-	-	-	0.4%	0.8%	-	-	-	0.8%	-	-	0.8%	-	-
KAU-12	-	-	-	-	-	0.4%	-	0.4%	0.8%	-	0.4%	-	0.4%	-	-	-	-
KAU-13	0.4%	-	-	-	-	-	0.4%	7.2%	-	-	-	-	-	-	-	-	-
KAU-14	-	-	-	-	-	-	-	0.8%	-	-	-	-	-	0.8%	0.4%	-	0.8%
KAU-15	-	-	-	6.0%	-	-	-	2.0%	0.8%	-	-	-	-	-	0.8%	2.0%	-

D.3.2. Corals

D.3.2.1 Coral Populations

In 2008, line-point intercept surveys documented moderate mean coral cover ($13.8 \pm 3.0\%$) at REA sites around Kaua'i (Fig. D.3.2.1.1, left). Benthic habitat was generally observed as pavement. Species richness varied between sites with 9 genera (7 scleractinian and 2 zoanthid) being represented within belt transect surveys. Coral composition was dominated by encrusting *Montipora* (59.9%) and *Porites* (20.2%) colonies, as well as, *Pocillopora* (13.5%) colonies (Fig. D.3.2.1.1, right). The most common scleractinian species observed included *Montipora capitata* (39.7%), *Montipora patula* (26.4%), and *Porites lobata* (13.5%); Table D.3.2.1.1).

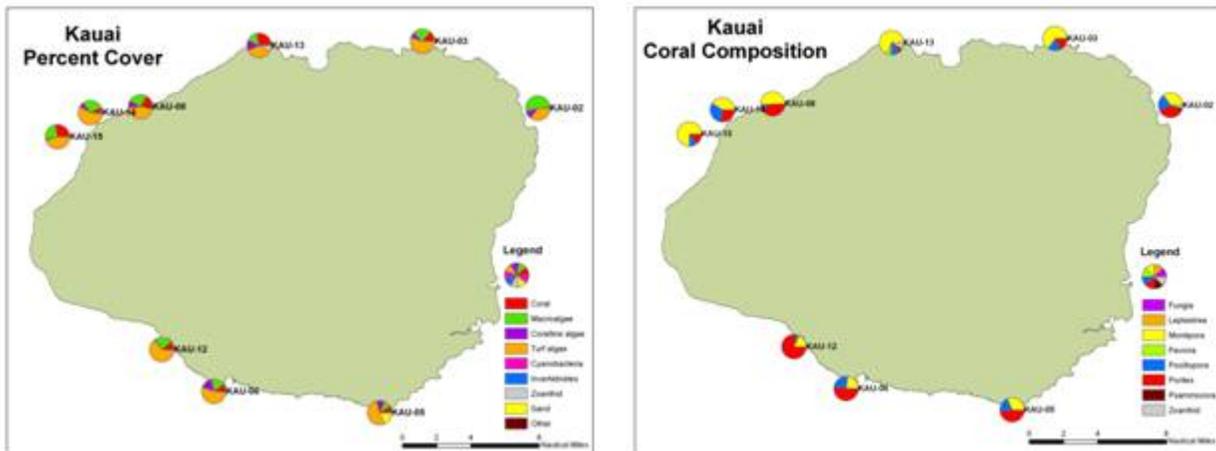


Figure D.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around Kaua'i in 2008.

Table D.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around Kaua'i in 2008.

Taxon Name	No. of Colonies	RelativeAbundance
<i>Cycloseris vaughani</i>	3	0.08
<i>Leptastrea pruinosa</i>	3	0.08
<i>Leptastrea purpurea</i>	3	0.08
<i>Montipora capitata</i>	1415	39.65
<i>Montipora flabellata</i>	272	7.62
<i>Montipora incrassata</i>	11	0.31
<i>Montipora patula</i>	941	26.37
<i>Palythoa</i> sp.	203	5.69
<i>Porites brighami</i>	2	0.06
<i>Porites compressa</i>	16	0.45
<i>Pavona duerdeni</i>	8	0.22
<i>Porites evermanni</i>	1	0.03
<i>Pocillopora eydouxi</i>	1	0.03
<i>Psammocora haimeana</i>	9	0.25
<i>Pocillopora ligulata</i>	2	0.06

Taxon Name	No. of Colonies	RelativeAbundance
<i>Porites lobata</i>	483	13.53
<i>Pocillopora meandrina</i>	118	3.31
<i>Pocillopora</i> sp.	31	0.87
<i>Porites</i> sp.	8	0.22
<i>Psammocora stellata</i>	29	0.81
<i>Pavona varians</i>	7	0.20
<i>Zoanthus</i> sp.	3	0.08

D.3.2.2 Coral Health

During 2008 REA surveys, only 1.0% of colonies surveyed were found to display evidence of compromised coral health conditions. Algal interactions (0.4%) and predation (0.1%) were the most common compromised state observed. Various states of compromised health were observed to affect 3 genera of scleractinian corals (Fig. D.3.2.2.1). Members of the genus *Porites* (10.6%) were most commonly affected with algal interactions (8.3%). Both algal interactions and barnacle infestations (0.9%) affected *Pocillopora* colonies (1.7%). Colonies of *Montipora* (1.5%) were found to have algal interactions (0.3%) and evidence of predation (0.2%). Evidence of compromised coral health states was observed at 5 of the 9 sites surveyed around Kaua'i. Higher prevalence was found at sites KAU-13 and KAU-14 along the northwest coast.

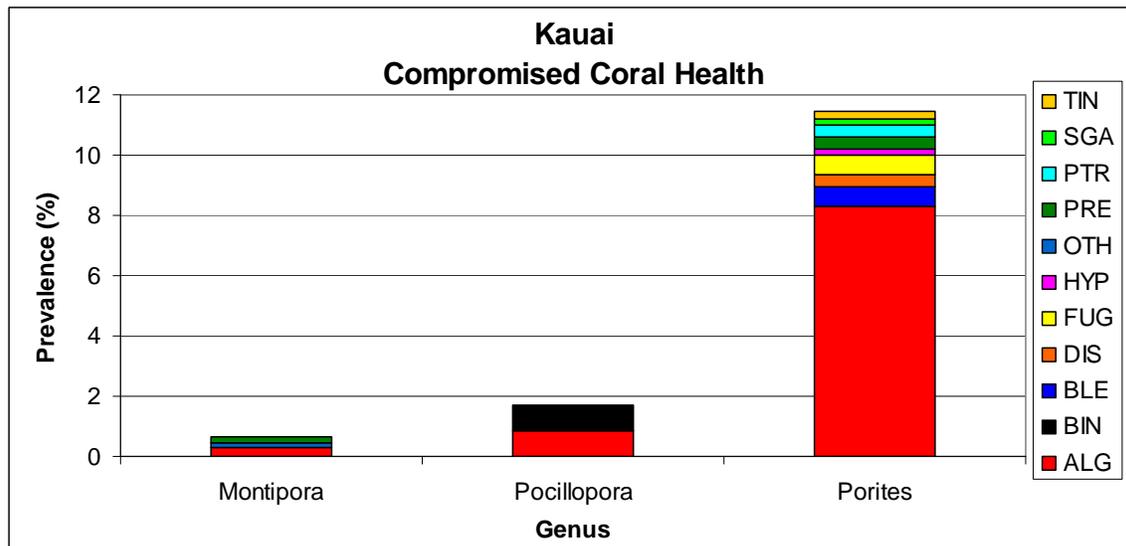


Figure D.3.2.2.1.--Prevalence of compromised coral health states by taxon at Kaua'i in 2008.

Percent mortality of colonies surveyed during 2008 was moderate (16.7%). Within the belt transects, *Pavona* (10.0%) and *Porites* (3.1%) colonies were most often observed to exhibit signs of partial mortality (Fig. D.3.2.2.2). Throughout forereef sites, other genera, such as *Pocillopora* (1.3%) and *Montipora* (2.4%) were also found to display partial mortality.

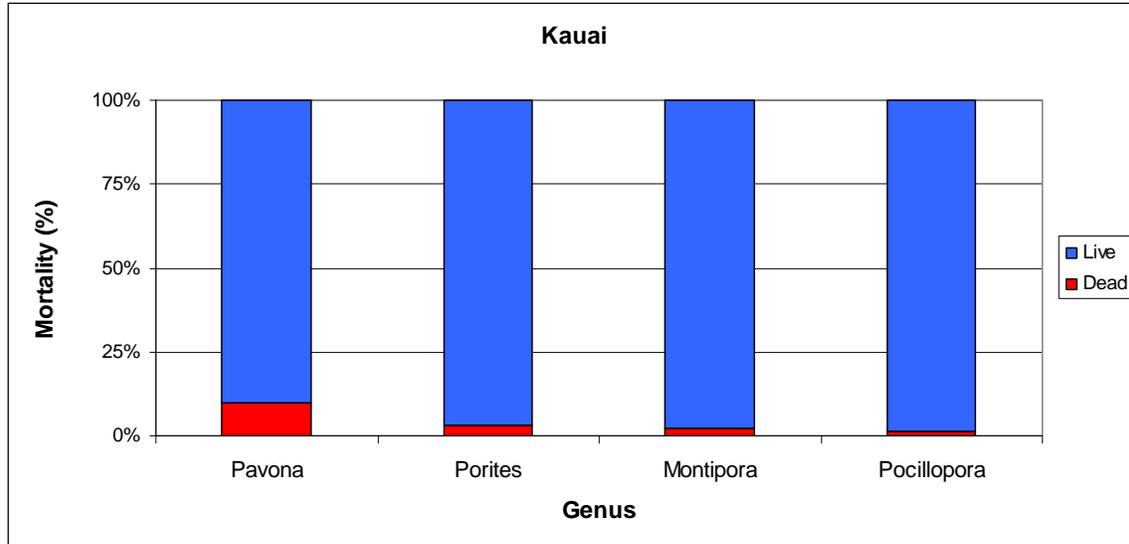


Figure D.3.2.2.2.--Mean percent live versus dead tissue for various coral genera at Kauai in 2008.

D.3.3. Noncoral Invertebrate Surveys

A total of 606 individuals of benthic invertebrate target species or taxa group were enumerated from 8 belt transects at 4 sites. The most abundant macroinvertebrates here were the Zoanthids, with an island-wide average density of 0.41 colonies/m² at sites surveyed. This density, however, was not consistently high between the sites. Site KAU-13 yielded 4.73 colonies/m², while KAU-05 and 03 only 0.09 colonies/m². Trapezid crabs were the second-most abundant organism, with the highest densities occurring at sites KAU-13 and KAU-05 (0.16 and 0.11/m², respectively). The rock-boring urchin *Echinometra mathaei* was the third-most abundant macroinvertebrate at Kauai, with the highest density occurring at site KAU-05 (0.11/m²). Asteroids were notably absent from all sites surveyed. Of note were the sightings of one *Octopus* sp., one *Stichopus* sea cucumber, and one *Panulirus* lobster at site KAU-05.

D.3.3.1 Urchin Measurements

Figure D.3.3.1.1 reveals the average test diameter of urchins from the genera *Echinometra* and *Echinostrephus* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented.

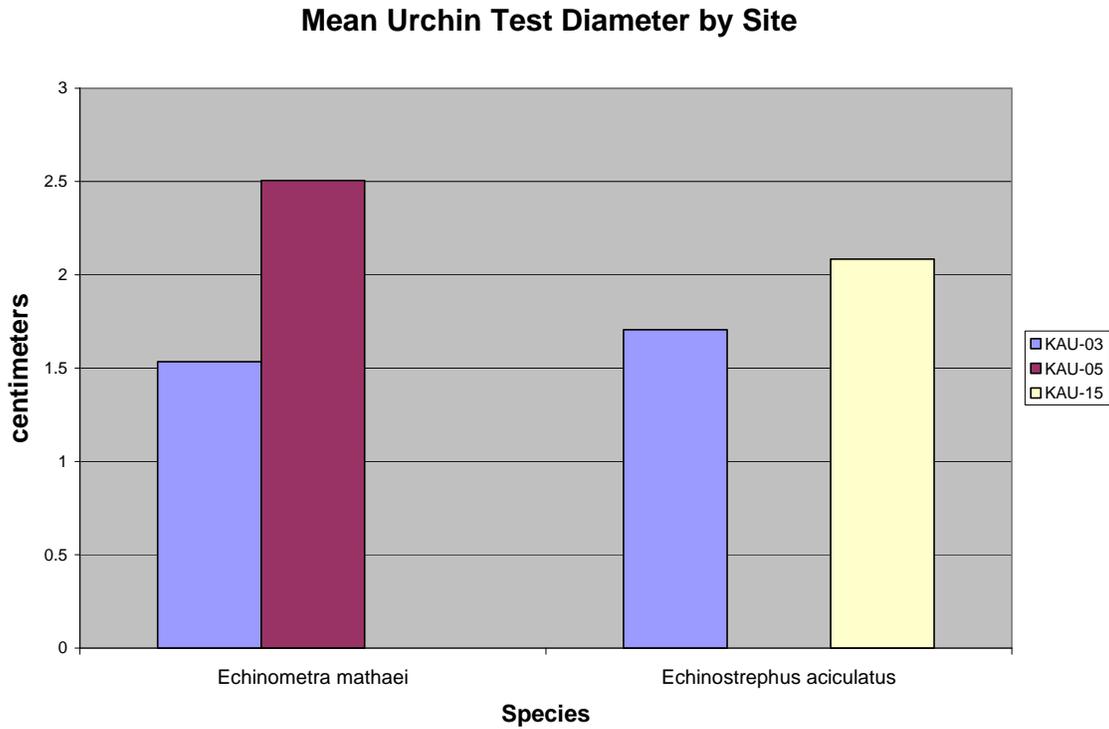


Figure D.3.3.1.1.--Mean test size of urchins by site.

D.3.3.2 ARMS Deployment

KAU-14 Deployed 2 ARMS ~ 54ft
22° 09.679' N 159° 43.763' W 05-NOV-2008

KAU-08 Deployed 2 ARMS ~ 12.5 m
22° 10.012' N 159° 40.813' W 05-NOV-2008

KAU-02 Deployed 2 ARMS ~ 13.7 m
22° 09.845' N 159° 17.935' W 06-NOV-2008

KAU-06 Deployed 2 ARMS ~ 12.2 m
21° 53.380' N 159° 36.541' W 07-NOV-2008

KAU-12 Deployed 2 ARMS ~ 17.4 m
21° 55.827' N 159° 39.573' W 07-NOV-2008

D.3.4 Towed-diver Benthic Surveys

A total of 19 towed-diver surveys were conducted off the coast of Kauaʻi in 2008. Surveys coverage was split between the north coast (6 tows), mana reef (4 tows), south (7 tows), and the northwest region (2 tows, Fig. D.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.

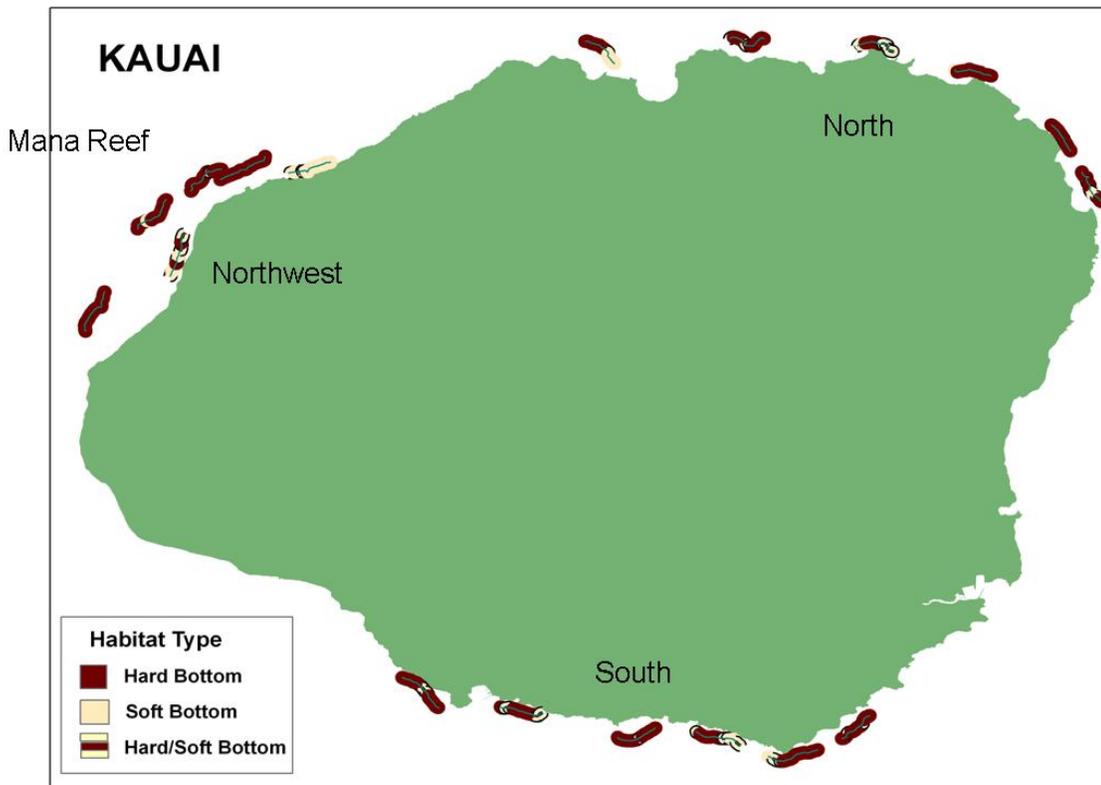


Figure D.3.4.1.--Locations of 19 towed-diver surveys around Kauaʻi in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Pavement was the predominant habitat observed on towed-diver surveys at Kauaʻi in 2008. Sand flats were also common on tows in the northwest and south regions. Due to limited area coverage with regards to the island as a whole, island averages are not presented. Instead, means (percent cover) and total (invertebrate counts) values are presented for each region. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in the Table D.3.4.1, and Figure D.3.4.2.

Hard coral was extremely low in the northwest and south regions and slightly higher in the north and mana reef region. Stressed coral was low in all regions. Macroalgae was highest in the north and mana reef area (mean 24 and 27%, respectively). Coralline algae cover was low throughout the island. Macroinvertebrates were rare with the exception of free and boring urchins, which were most abundant in the north and mana reef area.

Table D.3.4.1.--Mean percent cover and macroinvertebrate totals by tow region.

Region	Hard Coral	Stress Coral	Macro-algae	Coralline Algae	COTS	Free Urchins	Boring Urchins	Sea Cucumbers
Mana reef	11	1	27	6	5	647	617	5
North	9	2	24	4	9	549	70	12
Northwest	1	0	2	1	0	5	3	0
South	5	2	6	4	4	14	357	21

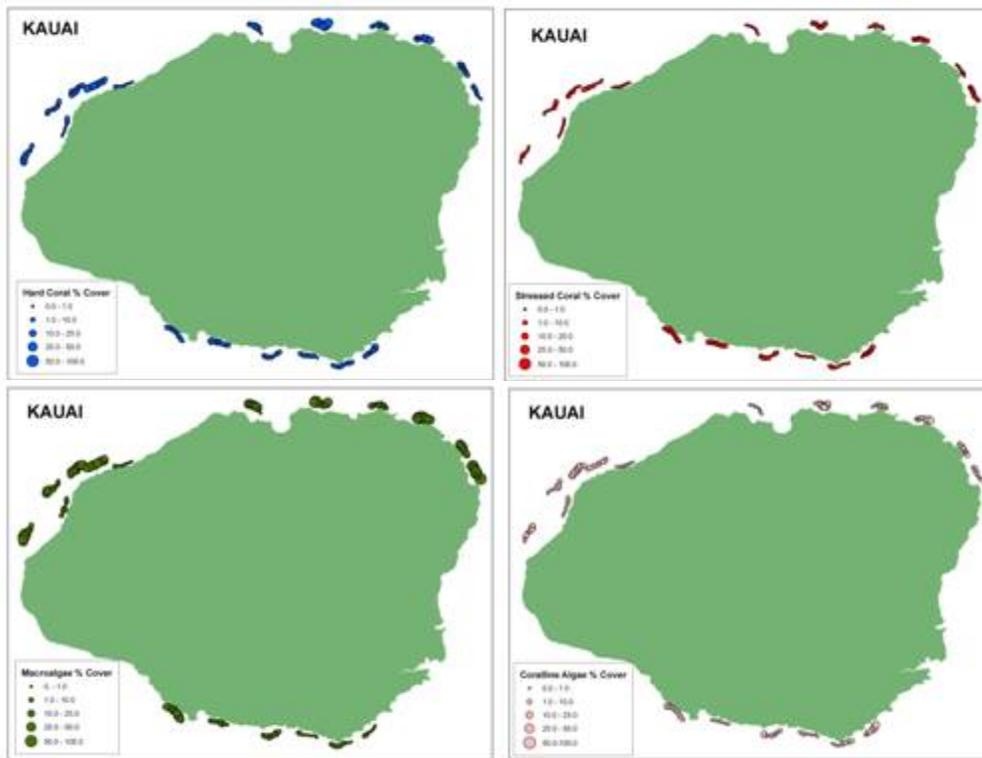


Figure D.3.4.2.--Distribution of coral cover, stressed coral, macroalgae, coralline algae, and macroalgae around Kaua`i in 2008.

D.4 Fish

D.4.1 REA Fish Surveys

Belt transect data

During the survey period, belt transect surveys were conducted at 24 sites around Kaua`i. Surgeonfish were the largest contributor to total biomass with 2.75 kg 100 m⁻². Parrotfish were the second largest contributor to total biomass with 0.86 kg 100 m⁻², followed by snappers at 0.72 kg 100 m⁻² (Fig. D.4.1.1. and Table D.4.1.1.).

Overall Observations

A total of 134 fish species were observed during the survey period by all divers. The average total fish biomass around Kaua`i during the survey period was 5.99 kg 100 m⁻² for the belt transect surveys (Table D.4.1.1).

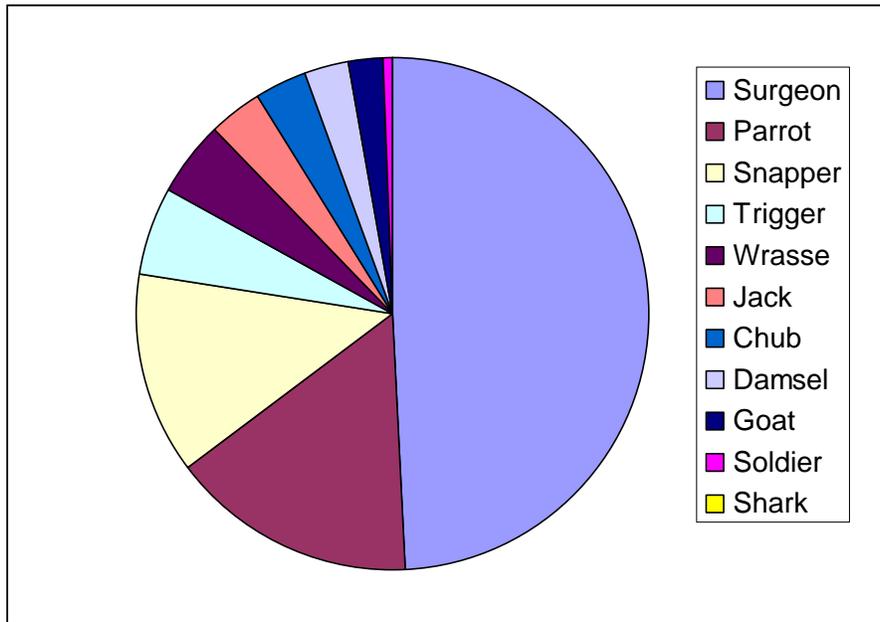


Figure D.4.1.1.--Total fish biomass composition by family.

Table D.4.1.1.--Coral reef fish biomass (kg 100 m⁻²) at sites around Kaua'i.

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	KAU-50	1.14	0.00	0.06	0.01	0.05	0.00	0.00	0.00	0.00	0.51	0.25	0.10
Deep	KAU-54	3.96	0.00	0.12	0.05	0.00	0.00	0.00	0.00	0.00	2.00	0.96	0.06
Deep	KAU-56	3.76	0.00	0.20	0.00	0.00	0.05	0.00	0.29	0.42	1.75	0.13	0.04
Deep	KAU-59	35.32	0.00	0.02	0.19	1.80	0.85	0.00	6.52	0.00	22.95	0.94	1.21
Deep	KAU-62	12.04	0.00	0.17	0.36	0.00	2.61	0.00	0.19	0.00	6.46	0.71	0.65
Mid	KAU-02	5.57	0.21	0.05	0.43	0.00	0.21	0.00	0.03	0.00	3.11	0.32	0.25
Mid	KAU-03	1.66	0.00	0.19	0.05	0.00	0.00	0.00	0.00	0.00	0.94	0.10	0.26
Mid	KAU-05	2.51	0.00	0.08	0.05	0.00	0.22	0.00	0.00	0.00	1.45	0.35	0.15
Mid	KAU-06	1.76	0.00	0.35	0.23	0.00	0.00	0.00	0.00	0.00	0.16	0.73	0.12
Mid	KAU-08	16.80	0.00	0.03	0.00	1.69	11.47	0.00	0.94	0.00	1.91	0.35	0.06
Mid	KAU-12	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.16	0.00
Mid	KAU-13	2.11	0.06	0.22	0.01	0.00	0.03	0.00	0.12	0.00	1.00	0.12	0.29
Mid	KAU-14	7.27	0.00	0.07	0.20	0.00	1.68	0.00	0.00	0.00	4.24	0.36	0.46
Mid	KAU-15	1.86	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.41	0.03
Mid	KAU-55	3.16	0.14	0.16	0.19	0.00	0.33	0.00	0.21	0.00	1.83	0.00	0.27
Shallow	KAU-51	3.34	0.27	0.15	0.05	0.00	0.88	0.00	0.28	0.00	1.42	0.00	0.25
Shallow	KAU-52	2.13	0.00	0.09	0.00	0.00	0.04	0.00	0.00	0.00	0.48	0.56	0.36
Shallow	KAU-53	14.85	0.50	0.36	0.82	0.94	0.39	0.00	5.24	0.00	5.12	0.04	0.34
Shallow	KAU-57	4.69	3.08	0.06	0.19	0.00	0.00	0.00	0.00	0.00	0.92	0.12	0.33
Shallow	KAU-58	3.61	0.00	0.21	0.00	0.00	0.00	0.00	0.33	0.00	2.34	0.10	0.34
Shallow	KAU-61	3.90	0.00	0.16	0.07	0.00	0.70	0.00	0.07	0.00	2.45	0.27	0.17
Shallow	KAU-63	3.28	0.08	0.63	0.13	0.00	0.01	0.00	0.22	0.09	0.25	0.24	0.53
Shallow	KAU-64	6.54	0.00	0.08	0.04	0.00	1.15	0.00	1.88	0.17	2.86	0.00	0.08
Shallow	KAU-66	1.83	0.00	0.13	0.02	0.00	0.00	0.00	0.47	0.09	0.68	0.21	0.07
	Total	5.99	0.18	0.15	0.13	0.19	0.86	0.00	0.72	0.03	2.75	0.31	0.27

D.4.2 Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED towed-diver team completed 18 surveys at Kaua`i covering 42.2 km (42.2 ha) of ocean floor (Table D.4.2.1). Mean survey length was 2.3 km with a maximum length of 2.8 km and a minimum of 1.8 km. Mean survey depth was 14.5 m with a maximum depth of 19.8 m and a minimum of 11.2 m. Mean temperature on these surveys was 26 °C with a maximum temperature of 26.4 °C and a minimum of 25.7 °C.

D.4.2.1.--Survey statistics for towed-diver sampling during the SE-08-10 MHIRAMP cruise.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

Ninety-four individual large-bodied reef fish (> 50 cm in total length) of 14 different species and 11 different families were encountered at Kaua`i (Table D.4.2.2). Overall numeric density of reef fishes was 0.022 #/100 m² (2.229 #/ha) with a biomass density of 0.115 kg/100 m² (0.012 t/ha). Numeric and biomass density were both dominated by *Scarus rubroviolaceus*. The most prevalent families in terms of numeric density were Scarids (54%), Lutjanids (19%), and Acanthurids (12%) (Fig. D.4.2.1). Biomass was dominated by Scarids (28%), Carcharhinids (19%), and Chanids (18%). (Fig. D.4.2.2). Biomass of large-bodied reef fish appears to be evenly distributed around Kaua`i with *Aprion virescens* being seen primarily on the south side of the island and *Naso unicornis* being seen primarily in the north. (Fig. D.4.2.3).

Table D.4.2.2.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed at Kaua'i during the SE-08-10 MHIRAMP cruise CRED towed-diver surveys.

Species	#	#/100m ²	#/ha	Biomass (kg)	kg/100m ²	t/ha
Acanthurus_xanthopterus	1	0.000	0.024	3.144545962	0.001	0.000
Aetobatus_narinari	1	0.000	0.024	14.46808715	0.003	0.000
Aprion_virescens	18	0.004	0.427	67.17113044	0.016	0.002
Aulostomus_chinensis	3	0.001	0.071	0.765531214	0.000	0.000
Caranx_ignobilis	1	0.000	0.024	15.11846806	0.004	0.000
Chanos_chanos	3	0.001	0.071	85.33350738	0.020	0.002
Chlorurus_perspicillatus	4	0.001	0.095	10.2	0.002	0.000
Fistularia_commersonii	1	0.000	0.024	0.075410284	0.000	0.000
Gymnothorax_flavimarginatu	2	0.000	0.047	8.159817209	0.002	0.000
Gymnothorax_meleagris	1	0.000	0.024	2.1	0.000	0.000
Naso_unicornis	10	0.002	0.237	25.67473762	0.006	0.001
Scarus_rubroviolaceus	46	0.011	1.091	127.5562783	0.030	0.003
Sphyræna_barracuda	1	0.000	0.024	34.9913402	0.008	0.001
Triaenodon_obesus	2	0.000	0.047	91.03315007	0.022	0.002
Grand Total	94	0.022	2.229	485.792	0.115	0.012
# of Species	14					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Kauai During 2008 CRED Towed-Diver Surveys

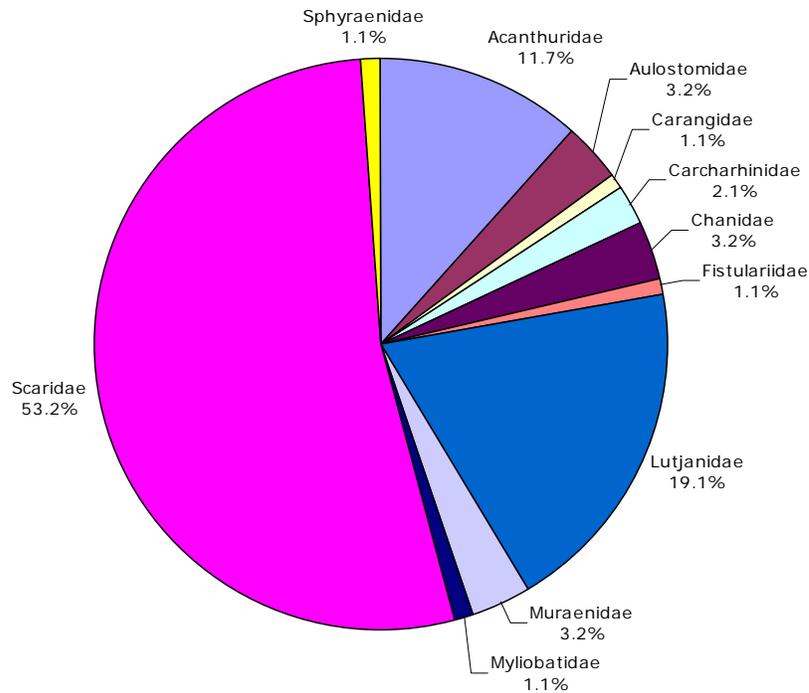


Figure D.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Kauai During 2008 CRED Towed-Diver Surveys

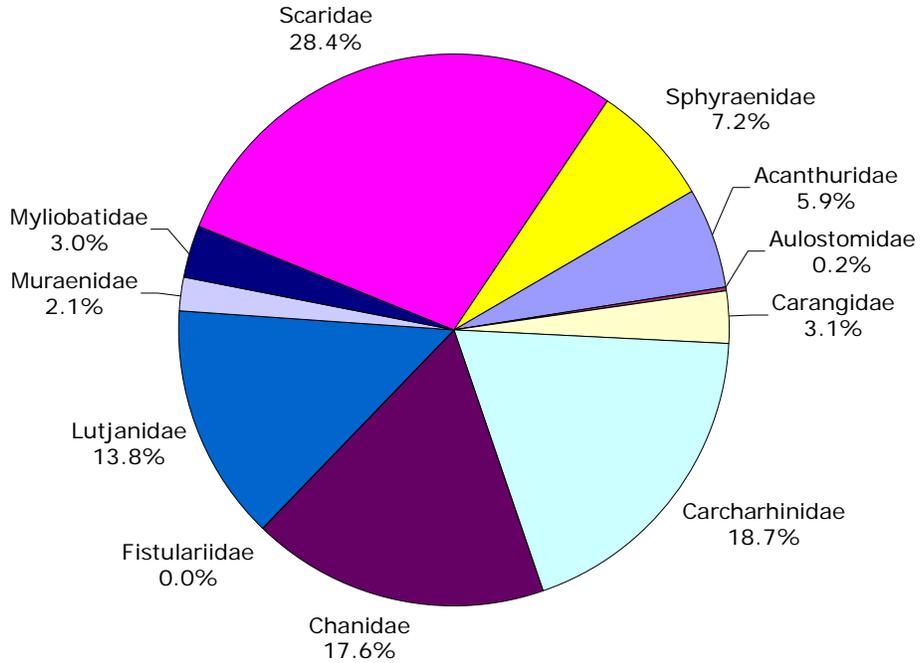


Figure D.4.2.2.--Biomass density by family.



Figure D.4.2.3.--Geographic distribution of biomass around Kaua`i. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.

Appendix E: Lāna`i

E.1. Oceanography and Water Quality

A total of 2 subsurface temperature recorders (STRs) were recovered and 2 deployed at Lāna`i. There were no new mooring deployments.

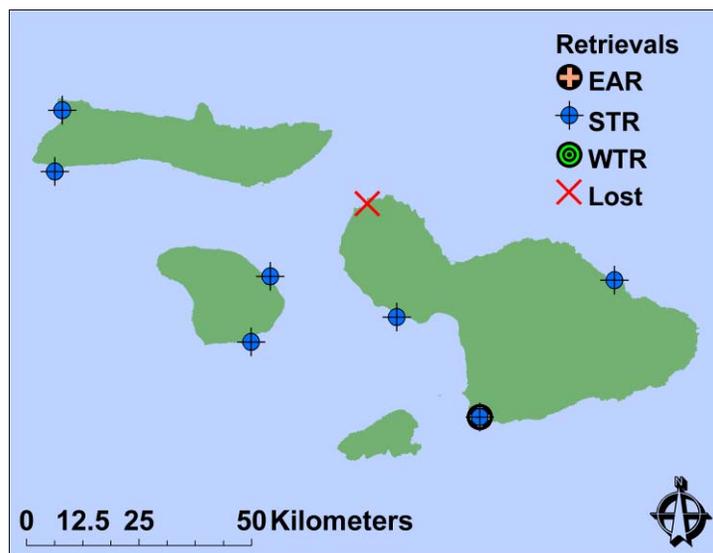


Figure E.1.1.--Retrieved moored oceanographic instrumentation map at Lāna`i, Maui, and Moloka`i.

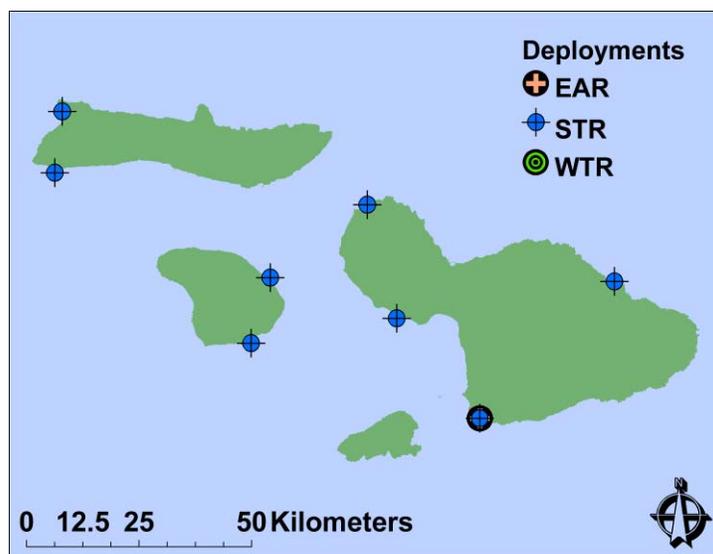


Figure E.1.2.--Deployed moored oceanographic instrumentation map at Lāna`i, Maui, and Moloka`i.

Table E.1.1.--Moored oceanographic instrumentation table for Lāna`i.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
STR	Deployment	39390381725	20.87185	156.8370517	10/19/2008	13.41
STR	Retrieval	39390381856	20.87185	156.8370517	10/19/2008	13.41
STR	Deployment	39510234395	20.74163	156.8752515	10/20/2008	11.58
STR	Retrieval	39390381814	20.74163	156.8752515	10/20/2008	11.58

Water Quality

A total of 29 shallow-water conductivity, temperature and depth (CTD) casts were conducted at the 30-m isobath around Lana`i using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. E.1.3.). Additionally, 4 “static” (non profiling mode) shallow-water CTD casts were conducted in conjunction with the benthic seawater carbonate chemistry sampling. A total of 2 shallow-water CTD casts were taken for use with microbial water samples.

A total of 71 discrete water samples (including 1 duplicate) were collected concurrently with shallow-water CTD casts at 3 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m and will later be analyzed for nutrient, chlorophyll, and carbonate chemistry (dissolved inorganic carbon (DIC) and total alkalinity (A_T)) content (carbonate chemistry samples were only collected at the 1-m and 10-m bins). Nutrient, chlorophyll, and carbonate chemistry samples were processed and stored according to protocol and were sent out for analysis when the cruise returned. In addition to the standard water sampling that accompanies some of the shallow-water CTD sites, benthic seawater carbonate chemistry samples were collected at 1 site at Lana`i. The benthic site yielded 4 carbonate chemistry water samples, 2 from the bottom, 1 from the mid depth of the water column and 1 from just beneath the surface. All benthic carbonate chemistry data will be processed following the cruise. Eight of the discrete water samples were processed for microbial analysis.

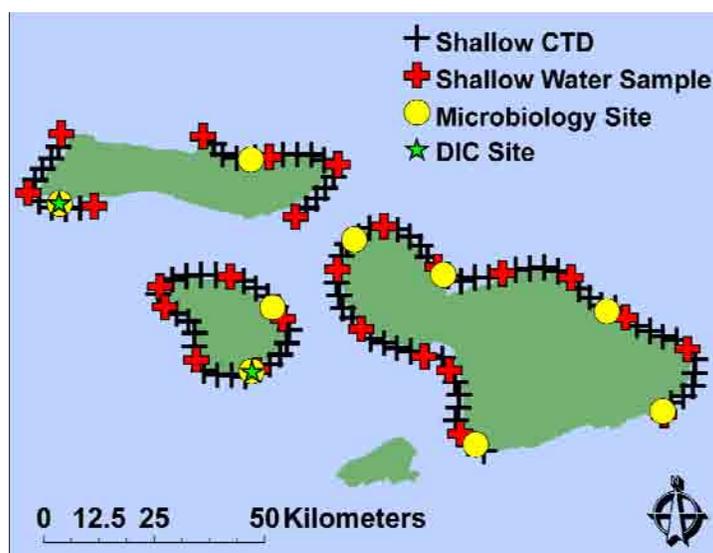


Figure E.1.3.--Shallow-water CTD and water sampling locations around Lāna`i, Maui, and Moloka`i.

E.2. Rapid Ecological Assessment (REA) Site Descriptions

Between October 26 and November 2, 2008, 16 REA surveys were conducted around the forereefs of Lāna`i. Complete REA surveys (fish and benthic) were conducted at 6 sites established in 2005 and 2006. Ten additional haphazardly selected sites were surveyed by fish scientists only. Site locations are plotted in Figure E.2.1., and physical and biological characteristics for each site are described below.

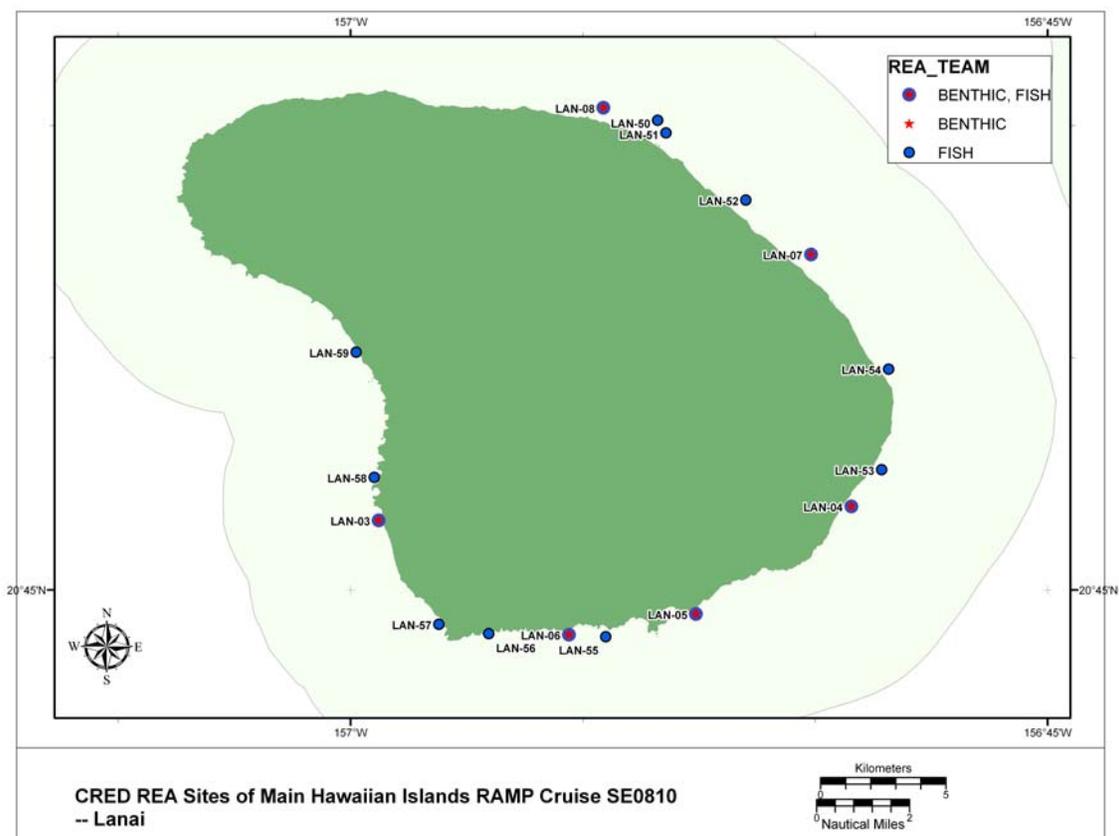


Figure E.2.1.--Locations of 2008 REA sites on Lāna`i.

REA Site Descriptions

LAN-03

10/20/2008

N 20° 46.498'
W 156° 59.397'

Forereef

Depth: 10.4–11.6 m



Survey Notes: Original global positioning system (GPS) point was at ~ the 7 m depth. Site moved offshore of original point to ~ 10 m depth, and GPS point was updated.

Habitat: Forereef

Benthic Cover: Benthos was dominated by turf algae colonized on dead coral, rubble and pavement (73.2%) with scattered colonies of *Porites lobata*, *P. evermanni*, and *Pocillopora meandrina*. Overall coral cover was relatively low (14.4%).

Coral: Relatively low coral cover was documented at this forereef site with colonies of *Porites lobata* (56.7%) and *P. evermanni* (28.2%) being the most common species observed. A total of 7 scleractinian genera were recorded within the belt transect. Overall coral health was good. Evidence of compromised health states included discolorations other than bleaching (0.9%), algal interactions (0.7%), bleaching (0.7%), and *Porites* trematodiasis (0.5%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Halimeda discoidea*, *H. distorta*, *Lobophora variegata*, *Neomeris* sp., *Dictyota ceylanica*, and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include *Dictyota friabilis*, *Padina* sp., and *Peyssonnelia* sp.

Fish: This site had medium complexity and low coral cover. Fish diversity was mediocre. A fullsize terminal redlip parrotfish, *Scarus rubroviolaceus*, was a highlight. Pennantfish, *Heniochus diphreutes*, were observed off transect although there weren't any other planktivores in evidence. The locally ubiquitous *Naso hexacanthus* also made an appearance.

LAN-04

10/19/2008

N 20° 46.799'
W 156° 49.223'

Forereef

Depth: 12.8–14.3 m



Survey Notes: Original GPS point used and updated to reflect location of diver buoy.

Habitat: Forereef

Benthic Cover: Benthos was dominated by *Porites lobata* (18.4%), *Montipora capitata* (22.0%) and turf algae colonized on rubble/dead coral (47.6%). Overall coral cover was moderately high (47.6%).

Coral: High coral cover was documented at this forereef site with colonies of *Porites lobata* (40.5%) and *Montipora capitata* (39.7%) being the most common species observed. A total of 5 genera (4 scleractinian and 1 anthozoan) recorded within the belt transect. Overall coral health was moderate with 11.5% of colonies being affected by various compromised health states. Cases of bleaching (5.4%), algal interactions (4.7%), and hyperpigmentation (1.4%) were observed.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, and *Halimeda distorta*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Caulerpa nummularia*, *Caulerpella ambigua*, and cyanobacteria.

Fish: Large fishes were relatively abundant at this site. Large schools of *Naso unicornfish* (e.g., *brevirostris* and *hexacanthus/caesius*) were observed and recorded. Small fish diversity was relatively high. Some *Dascyllus albisella* were recorded.

LAN-05

10/20/2008

N 20° 44.482'

W 156° 52.569'

Forereef

Depth: 11.9–13.7 m



Survey Notes: Original GPS point used and updated to reflect location of diver buoy.

Habitat: Forereef

Benthic Cover: Benthos was dominated by turf algae colonized on dead coral (44.4%) and scattered colonies of *Porites lobata*, *P. compressa*, and *P. evermanni*. Overall coral cover was moderately low (38.4%).

Coral: Moderate coral cover was documented at this forereef site with colonies of *Porites lobata* (39.0%), *P. evermanni* (29.9%), and *P. compressa* (11.8%) being the most common species observed. A total of 6 genera (5 scleractinian and 1 anthozoan) recorded within the belt transect. Overall coral health was marginal with 18.3% of colonies being affected by various compromised health states including algal interactions (8.6%), bleaching (4.4%), and predation (2.6%).

Algae: Algae documented by the line-point intercept survey include *Asparagopsis taxiformis*, crustose coralline red algae, *Halimeda distorta*, *Haloplegma duperreyi*, *Neomeris* sp., and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include *Lobophora variegata*.

Fish: Despite the fact that this site was located very near to a protected area, fish diversity was relatively low and consisted mostly of small individuals (total length < 20 cm). The largest fish recorded were parrotfish *Chlorurus sordidus* and *Scarus rubroviolaceus*. There was also a large school of *Naso hexacanthus* observed off transect.

LAN-06

10/20/2008

N 20° 44.037'

W 156° 55.299'

Forereef

Depth: 10.7–13.7 m



Survey Notes: Original GPS point used and updated to reflect location of diver buoy. Surveys not completed due to high current.

Habitat: Forereef

Benthic Cover: Benthos was dominated by *Porites lobata* (24.8%), *P. compressa* (21.2%), and *P. evermanni* (12.4%), and turf algae colonized on dead coral (28.3%). Overall coral cover was high (60.2%).

Coral: High coral cover was documented at this forereef site with colonies of *Porites evermanni* (32.8%), *P. lobata* (30.7%) and *P. compressa* (28.4%) being the most common species observed. A total of 3 scleractinian genera were recorded within the belt transect. Overall coral health was moderate with 16.8% of colonies being affected by various compromised health states including bleaching (7.6%) and algal interactions (7.6%).

Algae: Algae documented by the line-point intercept survey include *Asparagopsis taxiformis*, crustose coralline red algae, *Halimeda distorta*, and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include *Neomeris* sp., *Asparagopsis taxiformis*, and *Galaxaura* sp.

Fish: Fish diversity was high at this location. Medium-size *Naso* unicornfish seem to be common on this side of Lāna`i, and this site was no exception. A large moray eel *Gymnothorax flavomarginatus* was recorded on transect. Also of note was a school of juvenile mackerel scad, *Decapterus macarellus*, observed off transect.

LAN-07

10/19/2008

N 20° 52.224'
W 156° 50.093'

Forereef

Depth: 12.2–12.8 m



Survey Notes: Original GPS point used and updated to reflect location of diver buoy.

Habitat: Forereef

Benthic Cover: Benthos was dominated by *Montipora capitata* (33.0%), *Montipora patula* (24.3%) and turf algae colonized on rubble/dead coral (23.8%). Overall coral cover was moderately high (62.6%).

Coral: High coral cover was documented at this forereef site with colonies of *Montipora capitata* (44.3%) and *M. patula* (43.2%) being the most common species observed. A total of 4 scleractinian genera were recorded within the belt transect. Overall coral health was good with 10.9% of colonies being affected by various compromised health states including bleaching (6.8%) and algal interactions (3.5%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include a species of *Nemastoma*, *Lobophora variegata*, *Acanthophora pacifica*, *Ventricaria ventricosa*, *Halimeda distorta*, and cyanobacteria.

Fish: Despite the high coral cover and medium-high complexity, almost no large fishes were observed (total length > 20 cm). Most of the fish community was composed of smaller

individuals. Many *Dascyllus albisella* were recorded off-transect. Fish diversity was relatively high compared to other sites around the main Hawaiian Islands.

LAN-08

10/19/2008

N 20° 55.382'

W 156° 54.562'

Forereef

Depth: 13.7–14.6 m



Survey Notes: Original GPS point used and updated to reflect location of diver buoy.

Habitat: Forereef

Benthic Cover: Benthos was dominated by macroalgae (54.0%), turf algae colonized on rubble/dead coral (29.6%), and scattered *Montipora capitata*, *M. patula*, *Porites lobata*, and *P. compressa* colonies. Coral cover was moderately low (13.2%).

Coral: Relatively low coral cover was documented at this forereef site with colonies of *Porites lobata* (48.3%), *P. compressa* (19.8%) and *P. evermanni* (11.3%) being the most common species observed. A total of 6 scleractinian genera were recorded within the belt transect. Overall coral health was moderate with 16.8% of colonies being affected by compromised health states, such as bleaching (6.2%) and algal interactions (5.6%).

Algae: Algae documented by the line-point intercept survey include *Asparagopsis taxiformis*, crustose coralline red algae, cyanophytes, *Halimeda discoidea*, *H. distorta*, *Haloplegma duperreyi*, *Lobophora variegata*, a species of *Neomeris*, *Dictyota ceylanica*, *Portieria hornemannii*, and *Caulerpella ambigua*. Additional algae documented by the Roving Diver survey include a species of *Galaxaura*, *Acanthophora pacifica*, *Distromium flabellatum*, *Caulerpa nummularia*, *Halimeda distorta*, and *Gibsmithia hawaiiensis*.

Fish: This site had low reef fish diversity. Many *Oxycheilinus bimaculatus* wrasses were observed. Very few large fishes were counted. Small fishes were moderately abundant (e.g., *Thalassoma duperrey*, *Acanthurus nigrofuscus*, etc.). Habitat complexity was low to moderate.

Independent Fish Sites

LAN-50

10/19/2008

W 156° 53.391

N 20° 55.111

No picture available.

Forereef

Depth: 20-20 m

General site description

This site is located on the north shore of Lāna`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of rubble primarily

overgrown with algae on a sandy bottom. Coral cover was low and complexity was low. Additionally, the habitat contained low rugosity and consisted of scattered *Pocillopora* heads and some *Porites* and *Montipora* reef. Fish diversity was moderate with few medium-size fish. Smaller species were more abundant. One noteworthy species noted off transect was *Aprion virescens*.

LAN-51

10/19/2008

W 156° 53.213

N 20° 54.843

Forereef

Depth: 4-5 m



General site description

This site is located on the northeasternmost tip of Lāna`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of ~ 100% coral cover and high complexity. This high coral cover habitat created a moderate rugose and reticulated reef structure. Fish diversity was high with both abundant small and medium-size fish species. *Chlorurus sordidus* were abundant at this site.

LAN-52

10/19/2008

W 156° 51.496

N 20° 53.394

Forereef

Depth: 4-5 m



General site description

This site is located on the northeastern edge of Lāna`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of ~ 100% coral cover and high complexity and was similar to LAN-51. This high coral cover habitat created a moderate rugose and reticulated reef structure. Fish diversity was high with both abundant small and medium-sized fish species. A large school of *Acanthurus leucoparis* was present at site intermixed with *A. nigrofuscus*, *A. blochii*, and *Naso brevirostris*.

LAN-53

10/19/2008

W 156° 48.571

N 20° 47.587

Forereef

Depth: 19-19 m



General site description

This site is located on the eastern edge of Lāna`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of rubble on a sandy bottom with scattered *Pocillopora* heads and *Porites* and *Montipora* reef. Coral cover was moderate and complexity was low. Additionally, the habitat was moderately rugose. Fish diversity was moderate with both abundant small and medium-size (goatfish, snapper and surgeonfish) fishes.

LAN-54

10/19/2008

W 156° 48.423

N 20° 49.754

No picture available.

Forereef

Depth: 5-5 m

General site description

This site is located on the northeastern edge of Lāna`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of ~ 50% coral cover and high complexity and was similar to LAN-51 and LAN-52. This high coral cover habitat created a moderate rugose and reticulated reef structure. Fish diversity was high with both abundant small and medium-size fish species. Some *Melichthys niger* were observed.

LAN-55

10/20/2008

W 156° 54.510

N 20° 43.992

Forereef

Depth: 21-23 m



General site description

This site is located on the southern edge of Lāna`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of primarily reef with areas of sand and rubble surrounding the reef. The substrate was moderate to high coral cover and moderate to high complexity. Fish diversity was high with both abundant small and medium-size fish species. Planktivores were the most dominant species on the reef with schools of *Chromis agilis* and *Hemitaurichthys polylepis*.

LAN-56

10/20/2008

W 156° 57.025

N 20° 44.057

Forereef

Depth: 5-6 m



General site description

This site is located on the southwestern point of Lāna`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of moderate coral cover and high complexity. Complexity was due to highly rugose coral and pavement habitat. Fish diversity was high with both abundant small (chromis, wrasse, butterflyfish) and medium-size (surgeonfish and parrotfish) fish species.

LAN-57

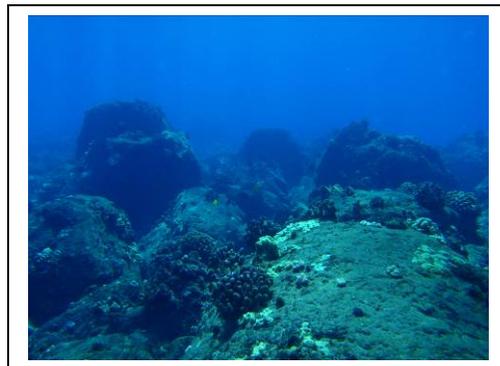
10/20/2008

W 156° 58.100

N 20° 44.260

Forereef

Depth: 5-5 m



General site description

This site is located on the southwestern edge of Lāna`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of boulder habitat with moderate coral cover and moderate to high complexity. Fish diversity was high with both abundant small and medium-size fish species. The site was also abundant with planktivores.

LAN-58

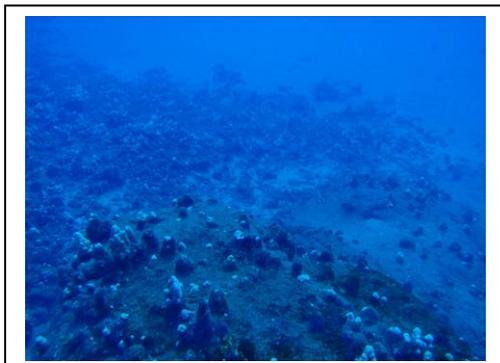
10/20/2008

W 156° 59.492

N 20° 47.422

Forereef

Depth: 20-22 m



General site description

This site is located on the southwestern edge of Lāna`i, immediately north of the commercial harbor. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of pavement and coral substrate surrounded by areas of sand and rubble. Coral cover was moderate as well as moderate complexity. Fish diversity was high with both abundant small (chromis, wrasse, butterflyfish) and medium-size (surgeon and parrotfish) fish species.

LAN-59

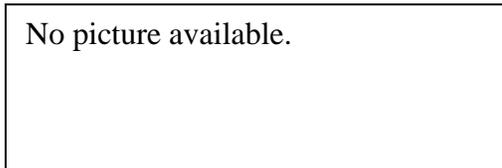
10/20/2008

W 156° 59.880

N 20° 50.119

Forereef

Depth: 3-3 m



General site description

This site is located on the southwest shore of Lāna`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site consisted of an uneven, rocky substrate upon which were scattered medium to large boulders. Coral cover was sparse. Fish diversity was moderate and there were a number of larger surgeons including *Acanthurus blocii* and *A. dussumieri*. There were also a few larger bullethead parrotfish (*Chlorurus sordidus*) and a small blue trevally (*Caranx melampygus*).

E.3. Benthic Environment

E.3.1. Algae

Benthic communities around Lāna`i were dominated by turf algal and coral functional groups (Table E.3.1.1). Coral was documented with the highest percent cover at 7 of the 14 sites surveyed. Turf algae percent cover exceeded that of other functional groups at 2 of the 6 sites surveyed, and corals were the dominant benthic element at 2 of the 6 sites (Table E.3.1.1). At site LAN-04, the percent cover of turf algae and coral was approximately equal (47.6%). Site LAN-08 was the only site where macroalgae percent cover exceeded that of all other functional groups (30.8%). A combined total of 16 species of macroalgae were observed (6 chlorophytes, 3 ochrophytes, 7 rhodophytes) from the 6 sites surveyed (Tables E.3.1.2 and E.3.1.3). *Lobophora*

variegata and *Haloplegma duperreyi* dominated the macroalgal community at site LAN-08 with percent covers of 10.4% and 10.8% (Table E.3.1.3). *Halimeda distorta* dominated the macroalgal community at site LAN-03 with a percent covers of 3.2%. *Asparagopsis taxiformis* was the most prevalent macroalgal species at site LAN-05 with a percent cover of 7.2% (Table E.3.1.3).

Table E.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at Lāna`i.

Site	Macroalgae	Turf Algae	Coralline red algae (crustose + upright)	Cyanobacteria	Coral
LAN-03	5.6%	73.2%	4.4%	0.4%	14.4%
LAN-04	0.8%	47.6%	4.0%	-	47.6%
LAN-05	12.4%	44.4%	4.0%	-	38.4%
LAN-06	2.7%	28.3%	8.8%	-	60.2%
LAN-07	3.4%	20.4%	10.2%	-	66.0%
LAN-08	30.8%	29.6%	1.6%	0.4%	13.2%

Table E.3.1.2.--Additional species recorded at each site at Lāna`i during roving diver survey.

Site	Chlorophyta
LAN-04 LAN-08	<i>Caulerpa nummularia</i>
LAN-04	<i>Caulerpella ambigua</i>
LAN-07 LAN-08	<i>Halimeda distorta</i>
LAN-04	<i>Neomeris</i> sp.
LAN-07	<i>Ventricaria ventricosa</i>
	Ochrophyta
LAN-08	<i>Distromium flabellatum</i>
LAN-07	<i>Lobophora variegata</i>
	Rhodophyta
LAN-07 LAN-08	<i>Acanthophora pacifica</i>
LAN-08	<i>Galaxaura</i> sp.
LAN-08	<i>Gibsmithia hawaiiensis</i>
LAN-07	<i>Nemastoma</i> sp.

Table E.3.1.2.--Percent cover of macroalgal species at long-term monitoring sites at Lāna`i. Sum totals for each row equal the percent cover of macroalgae recorded in Table A.

Site	<i>Asparagopsis taxiformis</i>	<i>Halimeda discoidea</i>	<i>Halimeda distorta</i>	<i>Haloplegma dupurreyi</i>	<i>Lobophora variegata</i>	<i>Neomeris</i> sp	<i>Dictyota ceylanica</i>	<i>Portieria hornemannii</i>	<i>Caulerpella ambigua</i>
LAN-03	-	0.4%	3.2%	-	0.8%	0.4%	0.4%	0.4%	-
LAN-04	-	-	0.8%	-	-	-	-	-	-
LAN-05	7.2%	-	2.4%	0.8%	-	0.8%	-	1.2%	-
LAN-06	0.9%	-	0.9%	-	-	-	-	0.9%	-
LAN-07	-	-	-	-	-	-	-	3.4%	-
LAN-08	2.0%	1.6%	0.4%	10.8%	10.4%	0.4%	0.4%	4.0%	0.8%

E.3.2. Corals

E.3.2.1 Coral Populations

In 2008, line-point intercept surveys documented relatively high coral cover ($40.0 \pm 9.2\%$) at REA sites around Lāna`i (Fig. E.3.2.1.1, left). Forereef benthic habitat was dominant around the island and species richness varied between sites with 9 genera (8 scleractinian and 1 zoanthid) being represented within belt transect surveys. Coral composition was dominated by both encrusting and branching *Porites* (56.2%) and encrusting *Montipora* (41.1%) colonies (Fig. E.3.2.1.1, right). The most common scleractinian species were *Porites lobata* (32.0%), *Montipora capitata* (21.8%), and *Montipora patula* (12.8%; Table E.3.2.1.1).

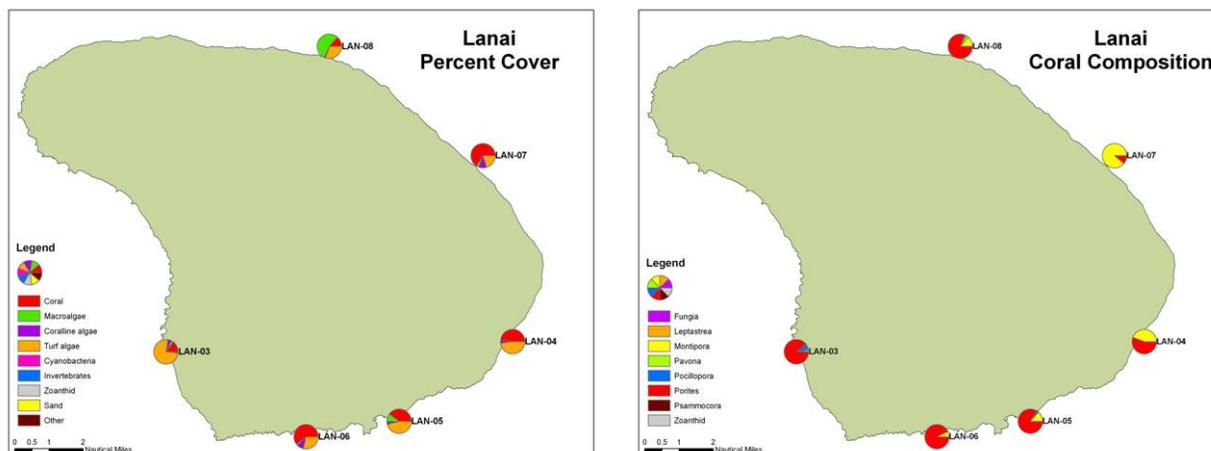


Figure E.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around Lāna`i in 2008.

Table E.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around Lāna`i in 2008.

Taxon Name	No. of Colonies	Relative Abundance
<i>Fungia scutaria</i>	1	0.05
<i>Leptastrea</i> sp.	2	0.10
<i>Leptoseris incrustans</i>	5	0.24
<i>Leptastrea purpurea</i>	2	0.10
<i>Montipora capitata</i>	457	21.78
<i>Montipora patula</i>	394	18.78
<i>Palythoa</i> sp.	5	0.24
<i>Porites compressa</i>	182	8.67
<i>Pavona duerdeni</i>	7	0.33
<i>Porites evermanni</i>	208	9.91
<i>Porites lobata</i>	671	31.98
<i>Pocillopora meandrina</i>	65	3.10
<i>Pocillopora</i> sp.	27	1.29
<i>Porites</i> sp.	6	0.29
<i>Porites rus</i>	3	0.14
<i>Porites solida</i>	39	1.86
<i>Psammocora stellata</i>	1	0.05
<i>Pavona varians</i>	23	1.10

E.3.2.2 Coral Health

During 2008 REA surveys, relatively low levels (11.1%) of compromised coral health states were observed. The occurrence of algal interactions (4.4%) and bleaching (4.4%) was most common. It is important to note that almost 92.0% of all *Porites* colonies were affected by algal interactions (41.3%), hyperpigmentation (34.5%), or other disease states (Fig. E.3.2.2.1). Colonies of *Montipora* (22.9%) and *Pocillopora* (4.6%) were also observed to exhibit algal interactions or bleaching (Fig. E.3.2.2.1).

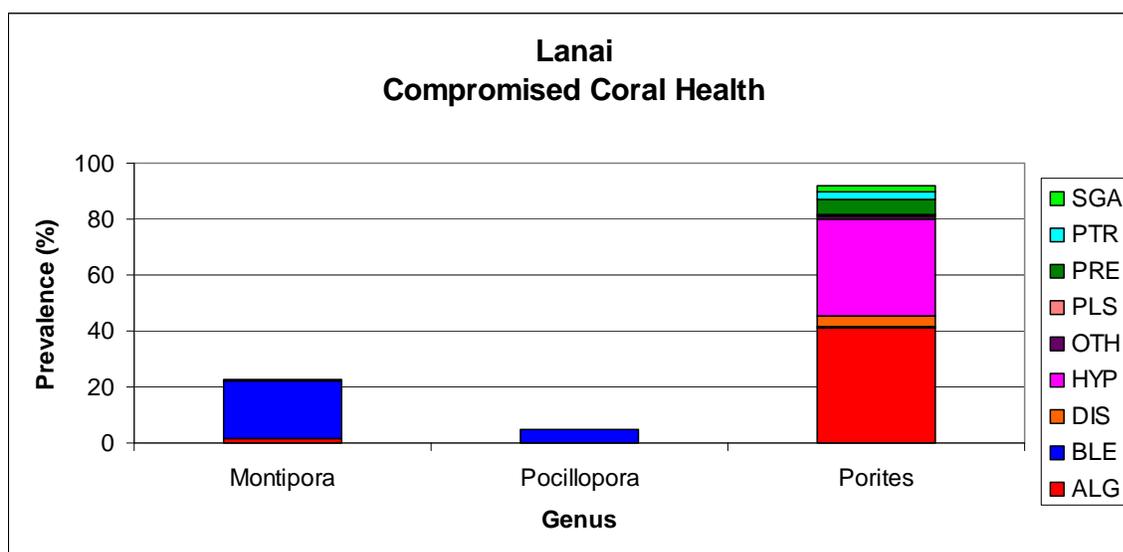


Figure E.3.2.2.1.--Prevalence of compromised coral health by taxon around Lāna`i in 2008.

Percent mortality of colonies surveyed during 2008 was high with 72.8% of colonies observed exhibiting tissue loss (Fig. E.3.2.2.2). Colonies of *Psammocora* were the most affected (50.0%). Colonies of *Porites* (10.6%) and *Pavona* (8.8%) also showed signs of mortality. Other genera, such as *Fungia*, *Leptastrea*, *Leptoseris*, and *Palythoa* were found to have healthy tissues.

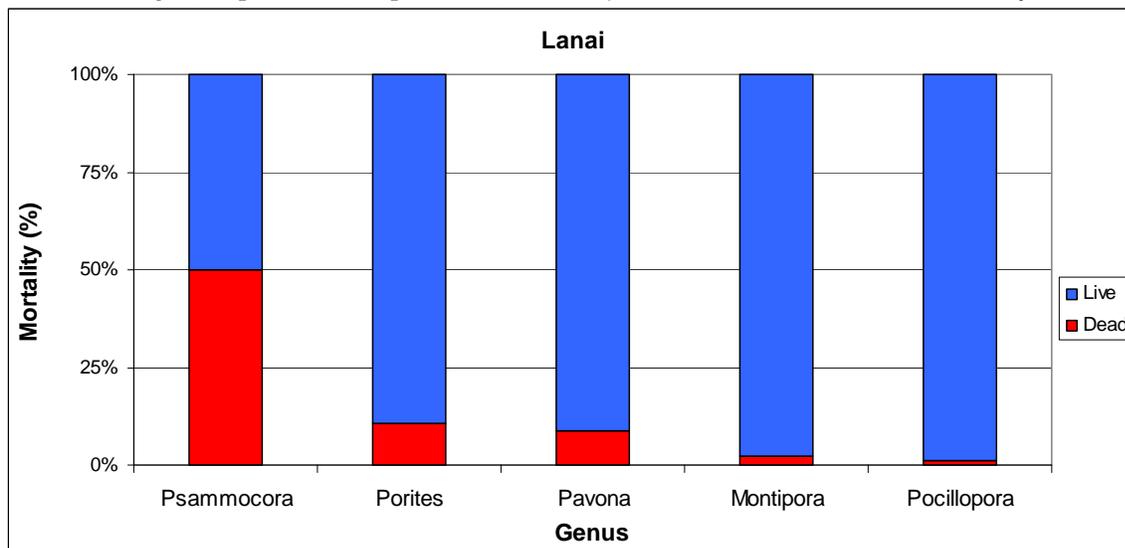


Figure E.3.2.2.2.--Mean percent live versus dead tissue for various coral genera at Lāna`i in 2008.

E.3.3. Noncoral Invertebrate Surveys

A total of 160 individuals of benthic invertebrate target species or taxa group were enumerated from 12 belt transects at 6 sites. Qualitative invertebrate abundance and diversity were low at Lāna`i. Quantitatively, the most abundant macroinvertebrate here was the collector urchin, *Tripneustes gratilla*, with the highest densities recorded at sites LAN-04 and LAN-06 (0.65 and 0.12/ m², respectively). Other echinoids were absent or found in very low numbers. Trapezid crabs were the second-most abundant organism, with the highest densities occurring at sites LAN-08, LAN-03, and LAN-05 (0.13, 0.12, 0.12/ m², respectively). Calcinus hermit crabs were the third-most abundant macroinvertebrate at Lāna`i, with the highest density occurring at sites LAN-03 and LAN-05 (0.11, and 0.06/ m², respectively). Asteroids and Holothurians were notably absent from all sites surveyed. Of note was the record of one Brachyuran crab at site LAN-05.

E.3.3.1 Urchin Measurements

Figure E.3.3.1.1 reveals the average test diameter of urchins from the genera *Echinometra* and *Tripneustes* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented.

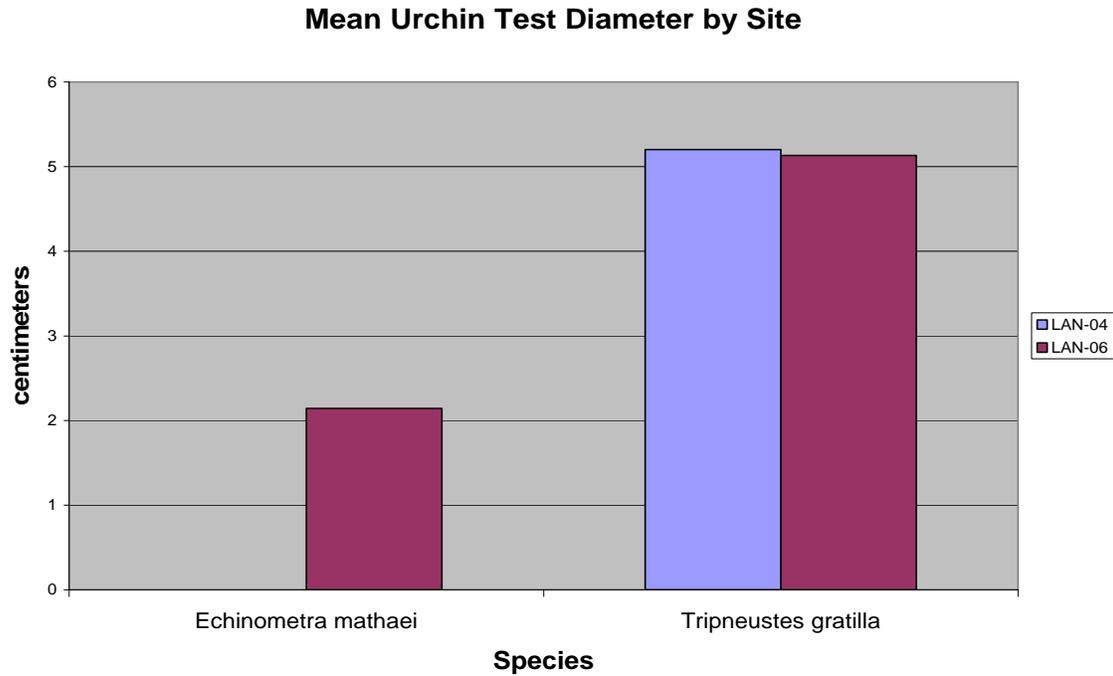


Figure E.3.3.1.1.--Mean test size of urchins by site.

E.3.3.2. Autonomous Reef Monitoring System (ARMS) Deployment

No ARMS were installed on the island of Lāna`i.

E.3.4 Towed-diver Benthic Surveys

A total of 12 towed-diver surveys were conducted off the coast of Lāna`i in 2008. Surveys coverage was split between the northeast coast (5 tows), south (2 tows), southwest (2 tows), and the west region (3 tows, Fig. E.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.

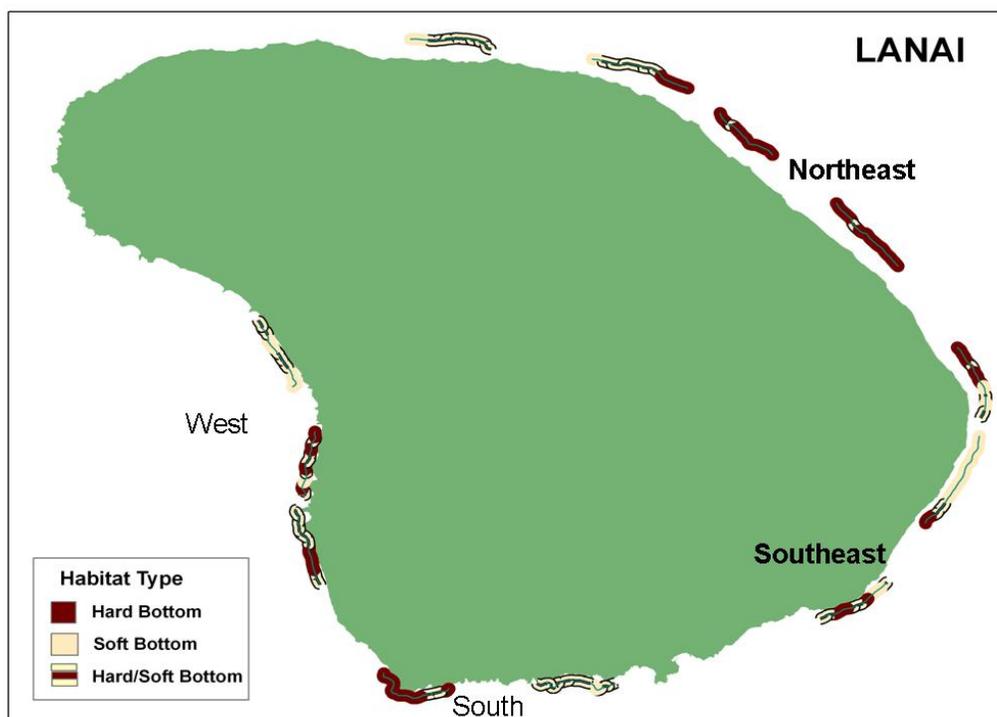


Figure E.3.4.1.--Locations of 12 towed-diver surveys around Lāna`i in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Surveys in the northeast and southeast were mostly over continuous reef with stretches of sand flats. Western surveys towed over predominantly rock boulder and sand flats. This observation could be misleading since habitat in this region was highly zoned with rock boulders present from shore along the slope down to about 45–50 ft where the bottom changed to mostly sand. Since tows were targeting the 15.2-m isobath but did not always remain in that depth range the patchy distribution of sand and hard bottom could be misleading. Due to limited area coverage with regards to the island as a whole, island averages are not presented. Instead, means (percent cover) and total (invertebrate counts) values are presented for each region. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in Table E.3.4.1 and Figure E.3.4.2.

Hard coral at Lāna`i was moderately high in the northeast and southeast regions (mean: 35 and 21%, respectively). Stressed coral was low around most of Lāna`i with a slight spike of predation from crown-of-thorns in the northeast section.

Macroalgae was also highest in the northeast and southeast regions (mean: 27 and 26%, respectively). Coralline algae cover was low in all regions. With the exception of boring urchins, macroinvertebrates were relatively rare.

Table E.3.4.1.--Mean percent cover and macroinvertebrate totals by tow region.

Region	Hard Coral	Stress Coral	Macro-algae	Coralline Algae	COTs	Free Urchins	Boring Urchins	Sea Cucumbers
Northeast	35	9	27	5	2	2	1134	9
South	13	1	6	4	1	0	239	10
Southeast	21	2	26	5	1	0	1404	0
West	8	1	2	1	0	1	185	8

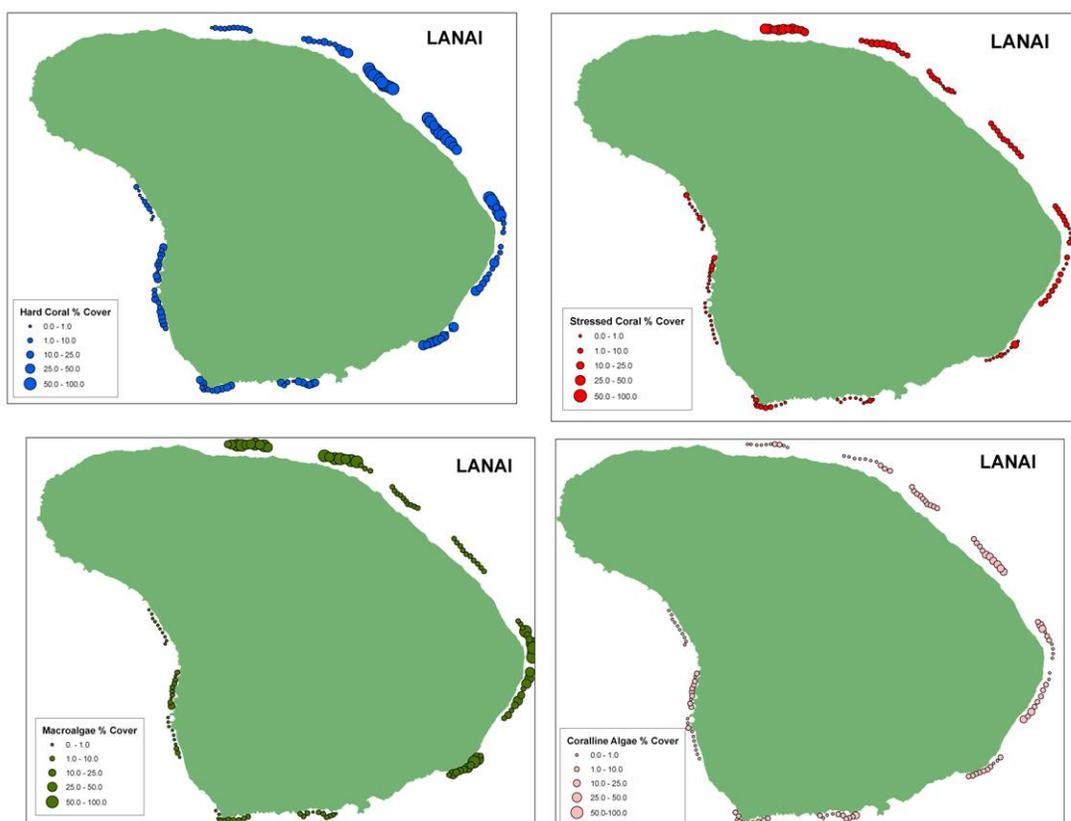


Figure E.3.4.1.--Distribution of coral cover, stressed coral, macroalgae, and coralline algae around Lānaʻi in 2008.

E.4 Fish

E.4.1 REA Fish Surveys

During the survey period, belt transect surveys were conducted at 16 sites around Lānaʻi. Surgefish were the largest contributor to total biomass with 1.27 kg 100 m⁻². Parrotfish were the second largest contributor to total biomass with 0.56 kg 100 m⁻², followed by wrasses at 0.25 kg 100 m⁻² (Table E.4.1.1)

Overall Observations

A total of 116 fish species were observed during the survey period by all divers. The average total fish biomass around Lāna`i during the survey period was 2.92 kg 100 m⁻² for the belt transect surveys (Table E.4.1.1).

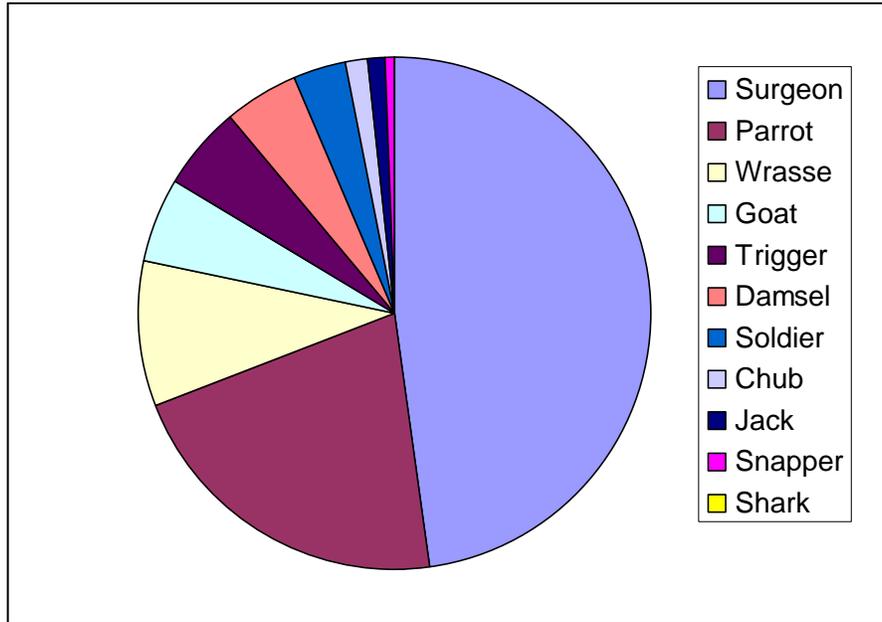


Figure E.4.1.1.--Total fish biomass composition by family.

Table E.4.1.1.--Coral reef fish biomass (kg 100 m⁻²) at sites around Lāna`i.

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	LAN-50	0.55	0.00	0.00	0.04	0.00	0.01	0.00	0.00	0.00	0.13	0.00	0.34
Deep	LAN-53	1.98	0.00	0.00	0.78	0.00	0.00	0.00	0.04	0.00	0.51	0.00	0.39
Deep	LAN-55	3.51	0.00	0.17	0.01	0.14	0.67	0.00	0.00	0.30	1.21	0.13	0.26
Deep	LAN-58	3.61	0.00	0.08	0.08	0.00	0.05	0.00	0.00	0.28	2.37	0.33	0.19
Mid	LAN-03	3.50	0.00	0.05	0.04	0.00	0.76	0.00	0.00	0.00	1.73	0.38	0.13
Mid	LAN-04	7.09	0.00	0.12	0.09	0.00	0.37	0.00	0.05	0.20	4.94	0.00	0.54
Mid	LAN-05	4.83	0.00	0.03	0.06	0.00	2.02	0.00	0.04	0.27	1.57	0.19	0.19
Mid	LAN-06	2.13	0.00	0.21	0.04	0.13	0.15	0.00	0.00	0.00	1.07	0.20	0.05
Mid	LAN-07	1.29	0.00	0.05	0.06	0.00	0.05	0.00	0.00	0.06	0.72	0.00	0.19
Mid	LAN-08	0.78	0.00	0.00	0.05	0.00	0.03	0.00	0.00	0.00	0.17	0.13	0.39
Shallow	LAN-51	1.26	0.00	0.11	0.00	0.00	0.07	0.00	0.00	0.00	0.73	0.00	0.28
Shallow	LAN-52	3.68	0.18	0.17	0.00	0.00	0.75	0.00	0.04	0.00	2.14	0.00	0.15
Shallow	LAN-54	2.29	0.00	0.04	0.07	0.00	1.47	0.00	0.00	0.00	0.60	0.00	0.08
Shallow	LAN-56	2.61	0.00	0.42	0.07	0.00	0.59	0.00	0.00	0.21	0.75	0.19	0.25
Shallow	LAN-57	3.50	0.29	0.46	0.05	0.00	0.69	0.00	0.00	0.00	0.93	0.38	0.24
Shallow	LAN-59	4.17	0.16	0.06	0.80	0.12	1.33	0.00	0.10	0.14	0.80	0.28	0.28
	Total	2.92	0.04	0.12	0.14	0.02	0.56	0.00	0.02	0.09	1.27	0.14	0.25

E.4.2 Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED towed-diver team completed 12 surveys at Lāna`i covering 32 km (32 ha) of ocean floor (Table E.4.2.1). Mean survey length was 2.7 km with a maximum length of 3.4 km and a minimum of 2.2 km. Mean survey depth was 14.1 m with a maximum depth of 16.1 m and a minimum of 12.4 m. Mean temperature on these surveys was 26 °C with a maximum temperature of 26.4 °C and a minimum of 25.5 °C.

Table E.4.2.1.--Survey statistics for towed-diver sampling during the SE-08-10 MHIRAMP cruise.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

At Lāna`i, 58 individual large-bodied reef fishes (> 50 cm in total length) of 12 different species and 10 different families were encountered (Table E.4.2.2). Overall numeric density for this class of reef fishes was 0.018 #/100 m² (1.804 #/ha) with a biomass density of 0.046 kg/100 m² (0.005 t/ha). Numeric and biomass density were both dominated by *Naso hexacanthus*. The most prevalent families in terms of numeric density were Acanthurids (47%), Scarids (16%), and Carangids(12%) (Fig. E.4.2.1). Biomass was dominated by Acanthurids (44%), Scarids (16%), and Carangids (11%). (Fig. E.4.2.2). Biomass of this class of reef fishes appears to be concentrated along the southern coast of the island (Fig. E.4.2.3). *Naso hexacanthus* was observed during a single survey on the southernmost tip of the island in an area of high current. Otherwise observations were primarily of *Scarus rubroviolaceus* which were seen primarily on the southwestern coast, only occasionally on the north side of the island and not at all along the eastern coast (which had high incidence of *Halimeda*).

Table E.4.2.2.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed at Lāna`i during the SE-08-10 MHIRAMP cruise CRED Towed-Diver surveys.

Species	#	#/100m ²	#/ha	Biomass (kg)	kg/100m ²	t/ha
<i>Acanthurus_xanthopterus</i>	2	0.001	0.062	6.289091925	0.002	0.000
<i>Aetobatus_narinari</i>	1	0.000	0.031	5.339783769	0.002	0.000
<i>Aprion_virescens</i>	3	0.001	0.093	15.57494167	0.005	0.000
<i>Aulostomus_chinensis</i>	6	0.002	0.187	3.532816905	0.001	0.000
<i>Carangoides_orthogrammus</i>	7	0.002	0.218	15.7993671	0.005	0.000
<i>Cephalopholis_argus</i>	1	0.000	0.031	2.355036083	0.001	0.000
<i>Chanos_chanos</i>	1	0.000	0.031	13.35240964	0.004	0.000
<i>Diodon_hystrix</i>	1	0.000	0.031	3.062110783	0.001	0.000
<i>Fistularia_commersonii</i>	1	0.000	0.031	0.075410284	0.000	0.000
<i>Naso_hexacanthus</i>	22	0.007	0.684	46.66541012	0.015	0.001
<i>Naso_unicomis</i>	4	0.001	0.124	11.99269416	0.004	0.000
<i>Scarus_rubroviolaceus</i>	9	0.003	0.280	24.333876	0.008	0.001
Grand Total	58	0.018	1.804	148.373	0.046	0.005
# of Species	12					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Lanai During 2008 CRED Towed-Diver Surveys

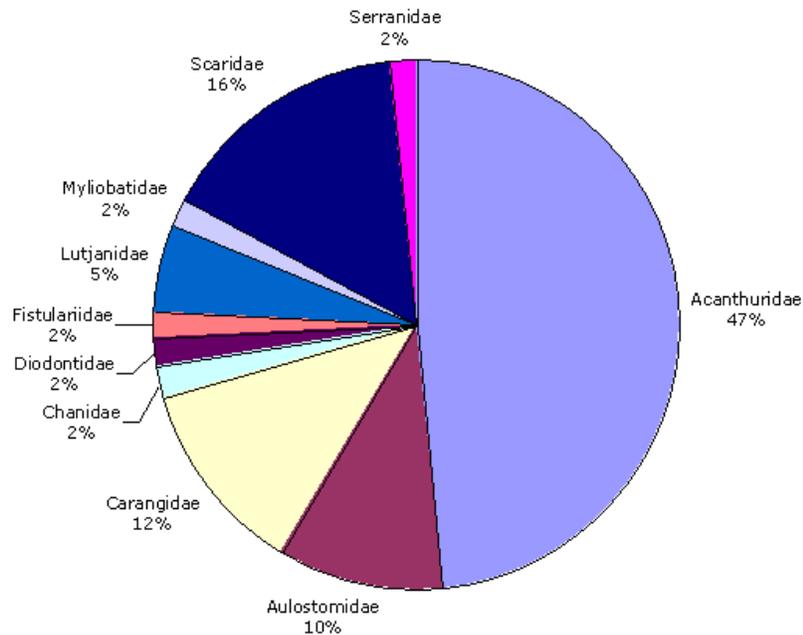


Figure E.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Lanai During 2008 CRED Towed-Diver Surveys

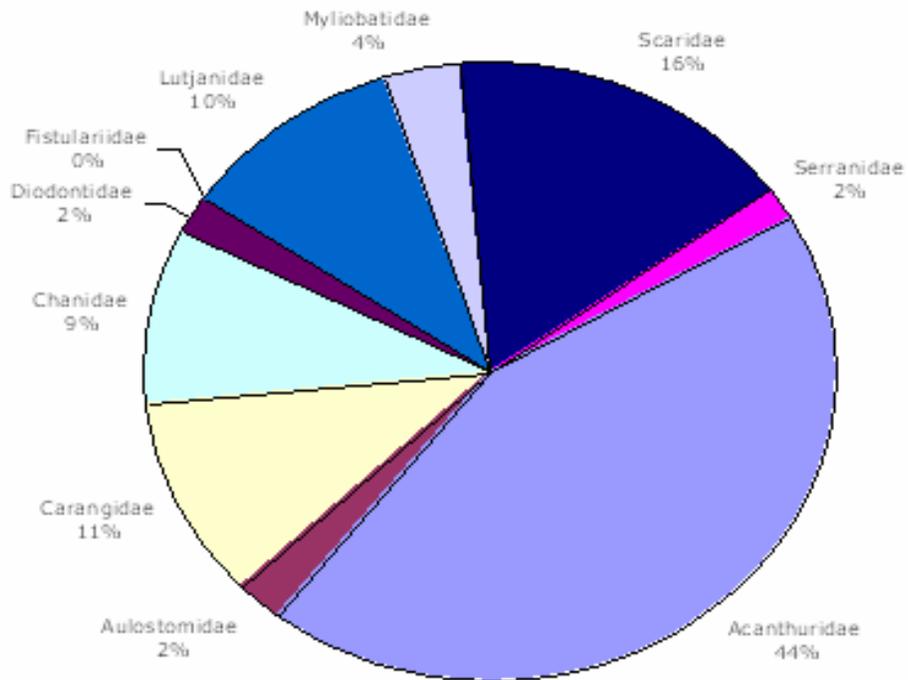


Figure E.4.2.2.--Biomass density by family.

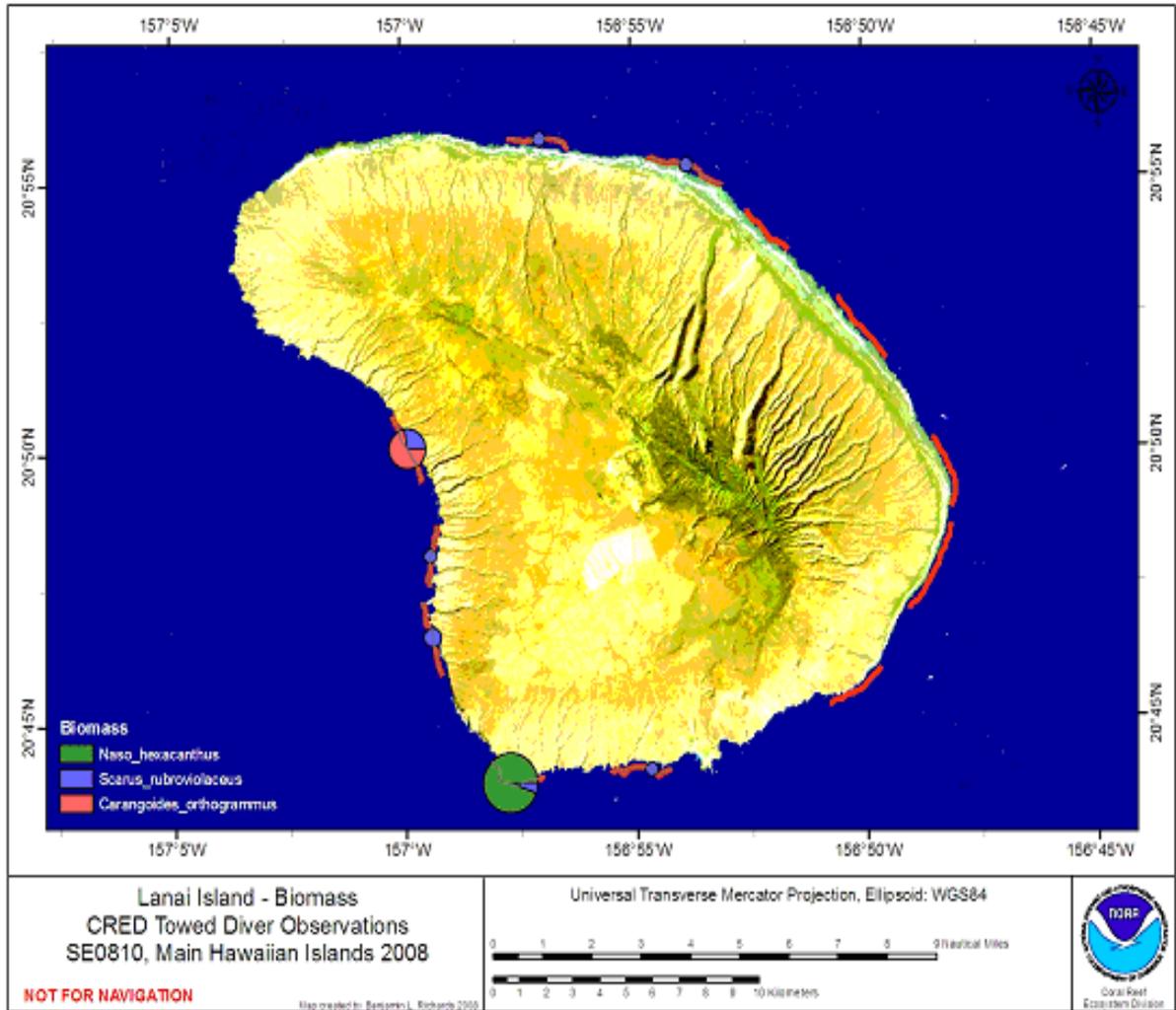


Figure E.4.2.3.--Geographic distribution of biomass around Lāna`i. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.

Appendix F: Maui

F.1. Oceanography and Water Quality

A total of 3 subsurface temperature recorders (STRs) were recovered and 4 deployed at Maui. One ecological acoustic recorder (EAR) was replaced and recovered.

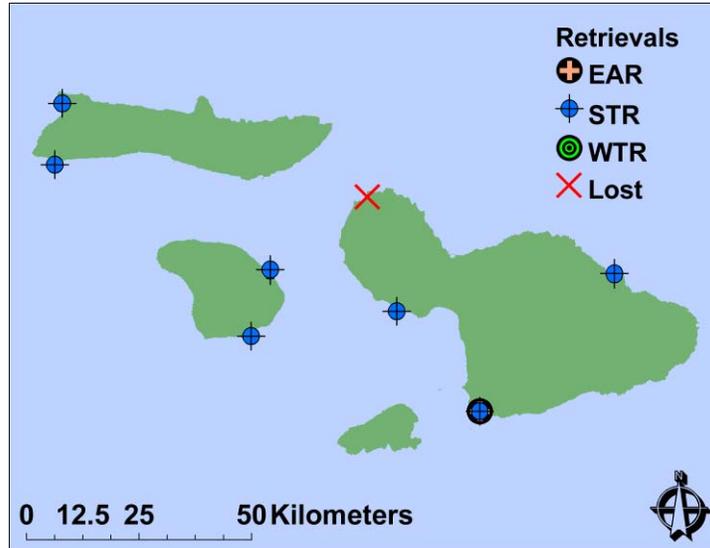


Figure F.1.1.--Retrieved moored oceanographic instrumentation map Lānaʻi, Maui, and Molokaʻi.

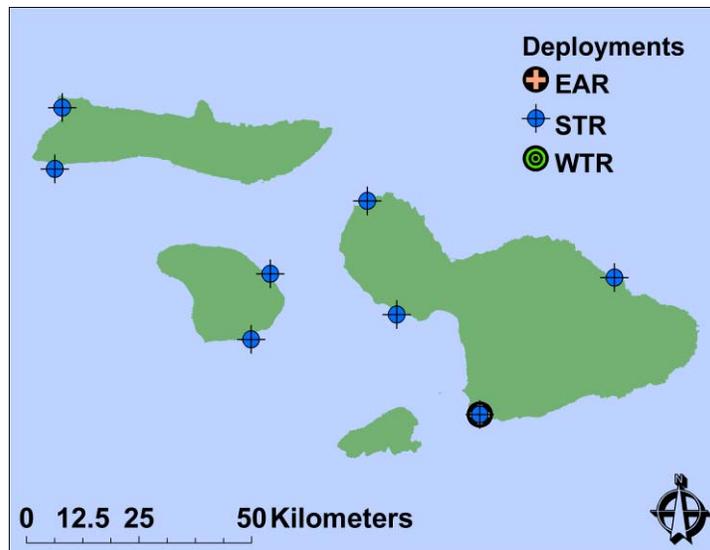


Figure F.1.2.--Deployed moored oceanographic instrumentation map at Lānaʻi, Maui, and Molokaʻi.

Table F.1.1.--Moored oceanographic instrumentation table for Maui.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
STR	Deployment	39390383028	20.864558	-156.151202	10/17/2008	14.63
STR	Retrieval	39390381855	20.864558	-156.151202	10/17/2008	14.63
EAR	Deployment	930046289	20.591953	-156.420334	10/18/2008	14.63
STR	Deployment	39510234486	20.591953	-156.420338	10/18/2008	14.63
EAR	Retrieval	930023411	20.591953	-156.42033	10/18/2008	14.63
STR	Deployment	39368591658	21.017356	-156.642967	10/23/2008	12.19
STR	Lost	39331791154	NA	NA	NA	NA
STR	Deployment	39390381722	20.790787	-156.584480	10/24/2008	11.89
STR	Retrieval	39331791366	20.790787	-156.584480	10/24/2008	12.80

Water Quality

A total of 57 shallow-water conductivity, temperature and depth (CTD) casts were conducted at the 30-m isobath around Mau‘i using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. F.1.3). A total of 5 shallow-water CTD casts were taken for use with microbial water samples.

A total of 54 discrete water samples (including 1 duplicate) were collected concurrently with shallow-water CTD casts at 3 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m and will later be analyzed for nutrient and chlorophyll. Nutrient and chlorophyll samples were processed and stored according to protocol and were sent out for analysis when the cruise returned. Twenty of the discrete water samples were processed for microbial analysis.

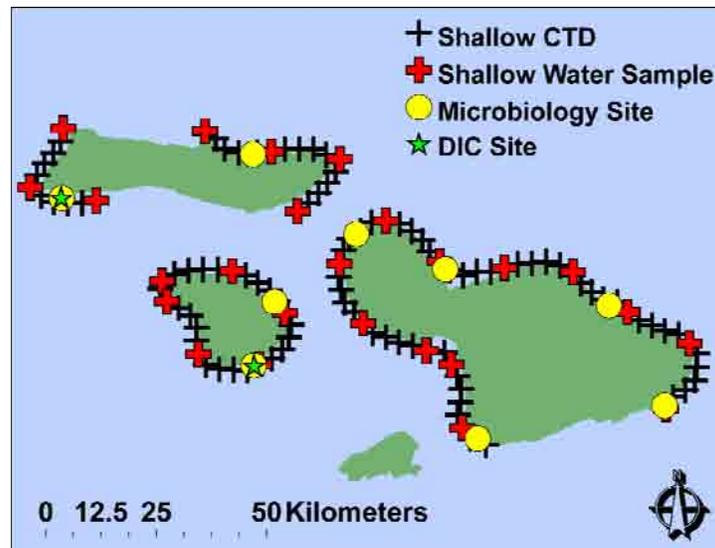


Figure F.1.3.--Shallow-water CTD and water sampling locations around Lāna`i, Maui, and Moloka`i.

F.2 Rapid Ecological Assessment (REA) Site Descriptions

Between October 17 and November 3, 2008, 62 REA surveys were conducted around forereefs of Maui. A total of 13 sites were full REA surveys (benthic and fish) conducted at historical stations, and 21 were additional sites randomly chosen and surveyed by fish

scientists only. Site locations are plotted in Figure F.2.1 and physical and biological characteristics for each site are described below.

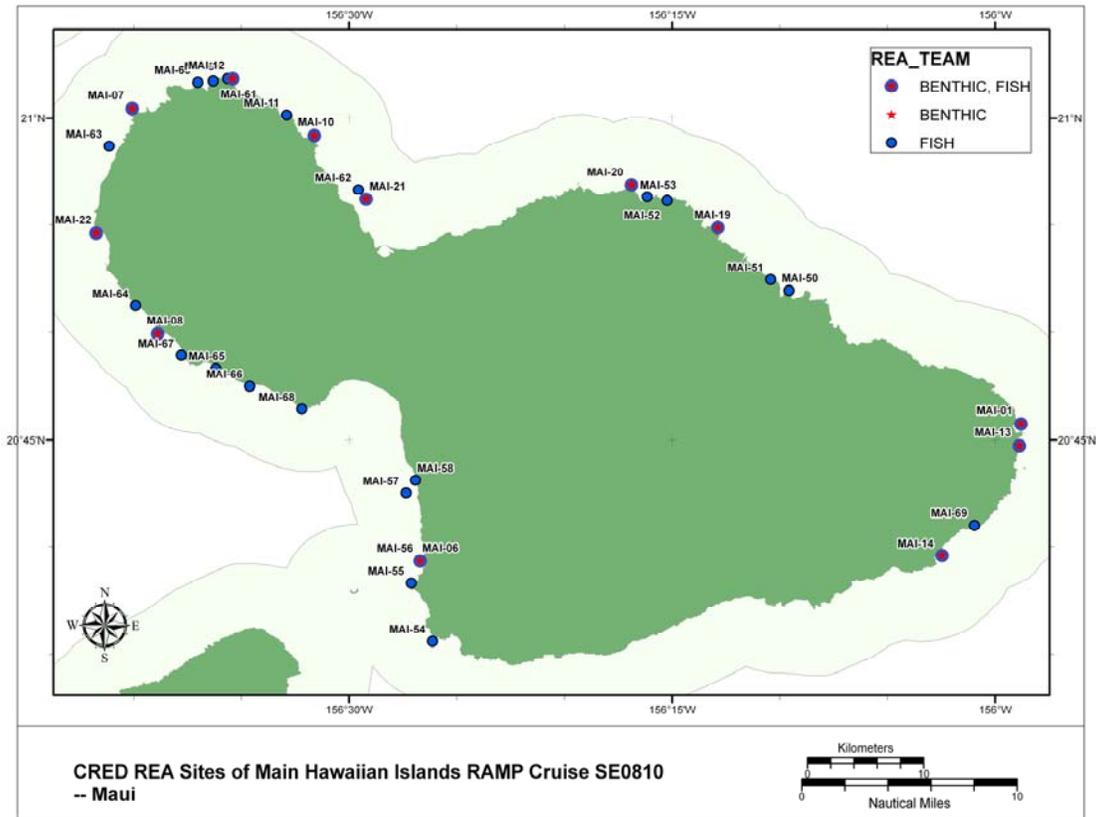


Figure F.2.1.--Locations of 2008 REA sites on Maui.

REA Site Descriptions

MAI-02

10/17/2008

N 20° 51.789'
W 156° 09.077'

Patch Reef

Depth: 11.3–12.2 m



Survey Notes: Original global positioning system (GPS) point not used due to excessive depth. New waypoint and site created.

Habitat: Patch reef.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement/dead coral (77.2%) and scattered *Pocillopora meandrina* and *Porites lobata* colonies. Coral cover (10.8%) and macroalgal cover (9.6%) were moderately low.

Coral: Coral cover was dominated by large encrusting *Porites lobata* colonies (75.9%). Smaller *Montipora capitata* (15.4%) and *Pocillopora meandrina* colonies (8.4%) were interspersed between *Porites* colonies. Coral bleaching was observed on 26.1% of *M. capitata* colonies. Skeletal growth anomalies, discolorations other than bleaching, and predation were also present predominantly on *Pocillopora* and *Porites* genera.

Algae: Algae documented by the line-point intercept survey include *Asparagopsis taxiformis*, *Caulerpa taxifolia*, *Codium arabicum*, crustose coralline red algae, *Halimeda discoidea*, *H. velasquezii*, *Lobophora variegata*, a species of *Padina*, a species of *Galaxaura*, a species of *Sargassum*, and *Dictyota friabilis*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Halimeda opuntia*, and *Dictyota ceylanica*.

Fish: A moderate assemblage of species exists at this site. Aside from a school of *Chromis vanderbilti*, no species in particular dominated in terms of the number of individuals. The triggerfish *Sufflamen bursa* was consistently present, as was *Chromis hanui*.

MAI-06

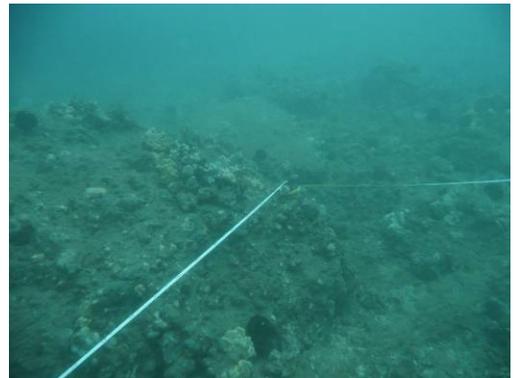
10/18/2008

N 20° 39.325'

W 156° 26.694'

Patch Reef

Depth: 7.6–10.1 m



Survey Notes: Original GPS point was on a sand flat. Site was relocated to a nearby ridge, and the transect line was placed at the bottom of a ridge.

Habitat: Patch reef.

Benthic Cover: Benthos was dominated by turf algae colonized on rubble/dead coral (79.9%) and scattered *Pocillopora meandrina*, *Pavona varians*, *Montipora capitata* and *Porites lobata* colonies. Coral cover was moderately low (16.1%).

Coral: Low coral cover was documented at this patch reef site with colonies of *Porites lobata* (59.0%), *Montipora capitata* (21.2%) and *Pocillopora meandrina* (13.9%) being the most common species observed. A total of 7 scleractinian genera were recorded within the belt transect. Overall coral health was good with 8.5 % of colonies exhibiting compromised health states including algal interactions (2.8%), bleaching (2.6%), and discolorations other than bleaching (1.2%).

Algae: Additional algae documented by the line-point intercept survey include crustose coralline red algae, cyanophytes, and a species of *Nemastoma*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Lobophora variegata*, *Dictyota ceylanica*, *Halimeda velasquezii*, *Gibsmithia hawaiiensis*, *Ventricaria ventricosa*, *Amansia glomerata*, and a species of *Padina*.

Fish: There was low to moderate diversity in fish species at this site. A school of *Chaetodon miliaris* followed the divers during each transect and seemed to be the most abundant fish in the immediate area. There was also a school of *Naso hexacanthus*

present during the first transect. Additionally, juvenile species were noted on a patch of *Porites compressa* reef including: *Chaetodon multicinctus*, *Halichoeres ornatissimus*, *Zebrasoma flavescens*, *Chaetodon miliaris* and *Scarus* sp. Other noteworthy species present were *Scomberoides lysan*.

MAI-07

10/23/2008

N 21° 00.446'

W 156° 40.063'

Forereef

Depth: 8.5–9.8 m



Survey Notes:

Original GPS waypoint was at ~ 18 m depth. Site relocated inshore of original waypoint to ~ 13 m depth.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement, dead coral and rubble (66.8%) with scattered colonies of *Porites lobata*, *P. evermannii*, *Montipora capitata*, and *Pocillopora meandrina*. Overall coral cover was relatively low (16.0%).

Coral: Low coral cover was documented at this site with colonies of *Porites lobata* (72.3%), and *Pocillopora meandrina* (15.1%) being the most common species observed. A total of 6 (5 scleractinian and 1 anthozoan) genera were recorded within the belt transect. Overall coral health was good with 5.5 % of colonies exhibiting a variety of compromised health states including bleaching, predation, and fungal interactions.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Halimeda velasquezii*, *H. discoidea*, and *Amansia glomerata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*.

Fish: This site is located on the northwest shore of Maui. The site was composed of medium to large boulders with rubble intermixed. Coral cover was low and complexity was high. Fish diversity was moderate to high with abundant small and medium-size fishes. Planktivores seemed to dominate fish species in the immediate area. Noteworthy species included one *Aprion virescens* seen off transect.

MAI-08

10/23/2008

N 20° 49.930'

W 156° 38.886'

Forereef

Depth: 8.5–9.8 m



Survey Notes: Original GPS waypoint used and then updated to reflect location of dive buoy marking transect lines.

Habitat: Forereef.

Benthic Cover: Benthos was dominated by coral (48.8%) and turf algae colonized on dead coral and rubble (35.6%) with scattered crustose coralline red algae and *Lobophora variegata*.

Coral: High coral cover was documented at this site with colonies of *Porites compressa* (34.2%), *P. evermanni* (27.1%) and *P. lobata* (15.6%) being the most common species observed. A total of 7 (6 scleractinian and 1 anthozoan) genera were recorded within the belt transect. Overall coral health was very good with only 1.6 % of colonies showing compromised health states. Signs of algal interactions (0.4%) and discolorations other than bleaching (0.4%) were most common.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, and *Halimeda opuntia*. Additional algae documented by the Roving Diver survey include *Halimeda distorta*, *Neomeris annulata*, *Caulerpa peltata*, and *Caulerpella ambigua*.

Fish: This site is located on the western shore of Maui. The site was composed of coral and rubble surrounded by areas of sand. Coral cover was moderate to high and complexity was moderate. Fish diversity was moderate to high with abundant small (i.e., *Ctenochaetus strigosus*, *Plectoglyphidodon johnstonianus*, *Acanthurus nigrofuscus* and *Stegastes fasciolatus*) and medium-size fishes (i.e., *Cephalopholis argus*, *Melichthys niger* and *vidua*). Small fishes were more abundant than medium-size fishes on transects surveyed.

MAI-10

10/22/2008

N 20° 59.190'

W 156° 31.609'

Forereef

Depth: 10.4–13.7 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines. Site located in a sheltered cove.

Habitat: Boulders with encrusting coral colonies.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement and dead coral (46.4%) and *Lobophora variegata* (21.2%), with scattered *Pocillopora meandrina*, *Montipora capitata* and *Porites lobata* colonies. Overall coral cover was moderately low (13.2%), as was macroalgal cover (24.8%).

Coral: Relatively low coral cover was documented at this site with colonies of *Porites lobata* (45.1%), *P. evermanni* (21.2%) and *Pocillopora meandrina* (20.1%) being the most common species observed. A total of 6 (5 scleractinian and 1 anthozoan) genera were recorded within the belt transect. Overall coral health was good with only 5.5 % of

colonies showing compromised health states, such as bleaching (2.2%) and discolorations other than bleaching (1.5%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, and *D. friabilis*. Additional algae documented by the Roving Diver survey include *Halimeda velasquezii*, *Neomeris annulata*, *Galaxaura* sp., *Dictyota* sp., and *Amphiroa* sp.

Fish: Medium-sized fishes dominated at this site. Very few large fishes and low numbers of recruits were recorded.

MAI-12

10/22/2008

N 21° 01.833'

W 156° 35.399'

Forereef

Depth: 10.7–13.7 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders with encrusting coral colonies.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement and dead coral (58.0%), with scattered *Pocillopora meandrina*, *Montipora patula*, *M. capitata* and *Porites lobata* colonies. Overall coral cover was moderately low (18.8%), as was macroalgal cover (12.8%).

Coral: Moderate coral cover was documented at this site with colonies of *Porites lobata* (46.9%), *Pocillopora meandrina* (32.0%) and *Montipora patula* (22.3%) being the most common species observed. A total of 7 (6 scleractinian and 1 anthozoan) genera were recorded within the belt transect. Occurrence of compromised coral health was moderate with 14.2% of colonies exhibiting signs of bleaching (10.2%) and discolorations other than bleaching (1.4%) and algal interactions (1.4%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Halimeda velasquezii*, *Lobophora variegata*, a species of *Neomeris*, *Dictyota friabilis*, and a species of *Sargassum*. Additional algae documented by the Roving Diver survey include a species of *Halimeda discoidea* and *Portieria hornemannii*.

Fish: Fish diversity was moderate at this site. Of particular note was the sighting of one 60-cm *Chlorurus perspicilatus*.

MAI-13

11/03/2008

N 20° 44.734'
W 155° 58.888'

Duplicate Waypoint
N 20° 44.722'
W 155° 58.892'

Depth: 10.7–11.9 m



Survey Notes: Original GPS point was located at ~ 24 m depth. Site moved inshore to appropriate depth range and new waypoint taken.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (46.0%), macroalgae (23.6%), and scattered colonies of *Montipora capitata*, *Pocillopora meandrina*, and *Porites lobata* (21.6%). Overall crustose coralline red algal cover was low (8.4%).

Coral: Moderate coral cover was documented at this site with colonies of *Porites lobata* (42.7%), *Pocillopora meandrina* (32.0%) and *Montipora patula* (11.7%) being the most common species observed. A total of 5 (4 scleractinian and 1 anthozoan) genera were recorded within the belt transect. A skeletal growth anomaly was observed on only one colony representing (0.4%) of colonies surveyed.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, *Asparagopsis taxiformis*, *Codium arabicum*, and species of *Padina* and *Dictyota*. Additional algae documented by the Roving Diver survey include a species of *Galaxaura*, *Halimeda discoidea*, *Halimeda opuntia*, and *Plocamium sandvicense*.

Inverts: Invertebrate surveys were not conducted at site.

Fish: This site had low species richness, but many young-of-the-year including *Acanthurus olivaceus*, *Acanthurus nigrofuscus*, *Chaetodon multicinctus*, and *C. quadrimaculatus*. There was a large *Sphyrna barracuda* at the start of the first transect. Small fishes dominated the area.

MAI-14

11/03/2008

N 20° 39.582'
W 156° 02.466'

Boulders

Depth: 10.7–11.6 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (66.0%) and scattered colonies of *Montipora capitata*, *Pocillopora meandrina*, and *Porites lobata* (18.4%). Overall macroalgal cover was moderately low (10.8%) and there was low crustose coralline red algal cover (3.2%).

Coral: Moderate coral cover was documented at this site with colonies of *Porites lobata* (56.8%) and *Pocillopora meandrina* (32.3%) being the most common species observed. A total of 4 (3 scleractinian and 1 anthozoan) genera were recorded within the belt transect. There was no occurrence of compromised coral health states.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, and species of *Galaxaura*, *Padina*, and *Dictyota*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Caulerpa taxifolia*, *Halimeda discoidea*, *H. distorta*, *Dotyella hawaiiensis*, and *Haloplegma duperreyi*.

Inverts: Invertebrate diversity seemed low at this site. Trapezid crabs were perhaps the most abundant here, as were zooanthids. Hermit crabs also were relatively numerous. Very few urchins were present. The smooth composition of the substrate provided very little cover.

Fish: This area harbored moderate species richness with good diversity. Herbivores were present in good numbers and large sizes, including *Scarus rubroviolaceus*, *Acanthurus dussumieri*, *A. olivaceus*, and *A. blochii*. A good recruitment was apparent. Also, one *Sphyrna barracuda* was counted on the transect.

MAI-19

10/17/2008

N 20° 54.846'

W 156° 12.864'

Boulders

Depth: 11.3–11.6 m



Survey Notes: Original GPS point used.

Habitat: Boulders with encrusting coral colonies.

Benthic Cover: Benthos was dominated by turf algae colonized on boulders (69.6%) and scattered *Pocillopora meandrina* and *Porites lobata* colonies. Coral cover was moderately low (8.8%).

Coral: Relatively low coral cover was documented at this site with colonies of *Porites lobata* (42.0%), *Pocillopora meandrina* (29.7%) and *Leptastrea purpurea* (16.5%) being the most common species observed. A total of 5 genera (4 scleractinian and 1 anthozoan) were recorded within the belt transect. Occurrence of compromised coral health states was moderate with 13.4% of colonies exhibiting bleaching (4.1%), pink line syndrome (3.0%), and algal interactions (2.6%).

Algae: Additional algae documented by the line-point intercept survey include crustose coralline red algae, cyanophytes, a species of *Dictyota*, *Halimeda velasquezii*, *Lobophora variegata*, a species of *Padina*, a species of *Galaxaura*, a species of *Sargassum*, and

Distromium flabellata. Additional algae documented by the Roving Diver survey include a species of *Galaxaura*, *Neomeris* sp., *Halimeda discoidea*, *Caulerpa taxifolia*, *Amansia glomerata*, *Sporochnus* sp. and *Portieria hornemannii*.

Fish: Diversity was low to moderate at this site where small-sized fishes were more dominant than medium-sized fishes (no large-sized fishes were observed in the immediate area). Abundant small-sized fishes included *Chromis vanderbilti*, *Acanthurus nigrofuscus* and *Thalassoma duperrey*. Abundant medium-sized fishes included *Naso literatus* and *Acanthurus dussumieri*.

MAI-20

10/17/2008

N 20° 56.880'

W 156° 16.902'

Boulders

Depth: 11.6–13.1 m



Survey Notes: Original GPS point used.

Habitat: Boulders with encrusting coral colonies.

Benthic Cover: Benthos was dominated by turf algae colonized on boulders (65.6%), *Lobophora variegata* (11.2%) and scattered *Pocillopora meandrina* and *Porites lobata* colonies. Coral cover was moderately low (7.2%).

Coral: Relatively low coral cover was documented at this site with colonies of *Porites lobata* (54.5%) and *Pocillopora meandrina* (34.5%) being the most common species observed. A total of 5 genera (4 scleractinian and 1 anthozoan) were recorded within the belt transect. Occurrence of compromised coral health states was moderate with 9.8% of colonies showing signs of bleaching (2.7%), discolorations other than bleaching (2.7%), and algal interactions (2.2%).

Algae: Additional algae documented by the line-point intercept survey include crustose coralline red algae, a species of *Galaxaura*, *Distromium flabellata*, *Lobophora variegata*, *Caulerpa taxifolia*, *Halimeda discoidea*, *H. velasquezii*, a species of *Neomeris*, a species of *Padina*, *Dictyota ceylanica*, and *D. friabilis*. Additional algae documented by the Roving Diver survey include a species of *Galaxaura* and *Portieria hornemannii*.

Fish: Midsize surgeonfish were abundant, with several larger *A. dussumieri* and *N. unicornis* present. Midsize schools of *Chromis ovalis* were also recorded. Species diversity overall was low-moderate.

MAI-21

10/22/2008

N 20° 56.184'
W 156° 29.212'

Forereef

Depth: 9.1–11.6 m



Survey Notes: New site created in 2008.

Habitat: Flat bottom with encrusting coral colonies.

Benthic Cover: Benthos was dominated by encrusting coral colonies (60.4%) and turf algae colonizing on dead coral (26.4%), with low macroalgal cover (2.4%).

Coral: High coral cover was documented at this site with encrusting colonies of *Porites lobata* (86.0%) being the dominant species. A total of 6 genera (5 scleractinian and 1 anthozoan) were recorded within the belt transect. Occurrence of compromised coral health states was relatively low with 7.5% of colonies exhibiting discolorations other than bleaching (3.6%), subacute tissue loss (0.9%), predation (0.9%), and pink line syndrome (0.9%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include *Gibsmithia hawaiiensis*, cyanobacteria, *Neomeris* sp., *Acanthophora pacifica*, *Dictyota friabilis*, and *Nemastoma* sp.

Fish: Large fishes were abundant at this site. Mid and small-sized fishes were also well represented. Overall fish diversity was moderate. Of particular note were the sightings of one 60-cm *Aprion virescens* and 3 > 50 cm *Scarus rubroviolaceus*.

MAI-22

10/23/2008

N 20° 54.605'
W 156° 41.738'

Forereef

Depth: 11.3–13.1 m



Survey Notes: New site created in 2008 and located offshore of a resort complex. Area had high boat traffic.

Habitat: Forereef.

Benthic Cover: Benthos was dominated by coral (55.6%) and turf algae colonized on dead coral and rubble (35.2%) with scattered crustose coralline red algae and *Lobophora variegata*.

Coral: High coral cover was documented at this site with members of the *Porites* genus, such as *P. compressa* (46.1%), *P. evermanni* (26.0%), and *P. lobata* (24.6%) occurring most often. A total of 3 scleractinian genera were recorded within the belt transect. Occurrence of compromised coral health states was low with 4.9% of colonies being affected by *Porites trematodiasis* (3.1%) and bleaching (0.9%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, and a species of *Padina*. Additional algae documented by the Roving Diver survey include *Halimeda velasquezii*, *Dictyosphaeria versluysii*, *Caulerpa peltata*, and *Ventricaria ventricosa*.

Fish: This site is a new REA site established during this cruise and is located on the northwest/western shore of Maui. The site was composed of primarily coral reef and rubble habitat with sand surrounding the reef area. Coral cover was high and complexity was low. Fish diversity was moderate with abundant small-size fishes. Medium-size fishes were less abundant than small fishes. Abundant small species included *Ctenochaetus strigosus* and *Plectoglyphidodon johnstonianus*.

MAI-01

11/03/2008

N 20° 45.739'

W 155° 58.799'

Forereef

Depth: 10.7–12.5 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by corals, including *Montipora capitata*, *M. flabellata* and *Porites lobata* (53.2%) and turf algae colonized on pavement and dead coral (30.4%). Overall macroalgal cover was low (6.8%), as well as crustose coralline red algal cover (4.8%).

Coral: High coral cover was documented at this forereef site with large colonies of *Montipora flabellata* (34.3%), *M. capitata* (28.5%) and *Porites lobata* (17.1%) being the most common species observed. A total of 7 genera (6 scleractinian and 1 anthozoan) were recorded within the belt transect. Overall coral health was good with only 3.7 % of colonies showing signs of predation.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, and *Amansia glomerata*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Peyssonnelia*, *Acanthophora pacifica*, *Dictyota ceylanica*, *Caulerpa taxifolia*, *Halimeda opuntia*, and *Plocamium sandvicense*.

Inverts: A total of 3 autonomous reef monitoring systems (ARMS) were installed at this site. Additionally, invertebrate surveys were conducted. Despite decent coral cover, the word “depauperate” could best describe the invertebrate community at this site.

Zooanthids were the only organism recorded in any abundance at all. Very few urchins and none of the usual Trapezid crabs were present.

Fish: This site is characterized as having moderate species richness and diversity. Schools of herbivores including *Acanthurus triostegus* and *A. blochii* were present, with an overall good presence of herbivores in general. Parrotfishes noted were large, including *Chlorurus perspicillatus* and *Scarus rubroviolaceus*. Other medium-sized fishes included *Acanthurus dussumieri*, *Lutjanus fulvus*, *Parupeneus insularis*, *Cephalopholis argus*, and *Myripristis berndti*. Smaller fishes were most prevalent, with numerous young-of-the-year *Ctenochaetus strigosus* and *Acanthurus nigrofuscus* present.

Independent Fish Sites

MAI-11

10/22/2008

W 156° 32.899
N 21° 00.137

Forereef

Depth: 12-13 m



General site description

This site is located on the northwest shore of Maui. The site was composed of medium to large boulders. Coral cover was moderate and complexity was high. Fish diversity was high with abundant small and medium-size fish. Small fishes were more abundant than medium-size fishes on transects surveyed. Planktivores seemed to dominate fish species in the immediate area.

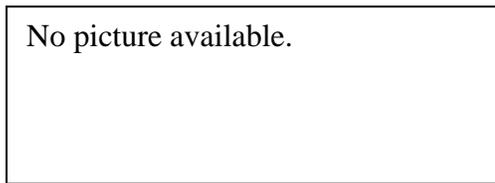
MAI-50

10/17/2008

W 156° 09.568
N 20° 51.948

Forereef

Depth: 21-21 m



General site description

This site is located on the north shore of Maui. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of large boulders. Coral cover was low and complexity was moderate. The substrate was mostly bare rocks. Fish diversity was moderate, with a moderate amount of medium-size fishes (e.g., snappers, parrotfish). Very few smaller size species.

MAI-51

10/17/2008

W 156° 10.422

N 20° 52.456

Forereef

Depth: 3-3 m



General site description

This site is located on the north shore of Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. It is tucked in a bay protected by a large rocky outcrop. The site was composed of medium to large boulders. Coral cover was low and complexity was moderate. The substrate was mostly bare rocks. Fish diversity was moderate, with few medium-size fish. Smaller species were more abundant than at MAI-50.

MAI-52

10/17/2008

W 156° 15.226

N 20° 56.117

Forereef

Depth: 3-3 m



General site description

This site is located on the north shore of Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. It is located on the eastern side of a large bay. The site was composed of medium to large boulders. Coral cover was low and complexity was moderate. The substrate consisted mostly of bare rocks. Fish diversity was moderate, with few medium-size fishes. Smaller species were fairly abundant.

MAI-53

10/17/2008

W 156° 16.159
N 20° 56.300

Forereef

Depth: 22-22 m



General site description

This site is located on the north shore of Maui. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of medium to large boulders resting on a sandy bottom. Coral cover was low and complexity was moderate. The substrate was made up of mostly bare rocks. Fish diversity was moderate, with a moderate amount of medium-size fishes (e.g., snappers, parrotfish).

MAI-54

10/18/2008

W 156° 26.122
N 20° 35.596

Forereef

Depth: 23-23 m



General site description

This site is located on the southwest shore of east Maui off of the west point of La Perouse Bay. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was characterized by a high complexity, steep reef slope with moderate coral cover. The substrate was coral rubble. Fish diversity was moderate with a significant number of large emperor snappers (*Monotaxis grandoculis*) off transect. Also of note was a large amberjack (*Seriola dumerilii*) roughly 100 cm and 2 grey snappers (*Aprion virescens*) at 60 and 40 cm respectively. Of these 3 fish only the larger *A. virescens* was on transect.

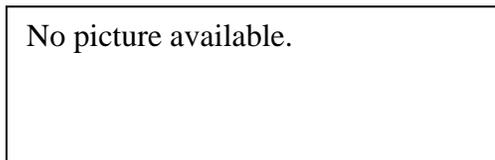
MAI-55

10/18/2008

W 156° 27.111
N 20° 38.304

Forereef

Depth: 5-5 m



General site description

This site is located on the southwest shore of east Maui in the Makena area just north of Little Beach. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. Transect A was located along the base of a rock wall with sandy substrate and very little coral. This transect had very few fish. Transect B was located in more ideal habitat with moderate complexity and low to moderate coral cover. Fish diversity here was moderate consisting of smaller size fishes.

MAI-56

10/18/2008

W 156° 26.690

N 20° 39.368

Forereef

Depth: 5-5 m



General site description

This site is located on the southwest shore of east Maui in the Wailea-Makena area. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site had a high level of complexity with rocky outcroppings some of which extend to or very near the surface. The substrate was made up of sand with moderate coral cover. Of note was a patch of *Porites compressa* near the middle of transect B. Visibility was poor at about 3 m likely resulting in an underestimation of larger fish. Fish diversity was moderate consisting of small, site attached species.

MAI-57

10/18/2008

W 156° 27.347

N 20° 42.518

Forereef

Depth: 20-20 m



General site description

This site is located in the southwest shore of east Maui offshore of the Kihei boat ramp. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was located on a large patch reef that consisted of very high and diverse coral cover. Complexity was low. Fish diversity was moderate to low consisting mainly of smaller, site-attached species. There was also a handful of moderate-size parrotfish.

MAI-58

10/18/2008

W 156° 26.915

N 20° 43.122

Forereef

Depth: 3-4 m

No picture available.

General site description

This site is located in the southwest shore of west Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was located on a patch reef surrounded by sand that consisted of high coral diversity and moderate coral cover. Complexity was moderate. Fish diversity was moderate consisting mainly of smaller, juvenile species. *Acanthurus nigrofuscus* seemed to dominate numeric density on transects. *Mulloidichthys flavolineatus* were also common on the transects while *Fistularia commersonii* were seen off-transect.

MAI-59

10/22/2008

W 156° 35.637

N 21° 01.838

Forereef

Depth: 4-4 m



General site description

This site is located on the northwest shore of Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of medium to large boulders. Coral cover was none to low, and complexity was moderate. The substrate was made up of mostly bare rocks. Fish diversity was moderate to high with abundant small and medium-size fishes.

MAI-60

10/22/2008

W 156° 37.021

N 21° 01.657

Forereef

Depth: 20-20 m



General site description

This site is located on the northwest shore of Maui. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of primarily boulder/rubble/pavement habitat. Coral cover was low to moderate and complexity was moderate to high. Fish diversity was high with abundant small, medium and large-size fishes. Several large fish species were observed in the immediate area of the transects including a small school of *Aprion virescens*, *Monotaxis granducolis*, *Lutjanus kasmira* and several surgeonfish species. Other noteworthy species seen were *Caranx melampygus*.

MAI-61

10/22/2008

W 156° 36.305

N 21° 01.718

Forereef

Depth: 3-4 m



General site description

This site is located on the northwest shore of Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site consisted mostly of very flat pavement covered to a moderate degree by encrusting *Porites* and *Montipora*. The flat substrate was, in part, broken up by several holes and a long trench. Complexity was low, while coral cover was moderate. The flat sections of the site seemed to be a nursery for recruits, while the sections with more cover and structure harbored more medium-large fishes.

MAI-62

10/22/2008

W 156° 29.566

N 20° 56.641

Forereef

Depth: 21-21 m



General site description

This site is located on the northwest shore of Maui. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of primarily coral and coral rubble habitat intermixed with pavement. Coral cover was high and complexity was moderate. Coral species consisted of primarily *Montipora* sp. and

Porites compressa, and coralline algae also dominated the reef. Fish diversity was high with abundant small and medium-size fishes (surgeon, parrot, planktivores, butterflyfish, damsels and chromis). Crown-of-thorns were also abundant in the immediate area.

MAI-63

10/23/2008

W 156° 41.136
N 20° 58.688

No picture available.

Forereef

Depth: 20-21 m

General site description

This site is located on the western shore of West Maui. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed of flat rubble and sand interspersed with small coral bomies. Coral cover was low and complexity was also low. Fish diversity was moderate and a mix of sand/rubble and coral dwelling species. Notable sightings include *Pseudanthias bicolor*, *Centropyge fisheri*, and *Rhinocanthus aculeatus*.

MAI-64

10/23/2008

W 156° 39.908
N 20° 51.235

No picture available.

Forereef

Depth: 4-4 m

General site description

This site is located on the southwestern shore of West Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of mainly coral colonies. Coral cover was moderate (slightly lower than MAI-65) and complexity was low. Fish diversity was low with abundant small fish. *Thalassoma duperrey* seemed again to dominate small species on each transect. *Melichthys vidua* and *M. niger* were sighted.

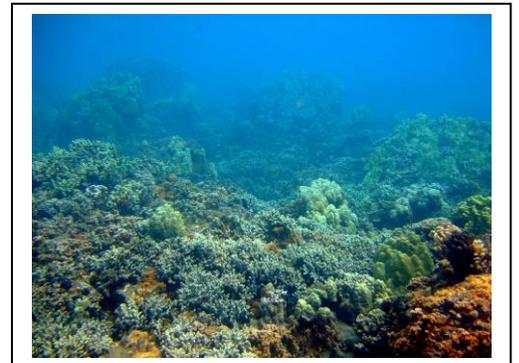
MAI-65

10/23/2008

W 156° 36.180
N 20° 48.317

Forereef

Depth: 4-4 m



General site description

This site is located on the southwestern shore of West Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of mainly coral colonies. Coral cover was high and complexity was medium. Fish diversity was low with abundant small fishes. *Thalassoma duperrey* seemed to dominate small species on each transect. Notable sightings include *Lutjanus fulvus*, *Caranx melampygus*, and *Mulloidichthys flavolineatus*.

MAI-66

10/23/2008

W 156° 34.612

N 20° 47.494

Forereef

Depth: 3-3 m



General site description

This site is located on the southwestern shore of West Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of mainly coral colonies. Coral cover was moderate (slightly lower than MAI-65) and complexity was medium. Fish diversity was low with abundant small fishes. *Thalassoma duperrey* seemed again to dominate small species on each transect. Notable sightings include *T. trilobatum* and *Chaetodon lunula*.

MAI-67

10/23/2008

W 156° 37.790

N 20° 48.930

Forereef

Depth: 4-4 m



General site description

This site is located on the western shore of Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of coral and pavement. Coral cover was moderate to high, and complexity was low. Fish diversity was low with abundant small and medium-size fishes. Small fishes were more abundant than medium-size fishes on transects surveyed. *Thalassoma duperrey* seemed to dominate small species on each transect.

MAI-68

10/23/2008

No picture available.

W 156° 32.190

N 20° 46.429

Forereef

Depth: 19-19 m

General site description

This site is located on the south shore of West Maui. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was composed mainly of large boulders resting on sand and *Halimeda* sp. beds at greater depths. Coral cover was moderate, and complexity was also moderate. Fish diversity was low with abundant small fishes. Many large schools of goatfish were observed. These goatfish probably dominated the biomass. Notable sightings include *Parapercis shaunslandi*, *Gymnothorax meleagris*, and *Dascyllus albisella*.

MAI-69

11/3/2008

No picture available.

W 156° 00.960

N 20° 40.983

Forereef

Depth: 3-3 m

General site description

This site was located inside a small cove on the east side of East Maui. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was composed of a medium complexity reef structure becoming sand deeper. Coral cover was low and complexity moderate. Fish diversity was moderate. A few *Sphyræna barracuda* were observed.

F.3. Benthic Environment

F.3.1. Algae

Benthic communities around Maui were dominated by turf algal and coral functional groups (Table F.3.1.1). Turf algae were documented with the highest percent cover at 9 of the 13 sites surveyed and had the second highest percent cover at 4 of the sites. Coral percent cover exceeded that of other functional groups at 4 of the 13 sites and had the second highest percent cover at 5 of the sites (Table F.3.1.1). A combined total of 33 species of macroalgae were observed (12 chlorophytes, 8 ochrophytes, 13 rhodophytes) from the 13 sites surveyed (Tables F.3.1.2, F.3.1.3). *Lobophora variegata* was found at all sites except MAI-06 and dominated the macroalgal community at 8 of the 13 sites with a percent cover range of 0.4% to 21.2% (Table F.3.1.3). *Padina* sp. was documented at 6 of the 13 sites and was the most prevalent macroalgal genera at 2 of the sites with a percent cover range of 0% to 10% across all sites (Table F.3.1.3).

Table F.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at Maui.

Site	Macroalgae	Turf Algae	Coralline Red Algae (crustose + upright)	Cyanobacteria	Coral
MAI-01	6.8%	30.4%	4.8%	-	53.2%
MAI-02	9.6%	77.2%	0.4%	-	10.8%
MAI-06	0.4%	79.6%	0.4%	0.4%	16.0%
MAI-07	4.8%	66.8%	8.0%	-	16.0%
MAI-08	4.4%	35.6%	10.4%	-	49.2%
MAI-10	24.8%	46.4%	15.2%	0.4%	13.2%
MAI-12	12.8%	58.0%	9.6%	-	18.8%
MAI-13	23.6%	46.0%	8.4%	-	21.6%
MAI-14	10.8%	66.0%	3.2%	-	18.4%
MAI-19	16.8%	69.6%	2.0%	2.4%	8.8%
MAI-20	19.2%	65.6%	7.2%	-	7.2%
MAI-21	2.4%	26.4%	8.8%	-	60.4%
MAI-22	1.6%	35.2%	3.6%	2.0%	55.6%

Table F.3.1.2.--Additional species recorded at each site at Maui during roving diver survey.

Site	Chlorophyta
MAI-08 MAI-22	<i>Caulerpa peltata</i>
MAI-01 MAI-14 MAI-19	<i>Caulerpa taxifolia</i>
MAI-08	<i>Caulerpella ambigua</i>
MAI-22	<i>Dictyosphaeria versluisii</i>
MAI-12 MAI-13 MAI-14 MAI-19	<i>Halimeda discoidea</i>
MAI-08 MAI-14	<i>Halimeda distorta</i>
MAI-01 MAI-02 MAI-08 MAI-13	<i>Halimeda opuntia</i>
MAI-06 MAI-10 MAI-22	<i>Halimeda velasquezii</i>
MAI-08 MAI-10	<i>Neomeris annulata</i>
MAI-01 MAI-02 MAI-06 MAI-07	<i>Neomeris sp.</i>

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MAI-14 MAI-19 MAI-21	
MAI-06 MAI-22	<i>Ventricaria ventricosa</i>
	Ochrophyta
MAI-01 MAI-02 MAI-06	<i>Dictyota ceylanica</i>
MAI-21	<i>Dictyota friabilis</i>
MAI-10	<i>Dictyota sp.</i>
MAI-06	<i>Lobophora variegata</i>
MAI-06	<i>Padina sp.</i>
MAI-19	<i>Sporochnus sp.</i>
	Rhodophyta
MAI-01 MAI-21	<i>Acanthophora pacifica</i>
MAI-06 MAI-19	<i>Amansia glomerata</i>
MAI-10	<i>Amphiroa sp.</i>
MAI-14	<i>Dotyella hawaiiensis</i>
MAI-10 MAI-13 MAI-19 MAI-20	<i>Galaxaura sp.</i>
MAI-10	<i>Gelid</i>
MAI-06 MAI-21	<i>Gibsmithia hawaiiensis</i>
MAI-14	<i>Haloplegma duperreyi</i>
MAI-21	<i>Nemastoma sp.</i>
MAI-01	<i>Peyssonnelia sp.</i>
MAI-01 MAI-13	<i>Plocamium sandvicense</i>
MAI-12 MAI-19 MAI-20	<i>Portieria hornemannii</i>

Table F.3.1.1.--Percent cover of macroalgal species at long-term monitoring sites at Maui. Sum totals for each row equal the percent cover of macroalgae recorded in Table F.3.1.1.

Site	<i>Caulerpa taxifolia</i>	<i>Codium arabicum</i>	<i>Halimeda discoidea</i>	<i>Halimeda opuntia</i>	<i>Halimeda velasquezii</i>	<i>Neomeris</i> sp	<i>Dictyota ceylanica</i>	<i>Dictyota friabilis</i>	<i>Dictyota</i> sp	<i>Distromium flabellatum</i>	<i>Lobophora variegata</i>	<i>Padina</i> sp	<i>Sargassum</i> sp	<i>Asparagopsis taxiformis</i>	<i>Galaxaura</i> sp	<i>Nemastoma</i> sp
MAI-01	-	-	-	-	-	-	-	-	-	-	3.2%	-	-	-	-	-
MAI-02	1.2%	0.4%	0.4%	-	2.0%	-	-	0.4%	-	-	0.4%	0.4%	0.8%	0.8%	2.4%	-
MAI-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4%
MAI-07	-	-	0.4%	-	0.4%	-	-	-	-	-	3.6%	-	-	-	-	-
MAI-08	-	-	-	3.6%	-	-	-	-	-	-	0.8%	-	-	-	-	-
MAI-10	-	-	-	-	-	-	3.2%	0.4%	-	-	21.2%	-	-	-	-	-
MAI-12	-	-	-	-	2.8%	0.4%	-	0.4%	-	-	8.8%	-	0.4%	-	-	-
MAI-13	-	0.4%	-	-	-	-	5.6%	-	2.4%	-	3.6%	10.0%	-	1.6%	-	-
MAI-14	-	-	1.2%	-	-	-	0.8%	-	1.2%	-	2.4%	2.8%	-	-	2.0%	-
MAI-19	-	-	-	-	0.4%	-	-	-	2.8%	2.8%	6.8%	2.4%	0.8%	-	0.8%	-
MAI-20	0.8%	-	0.4%	-	0.4%	0.4%	1.6%	0.4%	-	0.4%	11.2%	3.2%	-	-	0.4%	-
MAI-21	-	-	-	-	-	-	-	-	-	-	1.6%	-	-	-	-	-
MAI-22	-	-	-	-	-	-	-	-	-	-	1.2%	0.4%	-	-	-	-

F.3.2. Corals

F.3.2.1 Coral Populations

Line-point intercept surveys documented high coral cover (26.9 ± 5.5 %) at REA sites around Maui in 2008 (Fig. F.3.2.1.1, left). Benthic habitat was diverse at REA sites, including patch reefs, boulders, and forereef. Species richness varied between sites with 11 genera (9 scleractinian, 1 octocoral, and 1 zoanthid) being represented within belt transect surveys. Coral composition was dominated by encrusting colonies of *Porites* (69.5%) with colonies of *Montipora* (18.4%) also found (Fig. F.3.2.1.1, right). Overall relative abundance documented *Porites lobata* (51.1%), *Montipora capitata* (9.4%), *Pocillopora meandrina* (9.0%), and *M. patula* (8.7%) to be the most common species recorded in 2008 (Table F.3.2.1.1).

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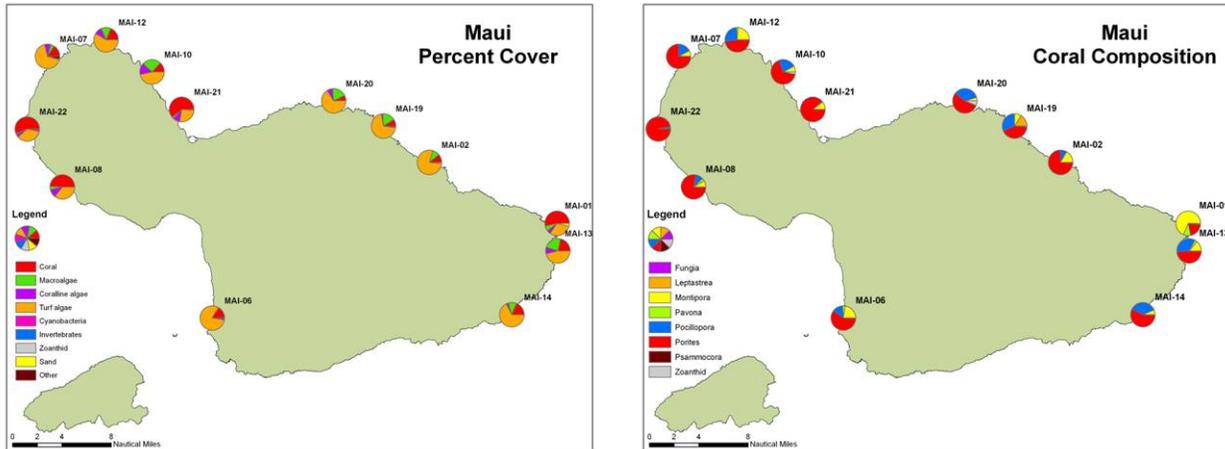


Figure F.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around Maui in 2008.

Table F.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around Maui in 2008.

Taxon Name	No. of colonies	Relative Abundance
<i>Cyphastrea ocellina</i>	2	0.04
<i>Cyphastrea sp.</i>	1	0.02
<i>Fungia scutaria</i>	4	0.08
<i>Leptastrea bewickensis</i>	5	0.10
<i>Leptoseris incrustans</i>	5	0.10
<i>Leptastrea pruinosa</i>	1	0.02
<i>Leptastrea purpurea</i>	4	0.08
<i>Montipora capitata</i>	450	9.35
<i>Montipora flabellata</i>	143	2.97
<i>Montipora incrassata</i>	5	0.10
<i>Montipora sp.</i>	2	0.04
<i>Montipora patula</i>	419	8.70
<i>Palythoa sp.</i>	139	2.89
<i>Porites brighami</i>	5	0.10
<i>Porites compressa</i>	199	4.13
<i>Pavona duerdeni</i>	46	0.96
<i>Porites evermanni</i>	187	3.88
<i>Pocillopora eydouxi</i>	2	0.04
<i>Psammocora haimeana</i>	1	0.02
<i>Pocillopora ligulata</i>	1	0.02
<i>Porites lobata</i>	2459	51.08
<i>Pavona maldivensis</i>	2	0.04
<i>Pocillopora meandrina</i>	433	8.99
<i>Pocillopora molokensis</i>	1	0.02
<i>Pocillopora sp.</i>	180	3.74
<i>Porites sp.</i>	19	0.39
<i>Porites rus</i>	2	0.04
<i>Porites solida</i>	1	0.02
<i>Psammocora stellata</i>	1	0.02

Taxon Name	No. of colonies	Relative Abundance
<i>Pavona varians</i>	92	1.91
<i>Simularia</i> sp.	3	0.06

F.3.2.2 Coral Health

During 2008 REA surveys, there were relatively low levels (6.4%) of compromised coral health at sites around Maui. Occurrence of coral bleaching was moderate (23.8%). Additionally, evidence of *Porites* trematodiasis (5.6%), predation (5.5%), and algal interactions (4.6%) were observed (Fig. F.3.2.2.1). Members of the genera *Montipora* (24.4%) and *Porites* (18.5%) were most commonly affected (Fig. F.3.2.2.1). Colonies of *Pavona* sp. were found to only be affected by algal interactions (1.1%).

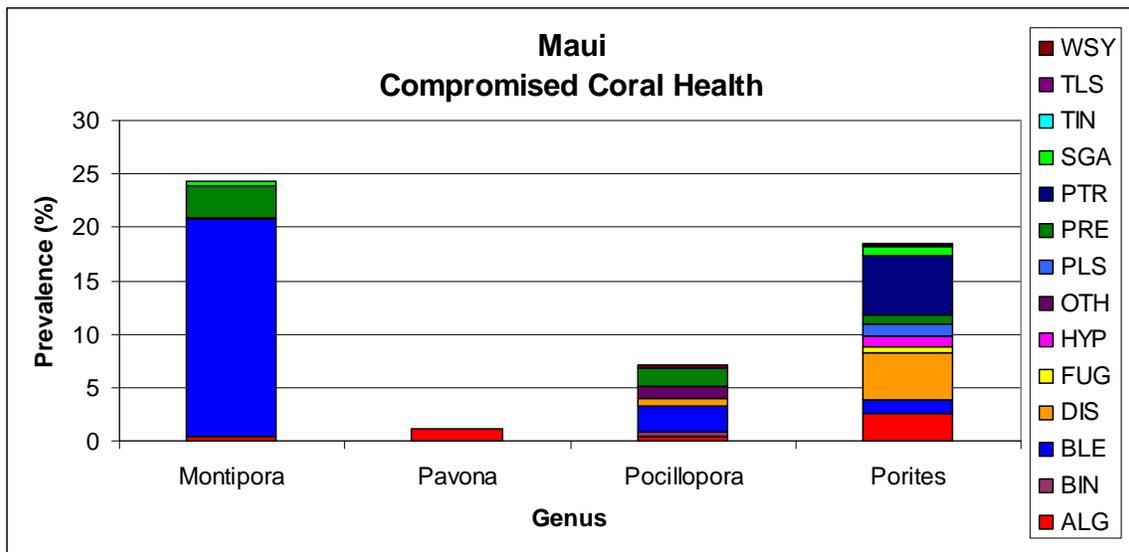


Figure F.3.2.2.1.--Prevalence of compromised coral health states by taxon around Maui in 2008.

Percent mortality of tissue on colonies surveyed during 2008 was varied between genera (Fig. F.3.2.2.2). Dead tissue was observed on 24.5% of *Leptastrea* colonies. Additionally, *Porites* and *Pavona* colonies were found to have 9.5 and 7.8%, respectively, of dead tissue. Other genera, such as *Fungia*, *Cyphastrea* and *Leptoseris* were found to have 100% live tissue.

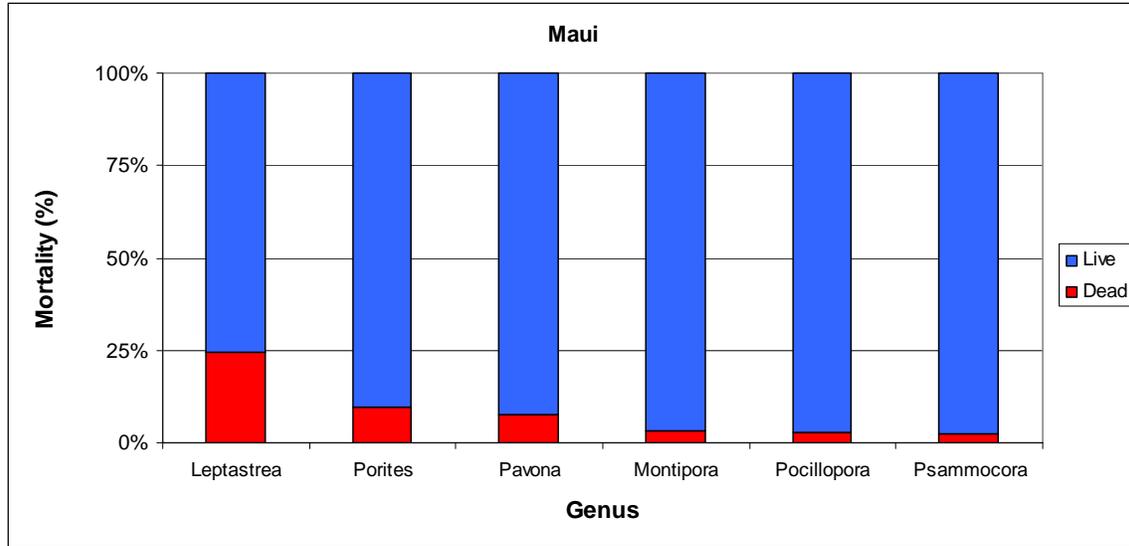


Figure F.3.2.2.2.--Mean percent live versus dead tissue for various coral genera at Maui in 2008.

F.3.3. Noncoral Invertebrate Surveys

A total of 1805 individuals of benthic invertebrate target species or taxa group were enumerated from 24 belt transects at 12 sites. The most abundant macroinvertebrate surveyed was the rock-boring urchin, *Echinometra mathaei*. The highest densities of *E. mathaei* were recorded at sites MAI-07, MAI-08, and MAI-12 (2.17, 1.24, and .07/m², respectively). In general, echinoids were well represented, with 7 of the target genera recorded. The cryptic trapezid crabs were second most abundant on Maui, with densities of 0.67, 0.51, and 0.49/m² at sites MAI-22, MAI-19 and MAI-12, respectively. A second rock-boring urchin, *Echinostrephus aciculatus*, was found to be the third most abundant macroinvertebrate overall, with sites MAI-07, MAI-10, and MAI-06 yielding the highest counts (1.92, 0.09, and 0.07/m² respectively). Aside from Ophiocomids (which were not consistently enumerated) Asteroids were not common on Maui. Absent from all sites were any individuals of the sea star genus *Linckia*. Of note was the record of 1 *Acanthaster planci* at MAI-22, and 5 pearl oysters, *Pinctada* sp., at MAI-08. Additionally, 1 individual of the genus *Toxopneustes* was recorded on the transect at MAI-02.

F.3.3.1 Urchin Measurements

Figure F.3.3.1.1 reveals the average test diameter of urchins from the genera *Echinometra*, *Echinostrephus*, *Echinothrix*, *Heterocentrotus*, and *Tripneustes* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented.

Mean Urchin Test Diameter by Site

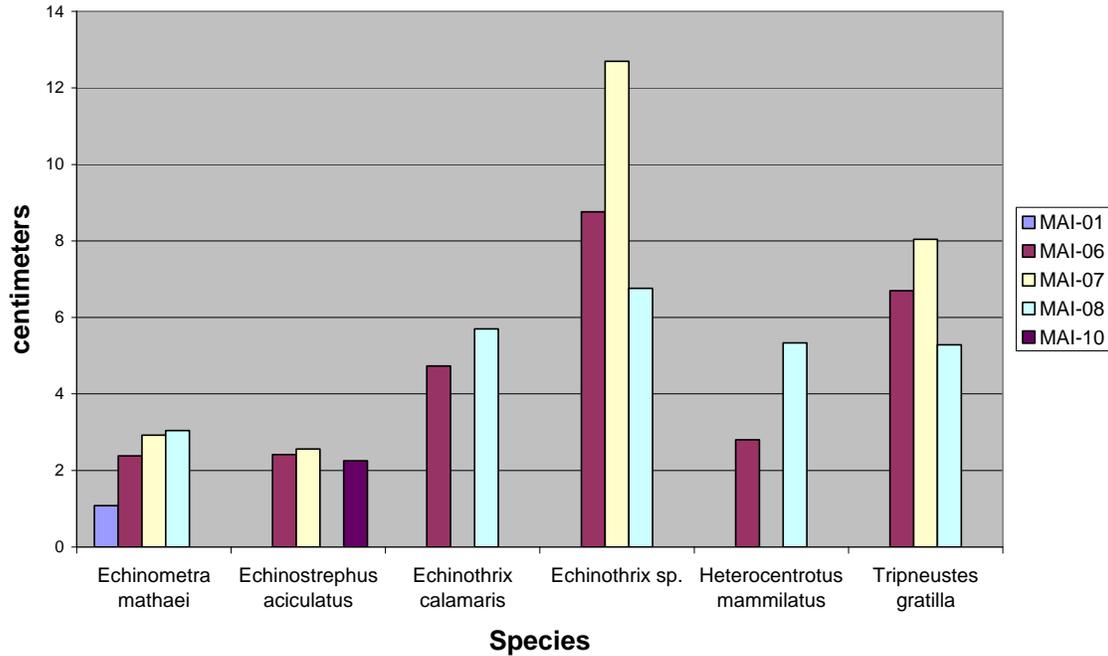


Figure F.3.3.1.1.--Mean test size of urchins by site.

F.3.3.2 ARMS Deployment

MAI-01

Deployed 3 ARMS ~ 11.6 m,
20° 45.739' N; 55° 58.799' W Hana Bay

F. 3.4 Towed-diver Benthic Surveys

A total of 28 towed-diver surveys were conducted off the coast of Maui in 2008. Surveys were focused around the northwest arm (12 tows) with additional tows conducted in both the north (5 tows), east (5 tows), and south regions (6 tows, Fig. F.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.



Figure F.3.4.1.--Locations of 28 towed-diver surveys around Maui in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Habitat types varied considerably both within tows and between regions. Habitat within the north region consisted primarily of rock boulders. Forereef habitat around the southern region of Maui varied with large areas of sand flats interrupted by continuous hard bottom (mostly continuous reef). East region tows consisted of mostly hard bottom habitat composed mostly of bedrock and continuous reef/pavement. The “northern” section of the northwest arm of Maui was dominated by rock boulders while habitat along the southwest arm consisted of mostly sand flats with interspersed patch reefs and sparse pavement patches. Due to limited area coverage with regards to the island as a whole, island averages are not presented. Instead, means (percent cover) and total (invertebrate counts) values are presented for each region. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in Table F.3.4.1 and Figure F.3.4.2.

Percent cover of hard corals was generally low with the exception of the eastern region (mean coral cover: 24.2%) and portions of the “north” northwest arm and south region (Table F.3.4.1, Fig. F.3.4.2). Coral stress was also generally low around the island with the exception of a localized spike in COTs in the south region. Habitat consisted of spur and grooves with high coral cover (between 40-62.5%) on the spurs consisting of mostly *Porites compressa*, but also *Montipora capitata*, *M. patula*, and *P. lobata*. There were 2 localized spikes in crown of thorns abundance on 2 separate spurs. A total of 56 and 38 COTs were counted on each spur within the 10 m tow swath.

Table F.3.4.1.--Mean percent cover and macroinvertebrate totals by tow region.

Region	Hard Coral	Stress Coral	Macro-algae	Coralline Algae	COTs	Free Urchins	Boring Urchins	Sea Cucumbers
East	24	2	2	8	12	4	275	46
North	5	3	3	5	8	11	67	26
Northwest	9	4	20	7	31	439	2584	31
South	13	3	13	8	95	894	5782	6

Macroalgae cover was also generally low with the exception of extensive *Halimeda* beds in the sand flats of the “southern section of the Northwest arm and the south region. Coralline algae was relatively low (average per region ranged from 4.5 to 8.2%) in all regions. Macroinvertebrates were relatively low in the north and east regions. The south region had a high number of free urchins in the spur-and-groove habitat as well as the localized spike in COTs. Free urchins were the most common macroinvertebrate observed in the Northwest arm.

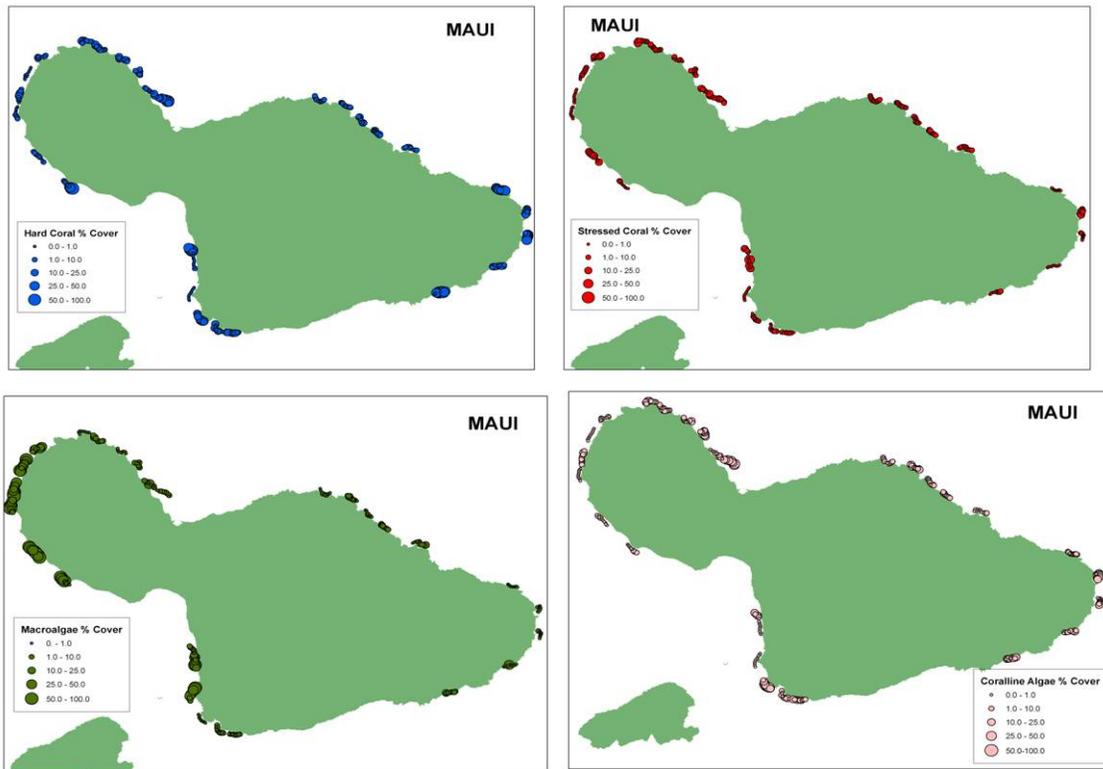


Figure F.3.4.2.--Distribution of coral cover, stressed coral, macroalgae, and coralline algae around Maui in 2008.

D.4 Fish

D.4.1 REA Fish Surveys

Belt transect data

During the survey period, belt transect surveys were conducted at 34 sites around Maui. Surgefish were the largest contributor to total biomass with 1.27 kg 100 m⁻². Parrotfish

were the second largest contributor to total biomass with $0.58 \text{ kg } 100 \text{ m}^{-2}$, followed by wrasses at $0.30 \text{ kg } 100 \text{ m}^{-2}$ (Fig. F.4.1.1, Table F.4.1.1).

Overall Observations

A total of 154 fish species were observed during the survey period by all divers. The average total fish biomass around Maui during the survey period was $3.41 \text{ kg } 100 \text{ m}^{-2}$ for the belt transect surveys (Table F.4.1.1).

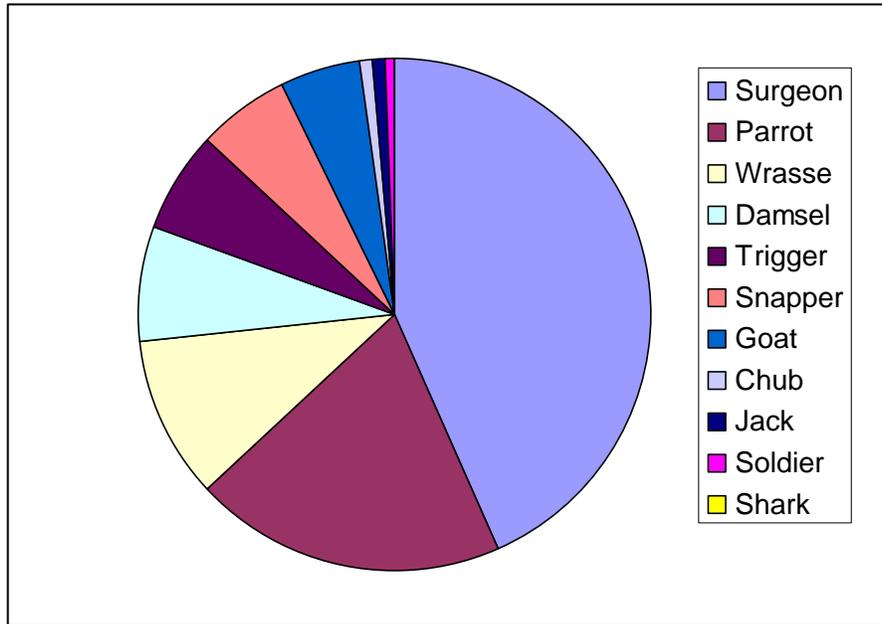


Figure F.4.1.1.--Total fish biomass composition by family.

Table F.4.1.1.--Coral reef fish biomass (kg 100 m⁻²) at sites around Maui.

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	MAI-50	1.79	0.00	0.13	0.08	0.00	0.00	0.00	0.33	0.00	0.61	0.28	0.14
Deep	MAI-53	9.34	0.00	0.01	0.66	0.00	4.09	0.00	0.07	0.00	3.29	0.13	0.87
Deep	MAI-54	9.45	0.00	0.03	0.24	0.00	0.65	0.00	1.23	0.00	5.16	0.04	0.63
Deep	MAI-57	1.89	0.00	0.02	0.01	0.00	0.40	0.00	0.00	0.00	0.84	0.00	0.19
Deep	MAI-60	4.14	0.00	0.08	0.01	0.00	0.11	0.00	2.96	0.00	0.35	0.12	0.27
Deep	MAI-62	3.69	0.00	0.13	0.02	0.00	0.00	0.00	0.00	0.00	1.44	1.24	0.28
Deep	MAI-63	2.75	0.00	0.05	0.04	0.00	0.00	0.00	0.00	0.01	1.32	0.31	0.23
Deep	MAI-68	4.65	0.00	0.04	1.82	0.43	0.11	0.00	0.24	0.00	0.64	0.26	0.40
Mid	MAI-01	5.55	0.00	0.03	0.03	0.00	2.21	0.00	0.19	0.39	1.90	0.04	0.21
Mid	MAI-02	1.92	0.00	0.20	0.01	0.00	0.00	0.00	0.00	0.00	1.27	0.11	0.08
Mid	MAI-06	1.30	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.60	0.05	0.04
Mid	MAI-07	6.13	0.00	0.15	0.04	0.00	1.76	0.00	0.00	0.09	2.90	0.30	0.15
Mid	MAI-08	2.03	0.00	0.21	0.01	0.00	0.00	0.00	0.00	0.00	0.08	1.13	0.13
Mid	MAI-10	3.83	0.16	1.27	0.11	0.00	0.54	0.00	0.00	0.00	1.19	0.07	0.16
Mid	MAI-11	4.96	0.00	0.48	0.14	0.00	1.06	0.00	0.12	0.00	2.59	0.08	0.27
Mid	MAI-12	6.73	0.00	1.40	0.55	0.00	2.35	0.00	0.00	0.00	2.02	0.08	0.17
Mid	MAI-13	4.45	0.00	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.19	0.28	0.14
Mid	MAI-14	5.06	0.00	0.15	0.05	0.00	2.06	0.00	0.00	0.00	1.68	0.31	0.12
Mid	MAI-19	2.74	0.10	0.31	0.00	0.00	0.09	0.00	0.00	0.00	1.41	0.00	0.15
Mid	MAI-20	2.73	0.00	0.41	0.00	0.00	0.01	0.00	0.07	0.14	1.39	0.18	0.37
Mid	MAI-21	9.13	0.10	0.14	0.04	0.00	3.63	0.00	0.55	0.00	3.82	0.04	0.47
Mid	MAI-22	0.96	0.00	0.10	0.00	0.00	0.11	0.00	0.00	0.00	0.16	0.20	0.18
Shallow	MAI-51	2.44	0.00	0.10	0.00	0.23	0.00	0.00	0.17	0.00	0.52	0.06	1.19
Shallow	MAI-52	1.33	0.24	0.18	0.06	0.00	0.03	0.00	0.00	0.00	0.42	0.01	0.34
Shallow	MAI-55	1.68	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.79	0.25	0.09
Shallow	MAI-56	1.20	0.00	0.26	0.06	0.00	0.00	0.00	0.00	0.00	0.38	0.05	0.30
Shallow	MAI-58	2.84	0.00	0.17	0.73	0.00	0.00	0.00	0.00	0.00	1.03	0.00	0.40
Shallow	MAI-59	2.24	0.05	0.41	0.01	0.00	0.00	0.00	0.00	0.05	1.11	0.34	0.15
Shallow	MAI-61	1.18	0.00	0.16	0.01	0.00	0.03	0.00	0.00	0.00	0.67	0.00	0.12

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Shallow	MAI-64	0.93	0.00	0.09	0.00	0.00	0.01	0.00	0.00	0.00	0.39	0.08	0.34
Shallow	MAI-65	1.10	0.00	0.11	0.00	0.00	0.16	0.00	0.00	0.00	0.47	0.03	0.21
Shallow	MAI-66	1.50	0.00	0.02	0.04	0.00	0.14	0.00	0.00	0.00	0.97	0.16	0.15
Shallow	MAI-67	0.47	0.00	0.08	0.00	0.00	0.04	0.00	0.00	0.00	0.10	0.00	0.22
Shallow	MAI-69	3.78	0.12	0.23	0.09	0.00	0.28	0.00	0.04	0.00	1.51	0.00	1.04
	Total	3.41	0.02	0.21	0.15	0.02	0.58	0.00	0.18	0.02	1.27	0.18	0.30

F.4.2 Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED towed-diver team completed 28 surveys at Maui covering 65 km (65 ha) of ocean floor (Table F.4.2.1). Mean survey length was 2.3 km with a maximum length of 3.0 km and a minimum of 1.4 km. Mean survey depth was 14.1 m with a maximum depth of 17 m and a minimum of 9.5 m. Mean temperature on these surveys was 25.6 °C with a maximum temperature of 26.4 °C and a minimum of 24.8 °C.

Table F.4.2.1.--Survey statistics for towed-diver sampling during the SE-08-10 MHIRAMP cruise.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

At Maui, 154 individual large-bodied reef fish (> 50 cm in total length) of 17 different species and 12 different families were encountered (Table F.4.2.2). Overall numeric density for this class of reef fishes was 0.024 #/100 m² (2.373 #/ha) with a biomass density of 0.068 kg/100 m² (0.007 t/ha). Both numeric and biomass density were dominated by *Scarus rubroviolaceus*. The most prevalent families in terms of numeric density were Scarids (69%), Lutjanids (7%), and Acanthurids (6%) (Fig. F.4.2.1). Biomass was dominated by Scarids (65%), Myliobatids (15%), and Lutjanids (8%). (Fig. F.4.2.2). Biomass of reef fishes appears to be evenly distributed around the island. However, species composition appears to differ (Fig. F.4.2.3). The northern portion of the island showed the highest densities of *Scarus rubroviolaceus* and *Chlorurus perspicillatus*. *Aprion virescens* was encountered primarily on the east side of the island.

Table F.4.2.2.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed at Maui during the SE-08-10 MHIRAMP cruise CRED towed-diver surveys.

Species	#	#/100m2	#/ha	Biomass (kg)	kg/100m2	t/ha
Acanthurus_xanthopterus	1	0.000	0.015	3.144545962	0.000	0.000
Aetobatus_narinari	5	0.001	0.077	65.36872588	0.010	0.001
Aprion_virescens	11	0.002	0.170	37.34032385	0.006	0.001
Aulostomus_chinensis	6	0.001	0.092	1.799069144	0.000	0.000
Carangoides_orthogrammus	1	0.000	0.015	3.739866514	0.001	0.000
Cephalopholis_argus	2	0.000	0.031	4.710072166	0.001	0.000
Chlorurus_perspicillatus	33	0.005	0.509	86.68215	0.013	0.001
Diodon_hystrix	1	0.000	0.015	3.062110783	0.000	0.000
Fistularia_commersonii	6	0.001	0.092	6.189680807	0.001	0.000
Gymnothorax_flavimarginatu	1	0.000	0.015	3.692471616	0.001	0.000
Gymnothorax_meleagris	1	0.000	0.015	0.4536	0.000	0.000
Gymnothorax_undulatus	1	0.000	0.015	0.675	0.000	0.000
Naso_hexacanthus	8	0.001	0.123	16.96924004	0.003	0.000
Naso_unicornis	1	0.000	0.015	2.567473762	0.000	0.000
Oplegnathus_punctatus	1	0.000	0.015	2.5375	0.000	0.000
Scarus_rubroviolaceus	74	0.011	1.140	195.3884083	0.030	0.003
Sphyraena_barracuda	1	0.000	0.015	6.489110417	0.001	0.000
Grand Total	154	0.024	2.373	440.809	0.068	0.007
# of Species	17					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Maui During 2008 CRED Towed-Diver Surveys

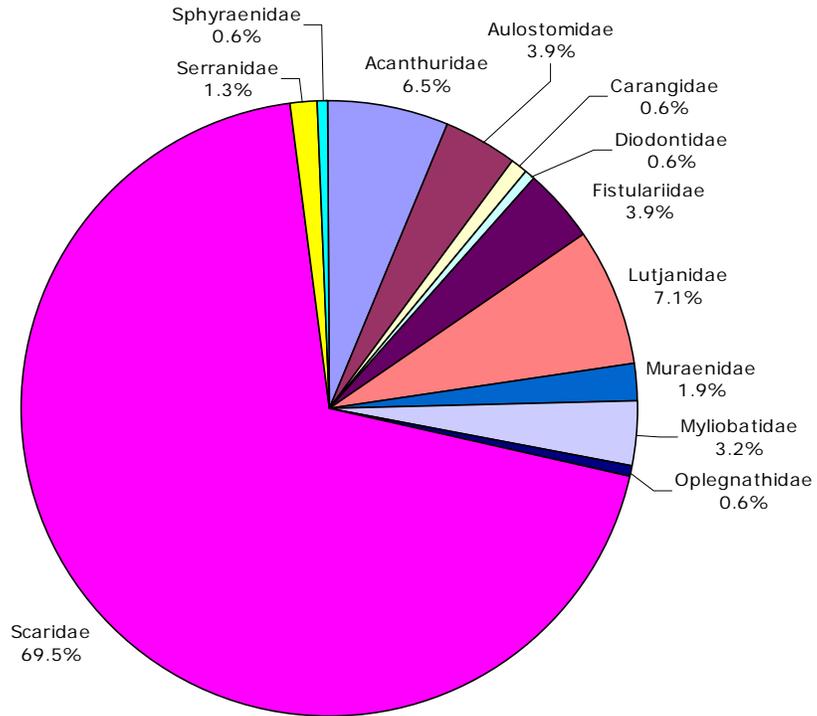


Figure F.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Maui During 2008 CRED Towed-Diver Surveys

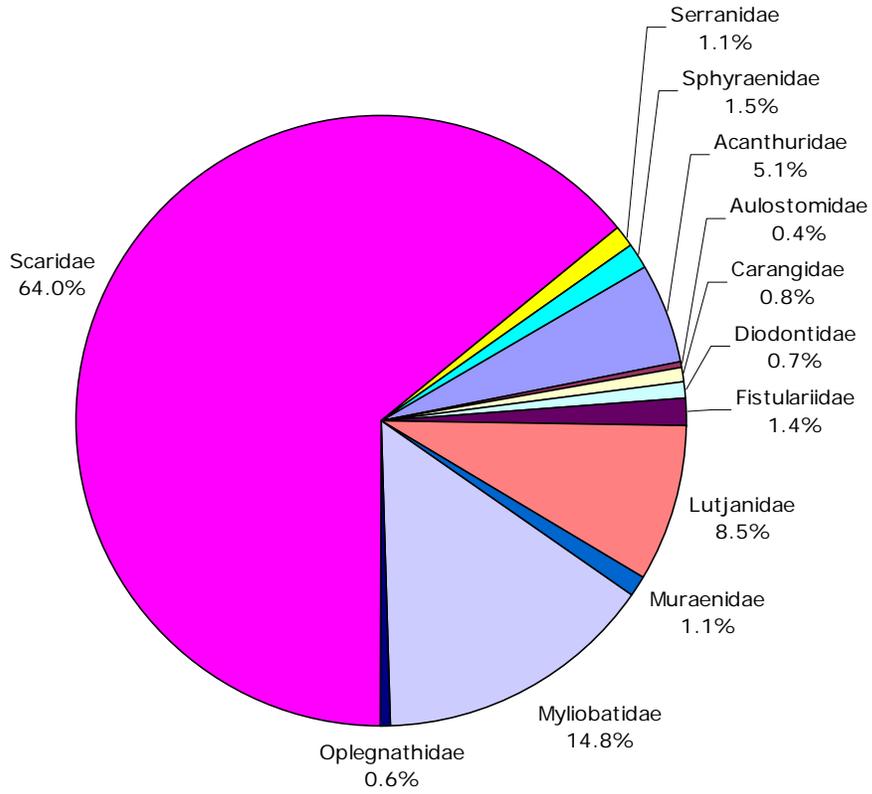


Figure F.4.2.2 Biomass density by family

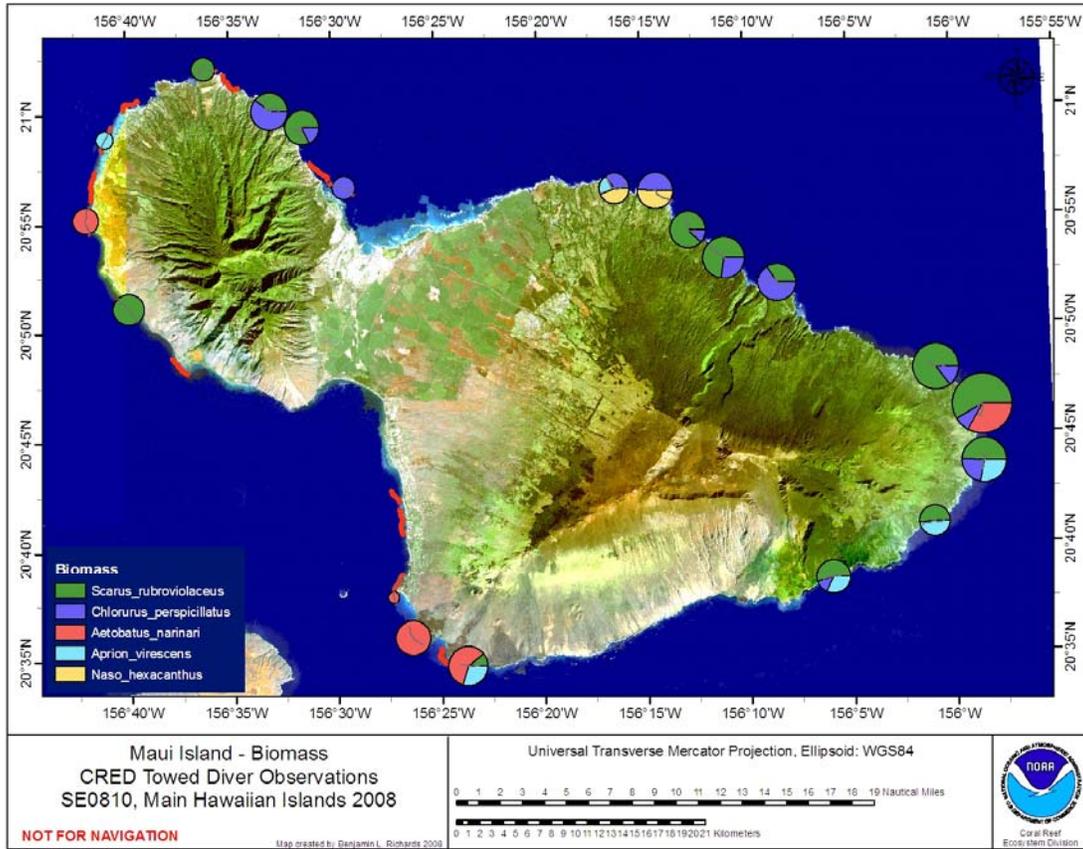


Figure F.4.2.3.--Geographic distribution of biomass around Maui. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.

Appendix G: Moloka`i

G.1. Oceanography and Water Quality

A total of 2 subsurface temperature recorders (STRs) were recovered and 2 deployed at Moloka`i. There were no new mooring deployments.

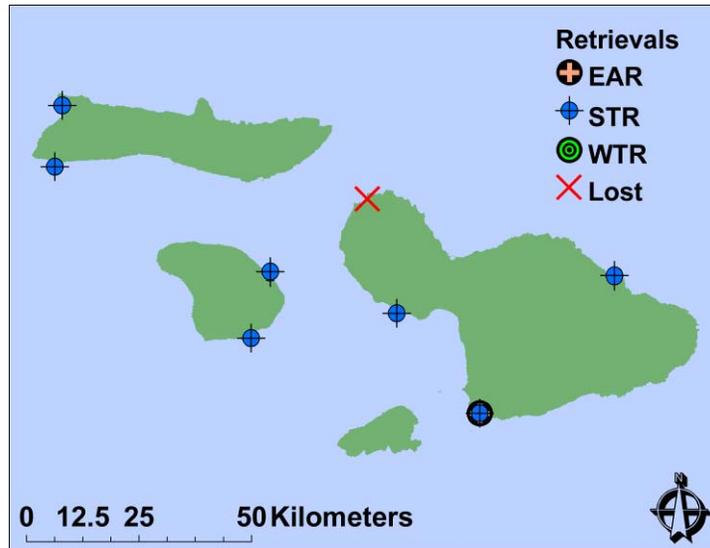


Figure G.1.1.--Retrieved moored oceanographic instrumentation map at Lāna`i, Maui, and Moloka`i.

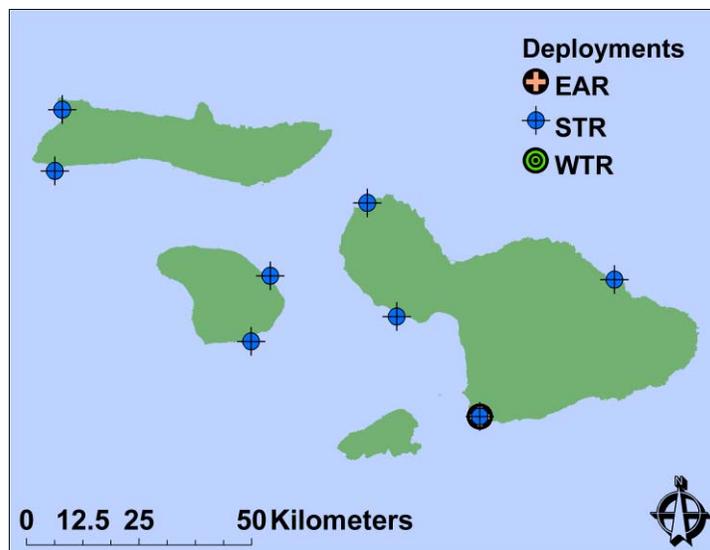


Figure G.1.2.-- Deployed moored oceanographic instrumentation map at Lāna`i, Maui, and Moloka`i.

Table G.1.1.--Moored oceanographic instrumentation table for Moloka`i.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
STR	Deployment	39510234390	21.203071	-157.25235	10/24/2008	10.36
STR	Retrieval	39331791193	21.203071	-157.25235	10/24/2008	10.36
STR	Deployment	39390381271	21.080915	-157.26698	10/25/2008	20.12
STR	Retrieval	39327181050	21.080915	-157.26698	10/25/2008	20.12

Water Quality

A total of 27 shallow-water conductivity, temperature and depth (CTD) casts were conducted at the 30-m isobath around Moloka`i using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. G.1.3.). A total of 5 “static,” nonprofiling mode, shallow-water, CTD casts were conducted in conjunction with the benthic seawater carbonate chemistry sampling. A total of 2 shallow-water CTD casts were taken for use with microbial water samples.

A total of 86 discrete water samples were collected concurrently with shallow-water CTD casts at 3 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m and will later be analyzed for nutrient, chlorophyll, and carbonate chemistry (dissolved inorganic carbon (DIC) and total alkalinity (A_T)) content (carbonate chemistry samples were only collected at the 1-m and 10-m bins). Nutrient, chlorophyll, and carbonate chemistry samples were processed and stored according to protocol and were sent out for analysis when the cruise returned. In addition to the standard water sampling that accompanies some of the shallow-water CTD sites, benthic seawater carbonate chemistry samples were collected at 1 site at Moloka`i. Each of the benthic sites yielded 4 carbonate chemistry water samples, 2 from the bottom, 1 from the mid depth of the water column and 1 from the just beneath the surface. All benthic carbonate chemistry data will be processed following the cruise. Eight of the discrete water samples were processed for microbial analysis.

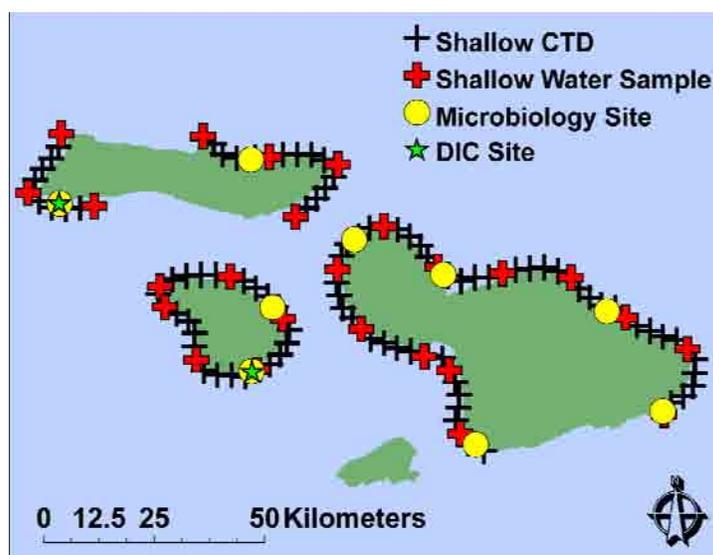


Figure G.1.3.--Shallow-water CTD and water sampling locations around Lāna`i, Maui, and Moloka`i.

G.2. Rapid Ecological Assessment (REA) Site Descriptions

Between October 21 and October 24, 2008, 16 REA surveys were conducted around forereefs of Moloka`i. Complete REA surveys (benthic and fish) were conducted at 6 stations established in 2005 and 2006. Ten additional new sites were haphazardly selected and surveyed by fish scientists only. Site locations are plotted in Figure G.2.1, and physical and biological characteristics for each site are described below.

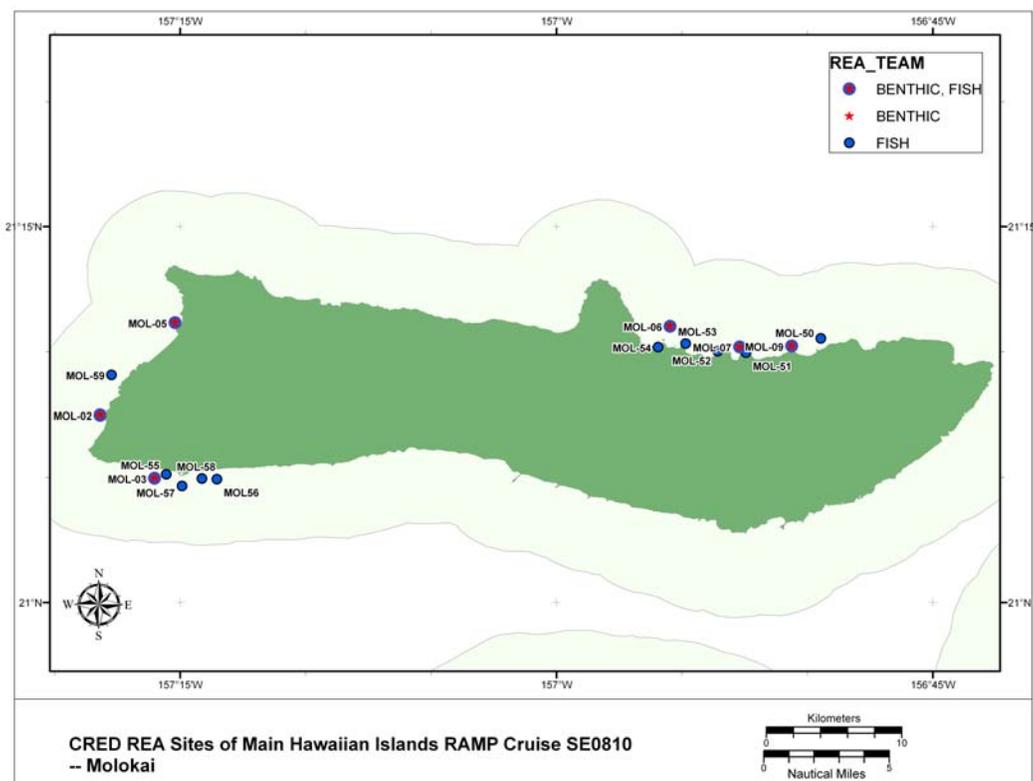


Figure G.2.1.--Locations of 2008 REA sites on Moloka`i.

REA Site Descriptions

MOL-02

10/24/2008

N 21° 07.483'

W 157° 18.191'

Forereef

Depth: 11.3–12.5 m



Survey Notes: Original global positioning system (GPS) point was updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement with encrusting coral colonies.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (41.6%) and macroalgae (33.2%). Overall coral cover was moderately low (18.4%).

Coral: Coral cover was dominated by colonies of *Porites lobata* (56.5%) and *Pocillopora meandrina* (30.4%). A total of 4 scleractinian coral genera were represented within belt transects. Few colonies (1.2%) exhibited compromised health states such as fungal and algal interactions, predation and *Porites* trematodiasis.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, cyanobacteria, *Gibsmithia hawaiiensis*, *Dictyota ceylanica*, *Asparagopsis taxiformis*, *Halimeda discoidea*, and *Haloplegma duperreyi*. Additional algae documented by the Roving Diver survey include *Dictyosphaeria cavernosa* and species of *Neomeris* and *Martensia*.

Fish: Midsized fishes were notably absent from the survey area. The majority of fishes surveyed were small (< 10 m) and consisted mostly of wrasses, damsels, and recruits of larger species. A good compliment of larger Acanthurids was present on one transect. Overall species diversity was moderate.

MOL-03

10/24/2008

N 21° 04.966'

W 157° 16.016'

Forereef

Depth: 12.2–13.4 m



Survey Notes: Original GPS point was updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef with moderate substrate complexity.

Benthic Cover: Benthos was dominated by coral (61.2%) and turf algae colonized on dead coral and rubble (24.0%). Overall macroalgae cover was relatively low (8.0%).

Coral: Large colonies of *Montipora patula* (41.5%), *Porites compressa* (19.4%), and *P. lobata* (14.4%) dominated this forereef site. A total of 4 scleractinian genera were represented within the belt transect. Percentage of compromised coral health states was 6.4%, and cases of hyperpigmentation, algal interactions, skeletal growth anomalies, discolorations other than bleaching and coral bleaching were observed.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Halimeda opuntia*, and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include *Halimeda distorta*, a species of *Neomeris*, *Lobophora variegata*, and *Asparagopsis taxiformis*.

Fish: Overall fish diversity was moderate. Of particular note was the presence of one 60-cm *Aprion virescens* on the transect.

MOL-05

10/24/2008

N 21° 11.162'

W 157° 15.202'

Forereef

Depth: 10.1–11.0m



Survey Notes: Original GPS point was updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement with encrusting coral colonies and cropped/scoured macroalgae.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (64.0%) and small macroalgae individuals (23.2%) that have been either scoured by wave action or grazed by herbivores. Overall coral cover was low (5.6%).

Coral: Colonies of *Porites lobata* (81.1%) were the most common species seen at this forereef site. Small colonies of *Pavona duerdeni* (5.6%), *Pocillopora meandrina* (4.7%), and *Montipora patula* (4.7%) were also observed. Few cases of compromised coral health states were documented. Algal (2.5%) and fungal (0.6%) infections were observed, as well as discolorations other than bleaching (0.9%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Halimeda discoidea*, *Microdictyon setchellianum*, *Dictyosphaeria cavernosa*, *D. versluysii*, *Stypopodium flabelliforme*, *Haloplegma duperreyi*, and *Codium edule*. Additional algae documented by the Roving Diver survey include *Bryopsis pennata*, nongeniculate crustose coralline algae, cyanobacteria, a species of *Neomeris*, and *Dictyota ceylanica*.

Fish: Overall fish diversity was very low at this site. Fishes recorded along the transect consisted almost entirely of individuals of the species *Oxycheilinus bimaculatus* (wrasse). A scattering of other species, the majority of which were < 10 cm included small damsels, wrasses and goatfish. Two larger (> 20 cm) triggerfish were recorded.

MOL-06

10/21/2008

N 21° 11.019'

W 156° 55.470'

Pinnacle Wall

Depth: 13.1–13.7 m



Survey Notes: Original GPS point was updated to reflect position of dive buoy marking transect lines.

Habitat: Pinnacle Wall

Benthic Cover: Benthos was dominated by turf algae colonized on dead coral and pavement (52.0%) and crustose coralline red algae (22.8%) with scattered colonies of *Porites lobata* and *Pocillopora meandrina*. Overall coral cover was relatively low (12.8%).

Coral: Coral cover was predominantly composed of *Pocillopora meandrina* (58.6%) and *Porites lobata* (26.2%). A total of 10 genera (9 scleractinian and 1 anthozoan) were represented within belt transects including *Psammocora*, *Montipora*, *Leptastrea*, and *Cyphastrea*. Fungal and algal infections, 1.0 and 0.8% respectively, were observed as types of compromised coral health states.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata* and *Dictyota ceylanica*. Additional algae documented by the Roving Diver survey include a species of *Peyssonnelia*.

Fish: Fish diversity was poor at this site. Few large fishes were observed, except a few *Seriola dumerili* and a *Caranx ignobilis*. Notable sightings include a pair of *Xantichthys auromarginatus*.

MOL-07

10/21/2008

N 21° 10.193'

W 156° 52.701'

Forereef

Depth: 12.2–13.4 m



Survey Notes: Original GPS point was updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by turf algae colonized on dead coral and pavement (65.6%) and crustose coralline red algae (14.4%) with scattered colonies of *Porites lobata* and *Pocillopora meandrina*. Overall coral cover was relatively low (13.6%).

Coral: Relatively low coral cover mostly consisted of *Porites lobata* (39.6%) and *Pocillopora meandrina* (35.6%). A total of 10 genera (9 scleractinian and 1 anthozoan) were represented within belt transects. Cases of compromised coral health states included bleaching (2.2%), algal interactions (1.1%), and predation (0.6%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Padina* sp., *Dictyota ceylanica*, and nongeniculate coralline red algae. Additional algae documented by the Roving Diver survey include *Halimeda distorta*, *H. discoidea*, and *Peyssonnelia* sp.

Fish: Fish diversity was high. Many large fishes were observed, including *Caranx melampygus* and *Seriola dumerili*. Notable sightings include *Priacanthus meeki* and *Abudefduf vaigiensis*.

MOL-08

10/21/2008

N 21° 10.228'
W 156° 50.624'

Forereef

Depth: 13.7–14.6 m



Survey Notes:

New site created in 2008. Site was located on the wall of an emergent pinnacle.

Habitat: Forereef

Benthic Cover: Benthos was dominated by turf algal assemblage comprised mostly of *Dictyota* sp. and colonized on dead coral and pavement (46.8%). There were scattered colonies of *Porites lobata*. Overall coral cover was relatively low (24.4%).

Coral: Coral cover was comprised of 4 genera (3 scleractinian and 1 anthozoan). The most common species observed were *Porites lobata* (60.8%), *Pocillopora molokensis* (14.3%) and *P. meandrina* (14.0%). Bleaching was observed on 9 colonies (6.9%) while other examples of compromised health states, such as discolorations other than bleaching (2.3%) and tube worm infestations (1.5%), were also observed.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Lobophora variegata*, *Dictyota ceylanica*, nongeniculated coralline red algae, and *Dictyota friabilis*. Additional algae documented by the Roving Diver survey include *Halimeda discoidea* and a species of *Neomeris*.

Fish: Fish diversity was high. Many large fishes were observed, including many *Lutjanus kasmira*, *Sufflamen fraenatum*, and *Scarus rubroviolaceus*. Notable sightings include *Parupeneus pleurostigma*.

Independent Fish Sites

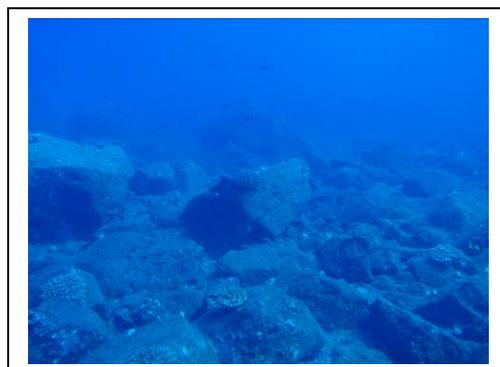
MOL-50

10/21/2008

W 156° 49.459
N 21° 10.535

Forereef

Depth: 22-23 m



General site description

This site is located on the north shore of Moloka`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. Habitat consisted of medium-sized and small

boulders on a sandy substrate. Coral cover was low. Upon reaching the site, 2 grey snappers (*Aprion virescens*) immediately came to investigate. Biomass was relatively high with *Montaxis grandoculis* in the area as well as several large parrotfish including a terminal *Scarus rubroviolaceus* on the transect. Large surgeons were also prevalent including *Acanthurus dussumieri* and *Naso unicornis*, both of which were represented on transect. Of note were several flagtail tilefish (*Malacanthus brevirostris*).

MOL-51

10/21/2008

W 156° 52.442

N 21° 09.960

Forereef

Depth: 5-5 m



General site description

This site is located on the north shore of Moloka`i in a small cove with very steep walls east of Kalaupapa peninsula. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. Habitat was highly complex consisting of rocky, eroded reef. Coral cover was sparse. A large school of medium-size herbivores dominated the area consisting of *Kyphosus* sp., *Acanthurus leucopareius*, and *A. triostegus* in that order. A small *Caranx melanpygus* was observed off transect. Apart from larger manybar goatfish (*Parupeneus multifasciatus*), the rest of the fish population consisted of juveniles and small site-attached species.

MOL-52

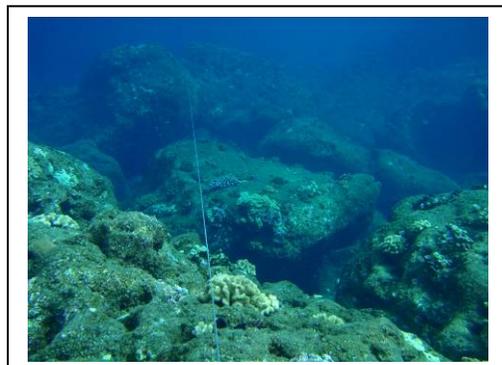
10/21/2008

W 156° 53.569

N 21° 10.022

Forereef

Depth: 4-4 m



General site description

This site is located on the north shore of Moloka`i a few miles east of Kalaupapa peninsula. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. Habitat consisted of very large boulders on pavement. Coral cover was very sparse. Fish diversity was moderate. There was a number of Kyphosids and *Acanthurus guttatus* in the shallows. A Hawaiian turkeyfish (*Pterois sphex*) was recorded on transect.

MOL-53

10/21/2008
W 156° 54.847
N 21° 10.327
Forereef
Depth: 24-24 m

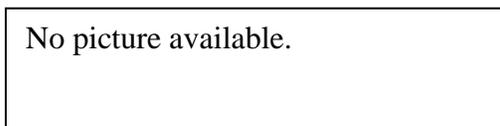


General site description

This site is located on the north shore of Moloka`i just east of Kalaupapa peninsula. It was established by the REA fish team as a new sampling location in the deep forereef stratum. Habitat complexity was moderate to high consisting of very large, medium, and small boulders scattered on rocky substrate with ridge and valley features. Coral cover was very low at this site. Fish biomass however was high. A blue trevally *Caranx melanpygus* was recorded on transect. There was a significant number of large surgeonfish including *Acanthurus olivaceus*, *A. dussumieri* and *A. unicornis*. A large pair (terminal and initial phase) of spectacled parrotfish (*Chlorurus perspicillatus*) were present of which the terminal male was recorded. Of note was a bandit angel (*Apolemichthys arcuatus*) on transect as well as a pair of large spotted knifejaws (*Oplegnathus punctatus*).

MOL-54

10/21/2008
W 156° 55.946
N 21° 10.185
Forereef
Depth: 3-3 m



General site description

This site was located on the north shore of Moloka`i, just east of the Kalaupapa peninsula. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was mostly composed of small boulders. Coral cover was very low and complexity was moderate. Fish diversity was relatively low.

MOL-55

10/24/2008

W 157° 15.547

N 21° 05.125

Forereef

Depth: 4-5 m



General site description

This site is located on the southwest shore of Moloka`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site had medium complexity and patchy coral cover. Fish diversity was fairly low and dominated by small, site-attached species. The largest fish in evidence were reef triggerfish *Rhinecanthus rectangulus*. The most common species at this site was *Thalassoma duperrey*.

MOL-56

10/24/2008

W 157° 13.531

N 21° 04.931

Forereef

Depth: 4-5 m



General site description

This site is located on the southwest shore of Moloka`i. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site had medium to high complexity with coral/rock outcroppings and numerous sand channels. Coral cover was moderate and native macroalgae was common. Fish diversity was high and large herbivores were common, though no large predators were observed. There were a few medium-size groupers *Cephalopholis argus* and 1 or 2 blacktail snappers *Lutjanus fulvus*.

MOL-57

10/24/2008

W 157° 14.923

N 21° 04.658

Forereef

Depth: 19-20 m



General site description

This site is located on the southwest shore of Moloka`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site was located on an area of high coral cover surrounded by sand and *Halimeda* sp. beds. Essentially a deepwater patch reef. Fish diversity was moderate and large predators were common. Several large grey snappers (*Aprion virescens*) were observed along with a group of 5 large island jacks (*Carangoides orthogrammus*).

MOL-58

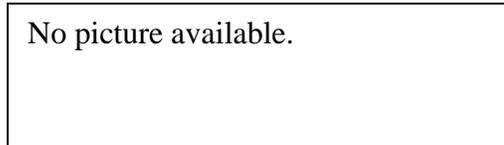
10/24/2008

W 157° 14.126

N 21° 04.958

Forereef

Depth: 3-3 m



General site description

This site is located on the south shore of Moloka`i, east of La`au point. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The structure of this site consisted of tongue-and-groove formations with low-medium coral cover. This resulted in a site with medium complexity. Due to the shallow depth at the site, conditions were surgy. Small wrasses were very abundant at this site, as were small damsels. Low numbers of large fishes were recorded.

MOL-59

10/24/2008

W 157° 17.730

N 21° 09.075

Forereef

Depth: 22-23 m



General site description

This site is located on the west shore of Moloka`i. It was established by the REA fish team as a new sampling location in the deep forereef stratum. This site was located on a compacted sediment bottom covered in *Halimeda* sp. There was, however, scattered coral heads, mostly *Pocillapora meandrina*. Transect A bisected the largest feature in the area which was a large *Porites evermanni* head. Fish abundance was highly concentrated around this feature, and diversity was locally high. Two large *Acanthurus dussumieri* were taking cover there as well as scores of smaller fish. Notable among these was several Bicolor anthias (*Pseudanthias bicolor*). There were also about 5 large grey snappers (*Aprion virescens*) which seemed to be attracted to the divers and were recorded on the transects.

G.3. Benthic Environment

G.3.1 Algae

Benthic communities around Moloka`i were dominated by turf, macro, and coralline red algal functional groups (Table A). Turf algae were documented with the highest percent cover at 5 of the 6 sites surveyed with a percent cover range of 24% to 65.6%. (Table A). Coral percent cover exceeded that of other functional groups at site MOL-03 with a percent cover of 61.2% but was only a minor component of the benthic community at all other sites (percent cover range = 2.4% to 18.4%; Table A). Macroalgae were prominent components of the benthic communities surrounding Moloka`i, comprising 4.4% to 40.4% of the benthos (Table G.3.1.1). A combined total of 21 species of macroalgae were observed (9 chlorophytes, 7 ochrophytes, 5 rhodophytes) from the 6 sites surveyed (Tables G.3.1.2, G.3.1.3). *Lobophora variegata* dominated the macroalgal community at 2 of the 6 sites with a percent cover range of 1.6% to 12.8% (Table C). *Dictyota ceylanica* was found at 4 of the 6 sites with a percent cover range of 0.4% to 8.8% at those sites (Table G.3.1.3).

Table G.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at Moloka`i.

Site	Macroalgae	Turf Algae	Coralline Red Algae (crustose + upright)	Cyanobacteria	Coral
MOL-08	40.4%	46.8%	9.6%	-	2.4%
MOL-02	33.2%	41.6%	6.0%	0.4%	18.4%
MOL-03	8.0%	24.0%	4.8%	0.8%	61.2%
MOL-05	23.2%	64.0%	6.8%	-	5.6%
MOL-06	4.4%	52.0%	22.8%	-	12.8%
MOL-07	4.8%	65.6%	14.4%	-	13.6%

Table G.3.1.2.--Additional species recorded at each site at Moloka`i during roving diver survey.

Site	Chlorophyta
MOL-05	<i>Bryopsis pennata</i>
MOL-02	Dictyosphaeria cavernosa
MOL-07 MOL-08	<i>Halimeda discoidea</i>
MOL-03 MOL-07	<i>Halimeda distorta</i>
MOL-02 MOL-03 MOL-05 MOL-08	<i>Neomeris sp.</i>
	Ochrophyta
MOL-05	Dictyota ceylanica
MOL-03	Lobophora variegata
	Rhodophyta
MOL-03	Asparagopsis taxiformis
MOL-05	<i>Haloplegma duperreyi</i>
MOL-02	<i>Martensia sp.</i>
MOL-06 MOL-07	<i>Peyssonnelia sp.</i>

Table G.3.2.3.--Percent cover of macroalgal species at long-term monitoring sites at Moloka`i. Sum totals for each row equal the percent cover of macroalgae recorded in Table G.3.1.1.

Site	<i>Codium edule</i>	<i>Dictyosphaeria cavernosa</i>	<i>Dictyosphaeria versluysii</i>	<i>Halimeda discoidea</i>	<i>Halimeda opuntia</i>	<i>Microdictyon setchellianum</i>	<i>Dictyota ceylanica</i>	<i>Dictyota friabilis</i>	<i>Dictyota</i> sp	<i>Distromium flabellatum</i>	<i>Lobophora variegata</i>	<i>Padina</i> sp	<i>Styopodium flabelliforme</i>	<i>Asparagopsis taxiformis</i>	<i>Haloplegma duperreyi</i>	<i>Portieria hornemannii</i>
MOL-02	-	-	-	12.0%	-	-	0.4%	-	-	-	3.2%	-	-	9.2%	4.0%	-
MOL-03	-	-	-	-	0.8%	-	-	-	-	-	-	-	-	-	-	7.2%
MOL-05	0.8%	4.0%	0.8%	1.6%	-	1.2%	-	-	-	-	12.8%	-	1.6%	-	0.4%	-
MOL-06	-	-	-	-	-	-	1.2%	-	-	-	2.0%	-	-	-	-	-
MOL-07	-	-	-	-	-	-	0.4%	-	-	-	1.6%	2.4%	-	-	-	-
MOL-09	-	-	-	-	-	-	8.8%	0.4%	22.0%	2.0%	4.0%	-	-	-	-	-

G.3.2. Corals

G.3.2.1 Coral Populations

Line-point intercept surveys indicate moderate coral cover ($21.5 \pm 8.8\%$) at REA sites around Moloka'i in 2008 (Fig. G.3.2.1.1, left). Diverse benthic habitat types were found around the island, including pavement, forereef, boulders, and pinnacle walls. Species richness varied at REA sites with 12 genera (11 scleractinian and 1 zoanthid) being represented within belt transect surveys. Coral composition at Moloka'i was dominated by encrusting colonies of *Porites* (43.5%) and *Montipora* (33.7%) while branching colonies of *Pocillopora* (19.1%) were also found (Fig. G.3.2.1.1, right). The most common scleractinian species observed in 2008 included *Porites lobata* (42.0%), *Pocillopora meandrina* (18.1%) and *Montipora patula* (12.8%; Table G.3.2.1.1).

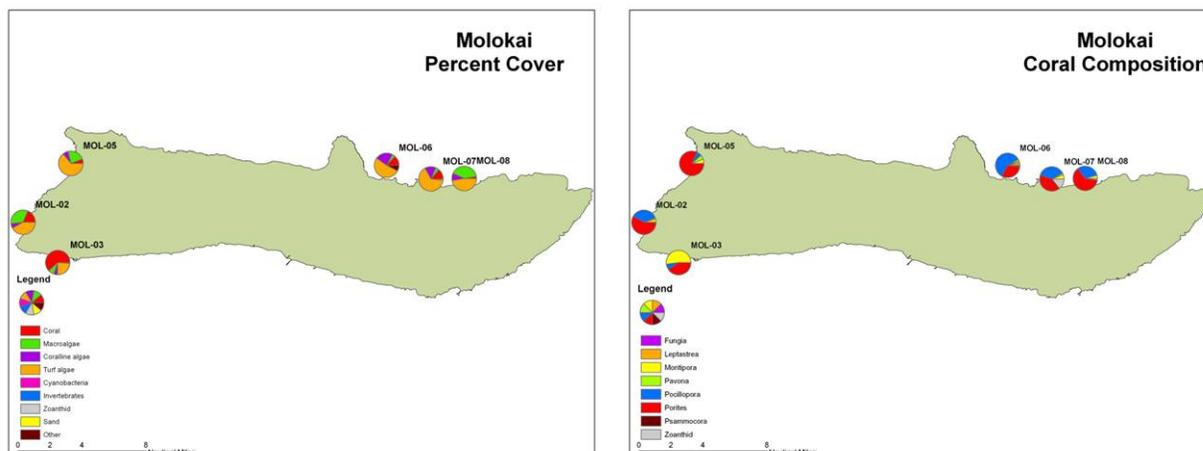


Figure G.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around Moloka'i in 2008.

Table G.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around Moloka'i in 2008.

Taxon Name	No. of Colonies	Relative Abundance
<i>Cyphastrea ocellina</i>	2	0.09
<i>Cyphastrea</i> sp.	9	0.43
<i>Fungia scutaria</i>	2	0.09
<i>Gardinoseris planulata</i>	3	0.14
<i>Leptoseris incrustans</i>	2	0.09
<i>Leptastrea purpurea</i>	11	0.52
<i>Leptastrea transversa</i>	1	0.05
<i>Montipora capitata</i>	199	9.42
<i>Montipora</i> sp.	1	0.05
<i>Montipora patula</i>	271	12.83
<i>Palythoa</i> sp.	48	2.27
<i>Porites compressa</i>	40	1.89
<i>Pocillopora damicornis</i>	1	0.05
<i>Pavona duerdeni</i>	15	0.71
<i>Porites evermanni</i>	45	2.13

Taxon Name	No. of Colonies	Relative Abundance
<i>Psammocora haimeana</i>	5	0.24
<i>Pocillopora ligulata</i>	2	0.09
<i>Porites lobata</i>	887	41.98
<i>Pocillopora meandrina</i>	382	18.08
<i>Pocillopora molokensis</i>	7	0.33
<i>Pocillopora</i> sp.	127	6.01
<i>Porites</i> sp.	23	1.09
<i>Porites solida</i>	11	0.52
<i>Psammocora stellata</i>	10	0.47
<i>Pavona varians</i>	8	0.38
<i>Tubastrea</i> sp.	1	0.05

G.3.2.2 Coral Health

During 2008 REA surveys, occurrence of compromised coral health states was relatively low (4.7%). Evidence of compromised coral health states was observed mainly on *Porites* (49.4%), *Psammocora* (20.0%), and *Pavona* (18.8%) colonies (Fig. G.3.2.2.1). Algal interactions (59.3%) were observed as the most common type of compromised health conditions and were most prevalent on *Porites* (20.2%), *Psammocora* (20.0%), and *Pavona* (18.8%) colonies. Additionally, fungal infections were observed only on colonies of *Porites* (10.2%) and “other” forms of compromised health states were dominant on *Pocillopora* heads (14.5%). Occurrence of coral bleaching was relatively low (8.2%) and mainly affected *Montipora* colonies (6.6%).

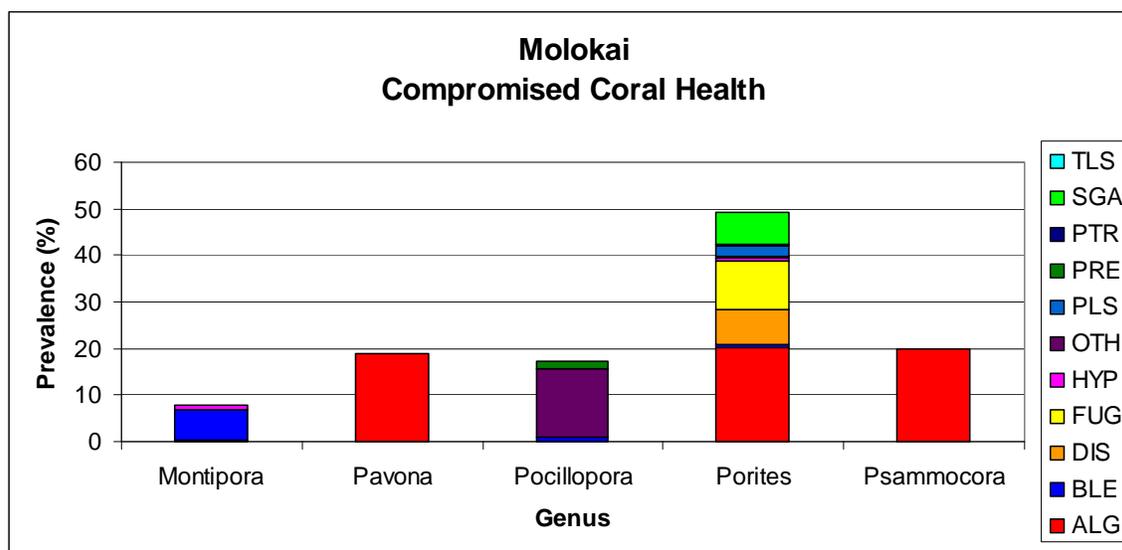


Figure G.3.2.2.1.--Prevalence of compromised coral health states by taxon around Molokai in 2008.

Percent mortality of colonies surveyed during 2008 varied between genera (Fig. G.3.2.2.2). Members of the genus *Pavona* were found to have 22.8% dead tissue present on colonies along the belt transect. *Leptastrea* and *Porites* colonies had 8.1 and 3.8% partial mortality, respectively. Dead tissue was also observed on colonies of *Pocillopora* (1.5%) and *Montipora* (0.6%). All colonies of *Psammocora*, *Leptoseris*, *Cyphastrea* and *Fungia* appeared to have 100% live tissue.

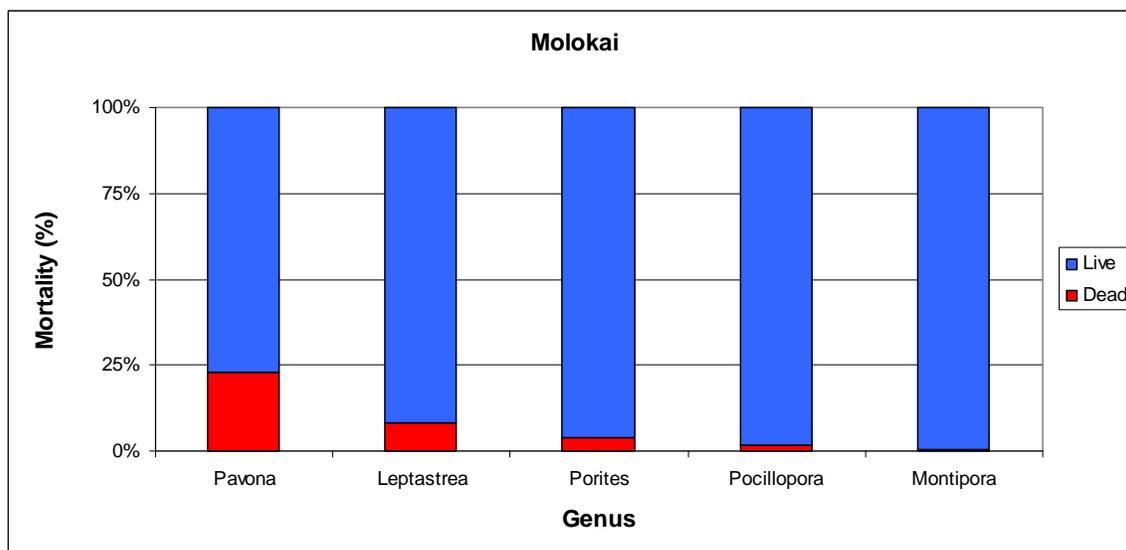


Figure G.3.2.2.2.--Mean percent of live versus dead tissue for various coral genera at Molokai in 2008.

G.3.3. Noncoral Invertebrate Surveys

A total of 518 individuals of benthic invertebrate target species or taxa group were enumerated from 12 belt transects at 6 sites. The most abundant macroinvertebrate surveyed was the cryptic trapezoid crab, with densities of 0.96, 0.84, 0.54/m² at sites MOL-03, MOL-02, and MOL-07, respectively. The rock-boring urchin, *Echinometra mathaei*, was the second most abundant organism surveyed on Molokai, with a high density of 0.55/m² at site MOL-05. However, *E. mathaei* was not found in consistently high numbers between sites, as they were only present at 2 of the 6 sites surveyed. Mean density across all sites was only 0.06/m². A second rock-boring urchin, *Echinostrephus aciculatus*, was found to be the third most abundant macroinvertebrate overall, with sites MOL-02, MOL-06, and MOL-05 yielding the highest counts (0.22, 0.07, and 0.06/m² respectively). *Calcinus* hermit crabs were particularly abundant here and present at every site. Of note was the sighting of one pearl oyster, *Pinctada margaritifera*, at site MOL-05.

G.3.3.1 Urchin Measurements

Figure G.3.3.1.1 reveals the average test diameter of urchins from the genera *Echinometra*, *Echinostrephus*, *Echinothrix*, and *Tripneustes* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented.

Mean Urchin Test Diameter by Site

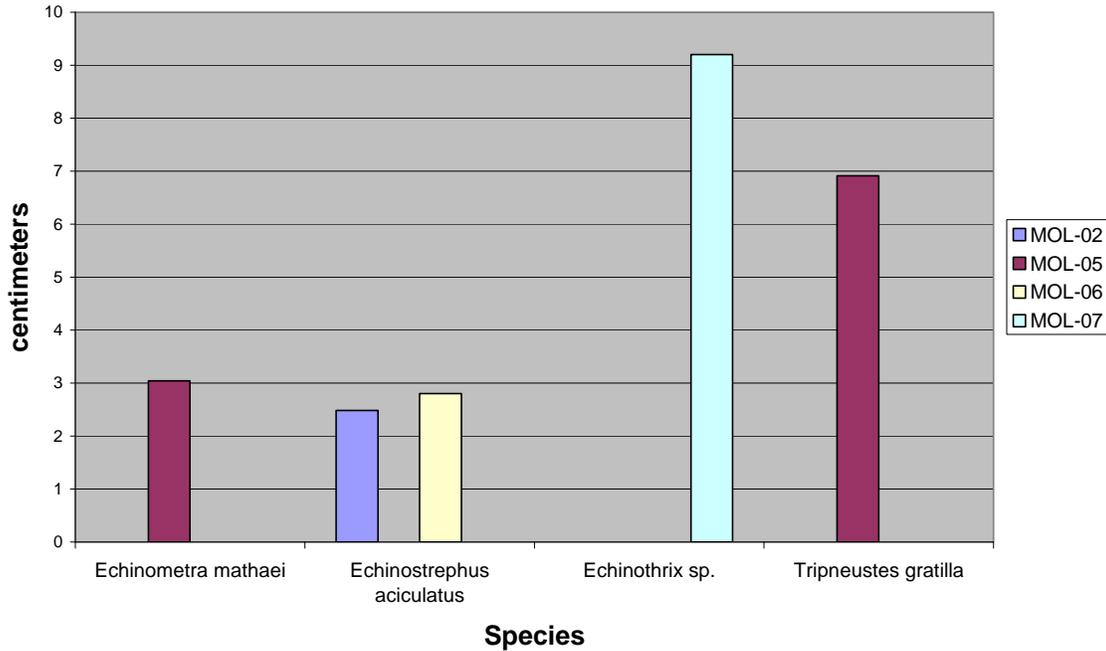


Figure G.3.3.1.1.--Mean test size of urchins by site.

G.3.3.2 . Autonomous Reef Monitoring Systems (ARMS) Deployment

No ARMS were deployed on the island of Moloka'i.

G.3.4 Towed-diver Benthic Surveys

A total of 12 towed-diver surveys were conducted off the coast of Molakai in 2008. Surveys were focused around the north to northeast region (6 tows) and the west region (6 tows, Fig. G.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.

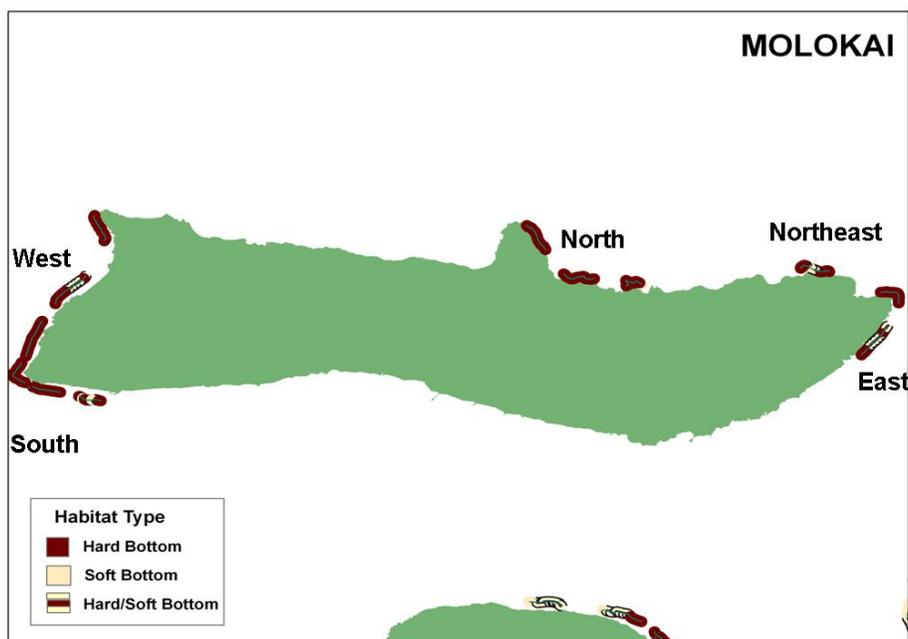


Figure G.3.4.1.--Locations of 12 towed-diver surveys around Moloka`i in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Habitat types varied considerably both within tows and between regions. Habitat from most tows off the north and northeast regions of Moloka`i were dominated by rock boulders. Forereef habitat around the east region was made up mostly of low relief pavement interspersed with sand flats. The west region of Moloka`i was dominated by pavement. Due to limited area coverage with regards to the island as a whole, island averages are not presented. Instead, means (percent cover) and total (invertebrate counts) values are presented for each region. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in Table G.3.4.1, and Figure G.3.4.2.

Table G.3.4.1.--Mean percent cover and macroinvertebrate totals by tow region.

Region	Hard Coral	Stress Coral	Macroalgae	Coralline Algae	COTs	Free Urchins	Boring Urchins	Sea Cucumbers
East	2	1	17	0	3	0	122	8
North	8	8	1	13	36	6	6	26
Northeast	8	4	1	6	9	20	31	18
South	10	6	19	2	0	0	38	1
West	6	4	23	2	0	423	385	22

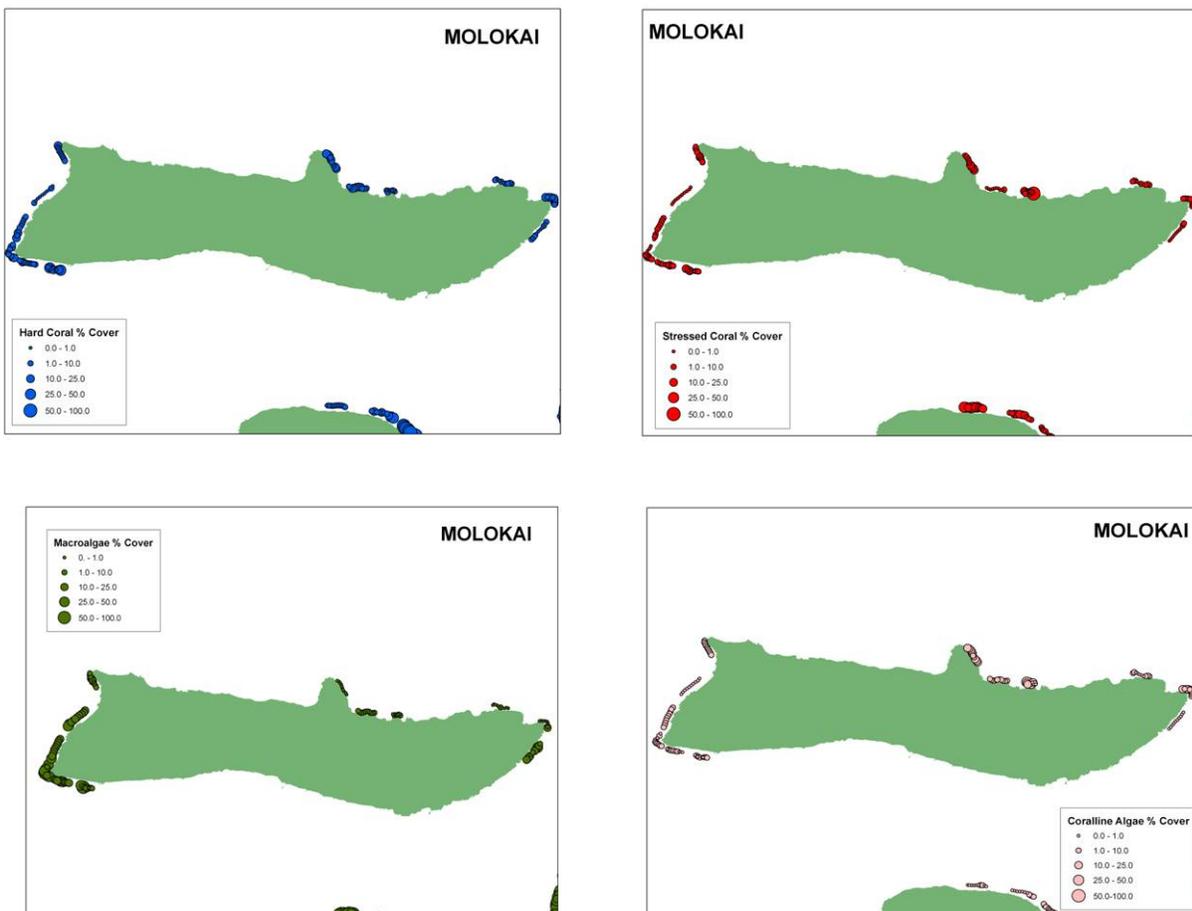


Figure G.3.4.2.--Distribution of coral cover, stressed coral, macroalgae, and coralline algae around Moloka`i in 2008.

G.4 Fish

G.4.1 REA Fish Surveys

Belt transect data

During the survey period, belt transect surveys were conducted at 16 sites around Moloka`i. Surgeonfish were the largest contributor to total biomass with 1.27 kg 100 m⁻². Snappers were the second largest contributor to total biomass with 0.92 kg 100 m⁻², followed by parrotfish at 0.49 kg 100 m⁻² (Table G.4.1.1, Fig. G.4.1.1).

Overall Observations

A total of 132 fish species were observed during the survey period by all divers. The average total fish biomass around Moloka`i during the survey period was 4.40 kg 100 m⁻² for the belt transect surveys (Table G.4.1.1).

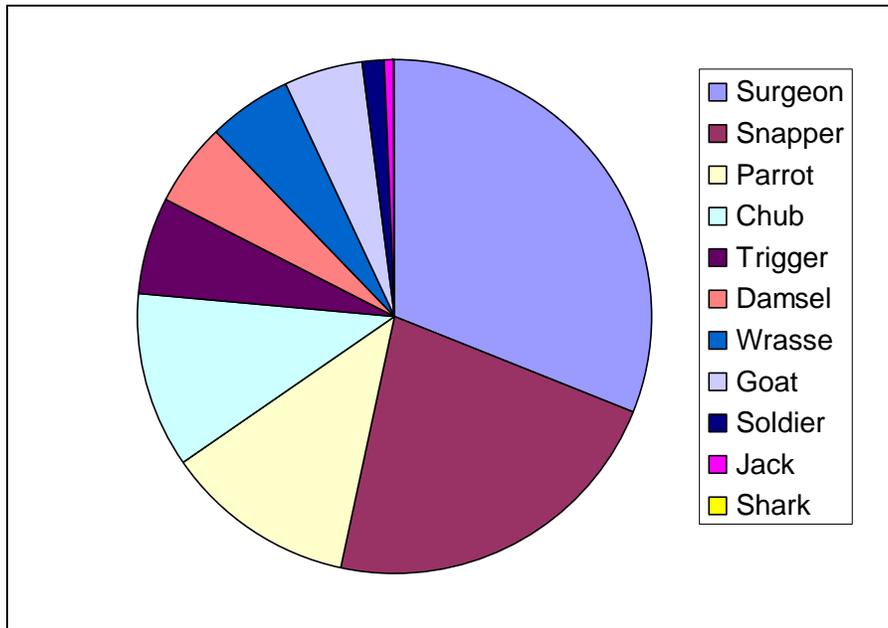


Figure G.4.1.1.--Total fish biomass composition by family.

Table G.4.1.1.--Coral reef fish biomass (kg 100^{m-2}) at sites around Moloka'i.

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	MOL-50	4.76	0.00	0.18	0.28	0.00	1.69	0.00	0.00	0.00	1.81	0.15	0.14
Deep	MOL-53	10.08	0.00	0.23	0.36	0.28	1.31	0.00	2.24	0.00	4.04	0.09	0.15
Deep	MOL-57	4.70	0.00	0.01	0.31	0.00	0.04	0.00	0.00	0.00	2.48	0.88	0.22
Deep	MOL-59	10.39	0.00	0.06	0.07	0.00	0.01	0.00	8.51	0.23	0.80	0.17	0.21
Mid	MOL-02	1.99	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.24	0.05
Mid	MOL-03	2.07	0.00	0.16	0.06	0.00	0.18	0.00	0.52	0.00	0.55	0.13	0.24
Mid	MOL-05	0.28	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.11	0.15
Mid	MOL-06	4.28	0.00	0.26	0.07	0.00	0.74	0.00	0.00	0.28	0.63	1.84	0.17
Mid	MOL-07	3.36	0.00	0.58	0.08	0.00	0.12	0.00	0.50	0.31	1.13	0.13	0.27
Mid	MOL-08	5.59	0.00	0.44	0.23	0.00	1.99	0.00	1.68	0.09	0.80	0.14	0.16
Shallow	MOL-51	9.17	4.91	0.48	1.03	0.00	0.66	0.00	0.29	0.00	1.30	0.00	0.24
Shallow	MOL-52	4.94	2.38	0.55	0.36	0.00	0.00	0.00	0.00	0.00	1.28	0.02	0.33
Shallow	MOL-54	1.74	0.10	0.14	0.14	0.00	0.00	0.00	0.90	0.00	0.15	0.00	0.30
Shallow	MOL-55	0.97	0.00	0.20	0.11	0.00	0.00	0.00	0.00	0.00	0.39	0.04	0.20
Shallow	MOL-56	5.00	0.00	0.08	0.06	0.00	0.95	0.00	0.11	0.08	3.05	0.00	0.32
Shallow	MOL-58	1.10	0.00	0.13	0.06	0.00	0.06	0.00	0.00	0.00	0.38	0.00	0.27
	Total	4.40	0.46	0.22	0.20	0.02	0.49	0.00	0.92	0.06	1.27	0.25	0.22

G.4.2 Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED towed-diver team completed 12 surveys at Moloka`i covering 30 km (30 ha) of ocean floor (Table G.3.4.2.1). Mean survey length was 2.5 km with a maximum length of 3.4 km and a minimum of 1.9 km. Mean survey depth was 14.8 m with a maximum depth of 16.2 m and a minimum of 13.1 m. Mean temperature on these surveys was 25.8 °C with a maximum temperature of 26.2 °C and a minimum of 25.3 °C.

Table G.3.4.2.1.--Survey statistics for towed-diver sampling during the SE-08-10 MHIRAMP cruise.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

One-hundred twenty individual large-bodied reef fish (> 50 cm in total length) of 14 different species and 8 different families were encountered at Moloka`i (Table G.3.4.2.2). Overall numeric density for this class of reef fishes was 0.040 #/100 m² (3.963 #/ha) with a biomass density of 0.175 kg/100 m² (0.017 t/ha). Numeric and biomass density were both dominated by *Scarus rubroviolaceus*.

The most prevalent families in terms of numeric density were Scarids (79%), Carangids (6%), and Acanthurids (5%) (Fig. G.3.4.2.1). Biomass was dominated by Scarids (50%), Sphyrnids (35%), and Carangids (5%). (Fig. G.3.4.2.2).

The 2008 surveys around Moloka`i were limited to the western and northeastern sides of the island. As such, not much can be said about the geographic distribution of biomass around the island. At this point, it appears that biomass was similar at these 2 locations apart from the observation of a single large hammerhead shark (*Sphyrna lewini*) at the northeastern tip of the island. Species composition also differed with *Chlorurus perspicillatus* being seen only in the northeastern portion of the island (Fig. G.3.4.2.3).

Table G.3.4.2.2.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed at Moloka`i during the SE-08-10 MHIRAMP cruise CRED towed-fiver surveys.

Species	#	#/100m2	#/ha	Biomass (kg)	kg/100m2	t/ha
Aetobatus_narinari	1	0.000	0.033	7.720244705	0.003	0.000
Aprion_virescens	4	0.001	0.132	15.55803373	0.005	0.001
Caranx_melampygyus	1	0.000	0.033	2.122234353	0.001	0.000
Chlorurus_perspicillatus	17	0.006	0.561	43.35	0.014	0.001
Fistularia_commersonii	2	0.001	0.066	0.150820568	0.000	0.000
Gymnothorax_flavimarginatu	1	0.000	0.033	3.692471616	0.001	0.000
Gymnothorax_javanicus	1	0.000	0.033	7.701927621	0.003	0.000
Gymnothorax_sp	1	0.000	0.033	2.100309727	0.001	0.000
Naso_hexacanthus	2	0.001	0.066	4.242310011	0.001	0.000
Naso_unicornis	4	0.001	0.132	10.26989505	0.003	0.000
Scarus_rubroviolaceus	79	0.026	2.609	219.754965	0.073	0.007
Scomberoides_lysan	2	0.001	0.066	2.007164818	0.001	0.000
Seriola_dumerili	4	0.001	0.132	24.86600206	0.008	0.001
Sphyrna_lewini	1	0.000	0.033	184.9166594	0.061	0.006
Grand Total	120	0.040	3.963	528.453	0.175	0.017
# of Species	14					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Molokai During 2008 CRED Towed-Diver Surveys

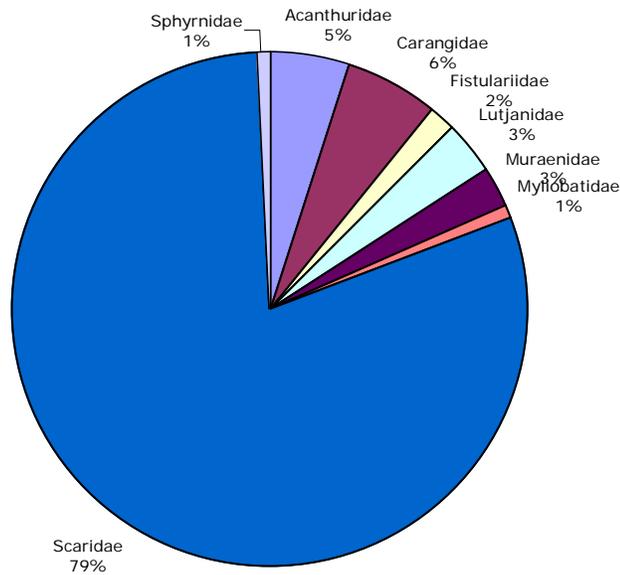


Figure G.3.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Molokai During 2008 CRED Towed-Diver Surveys

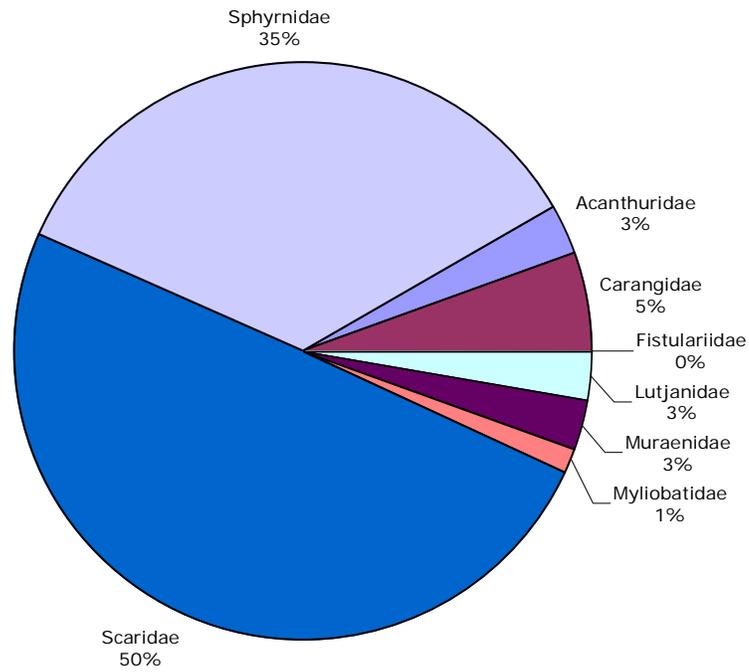


Figure G.3.4.2.2.--Biomass density by family.

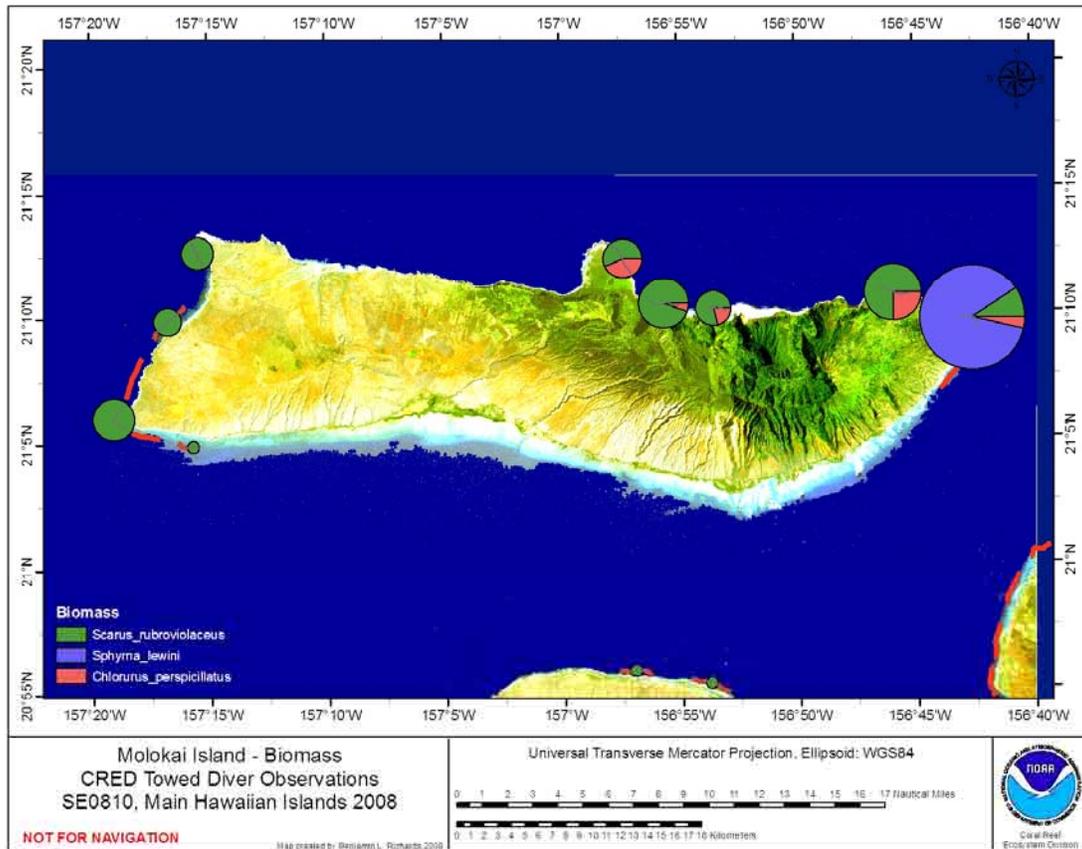


Figure G.3.4.2.3.--Geographic distribution of biomass around Moloka`i. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.

Appendix H: Ni`ihau

H.1. Oceanography and Water Quality

A total of 2 subsurface temperature recorders (STRs) were recovered and 2 were deployed at Ni`ihau/Lehua. One ecological acoustic recorder (EAR) mooring was retrieved and not replaced.

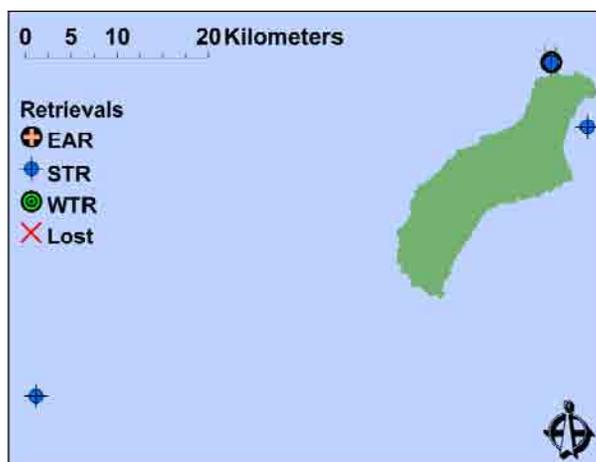


Figure H.1.1.--Retrieved moored oceanographic instrumentation map for Ni`ihau/Lehua and Five Fathom Pinnacle.

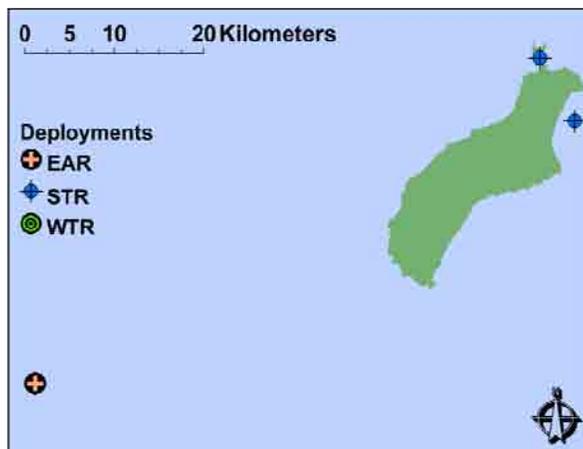


Figure H.1.2.--Retrieved moored oceanographic instrumentation map for Ni`ihau/Lehua and Five Fathom Pinnacle.

Table H.1.1.--Moored oceanographic instrumentation table for Ni`ihau/Lehua.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
STR	Deployment	39327181068	21.95128	-160.06177	11/09/2008	12.19
STR	Retrieval	39390381852	21.95128	-160.06177	11/09/2008	12.19
EAR	Retrieval	9300284-10	22.01460	-160.09698	11/08/2008	6.10
STR	Retrieval	39390381810	22.01460	-160.09698	11/08/2008	6.10
STR	Deployment	39292520905	22.01453	-160.09705	11/09/2008	6.40

Water Quality

A total of 20 shallow-water conductivity, temperature and depth (CTD) casts were conducted at the 30-m isobath around Ni`ihau using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. H.1.3.). A total of 4 additional “static”, nonprofiling mode, shallow-water, CTD casts were conducted in conjunction with the benthic seawater carbonate chemistry sampling. A total of 3 shallow-water CTD casts were taken for use with microbial water samples.

A total of 67 discrete water samples (including 1 duplicate) were collected concurrently with shallow-water CTD casts at 3 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m and will later be analyzed for nutrient, chlorophyll, and carbonate chemistry (dissolved inorganic carbon (DIC) and total alkalinity (A_T)) content (carbonate chemistry samples were only collected at the 1-m and 10-m bins). Nutrient, chlorophyll, and carbonate chemistry samples were processed and stored according to protocol and were sent out for analysis when the cruise returned. In addition to the standard water sampling that accompanies some of the shallow-water CTD sites, benthic seawater carbonate chemistry samples were collected at 1 site at Ni`ihau. The benthic sites yielded 4 carbonate chemistry water samples, 2 from the bottom, 1 from the mid depth of the water column, and 1 from the just beneath the surface. All benthic carbonate chemistry data will be processed following the cruise. Twelve of the discrete water samples were processed for microbial analysis.

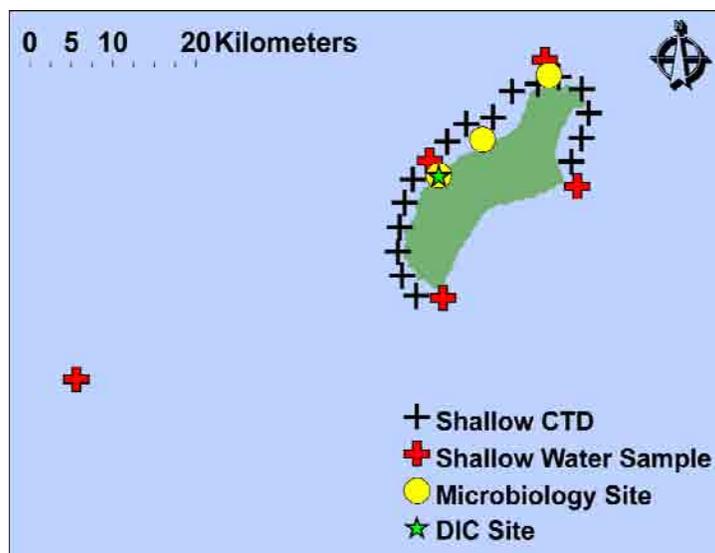


Figure H.1.3.--Shallow-water CTD and water sampling locations around Ni`ihau/Lehua and Five Fathom Pinnacle.

H.2 Rapid Ecological Assessment (REA) Site Descriptions

Between October 26 and November 2, 2008, 16 REA surveys were conducted around the forereefs of Ni`ihau. Complete REA surveys (benthic and fish) were at 5 stations established in 2005 and 2006, and 11 additional haphazardly selected sites were surveyed by fish scientists

only. Site locations are plotted in Figure H.2.1, and physical and biological characteristics for each site are described below.

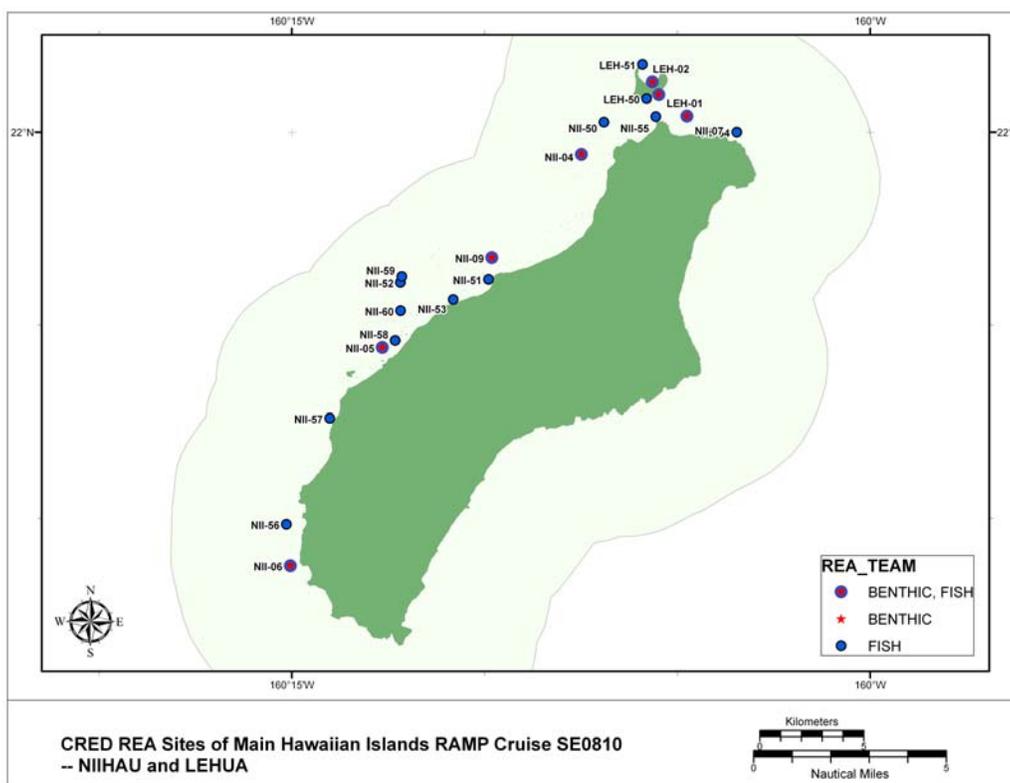


Figure H.2.1.--Locations of 2008 REA sites on Ni'ihau.

REA Site Descriptions

NII-04

11/08/2008

N 21° 59.423'
W 160° 07.490'

Pavement

Depth: 12.5–13.1 m



Survey Notes: Original global positioning system (GPS) point was located at ~ 11 m depth. The site was moved offshore to a more appropriate depth range and a new GPS point taken.

Habitat: Pavement

Benthic Cover: Benthos was dominated almost entirely by turf algae colonized on pavement (83.6%) with scattered colonies of *Montipora capitata*, *Psammocora stellata*, *Pocillopora meandrina*, and *Porites lobata* (2.8%). Macroalgal cover (2.8%) and crustose coralline red algal cover (7.2%) were low.

Coral: Very low coral cover was documented at this pavement site with colonies of *Pocillopora meandrina* (41.0%), and *Porites lobata* (29.4%) commonly occurring. A total of 6 genera (5 scleractinian and 1 anthozoan) were recorded within the belt transect. Occurrence of compromised coral health states was low with 2 cases of predation (1.2%) and 1 instance of algal interaction (0.6%) observed.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*.

Inverts: Invertebrate diversity was low at this site. However, the abundance of urchins was staggering. *Echinometra mathaei* was present in very high numbers, as was *Tripneustes gratilla*. *Echinostrephus* sp. were also recorded. The hard, bare pavement/rock substrate was unsuitable for autonomous reef monitoring systems (ARMS) installation, but provided great habitat for Echinoderms.

Fish: Reps A and B were made up of low fish biomass and Rep C had substantially higher biomass and diversity. Overall, fish diversity was high with abundant small and medium-sized fishes. Abundant small-sized fishes included *Chromis vanderbilti*, *Acanthurus nigrofuscus*, *Parupeneus multifasciatus*, *Ctenochaetus strigosus* and *Chromis ovalis*. Abundant medium-sized fishes included *Myripristis berndti*, *Acanthurus dussumieri*, schools of *Lutjanus kasmira* and *Acanthurus triostegus* and *Acanthurus olivaceus*. Noteworthy species included *Sphyræna barracuda*.

NII-05

11/10/2008

N 21° 54.415'

W 160° 12.653'

Boulders/Pavement

Depth: 10.7–14.0m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Boulders dominated the first transect. Pavement dominated the second transect.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (76.4%) with scattered coral colonies, including *Montipora capitata*, *M. Patula*, *Pocillopora meandrina*, and *Porites lobata* (7.2%). Overall, crustose coralline red algal cover was low (2.8%), as was macroalgal cover (5.6%).

Coral: Belt transects were not conducted in 2008.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Amansia glomerata*, *Acanthophora pacifica*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Martensia fragilis*, and *Haloplegma duperreyi*.

Inverts: Overall biodiversity of invertebrates was low at this site. *Echinostrephus aciculatus* was the dominant urchin on this flat substrate. One pearl oyster was present at this site. Large sand

patches were also present along this transect.

Fish: Fish species richness and diversity was moderate at this site, with fishes congregating in the more complex regions of the site. Common fishes included *Lutjanus kasmira*, *Thalassoma duperrey*, *Acanthurus nigrofuscus*, *A. olivaceus*, *Ctenochaetus strigosus*, *Chromis ovalis*, and *Parupeneus multifasciatus*. Other medium-sized fishes on the transect were *Naso unicornis*, *Bodianus bilunulatus*, *Parupeneus cyclostomus*, and *P. pleurostigma*. Less common fishes in the area noted off the transect were *Mulloidichthys flavolineatus* and *Chlorurus perspicillatus*.

NII-06

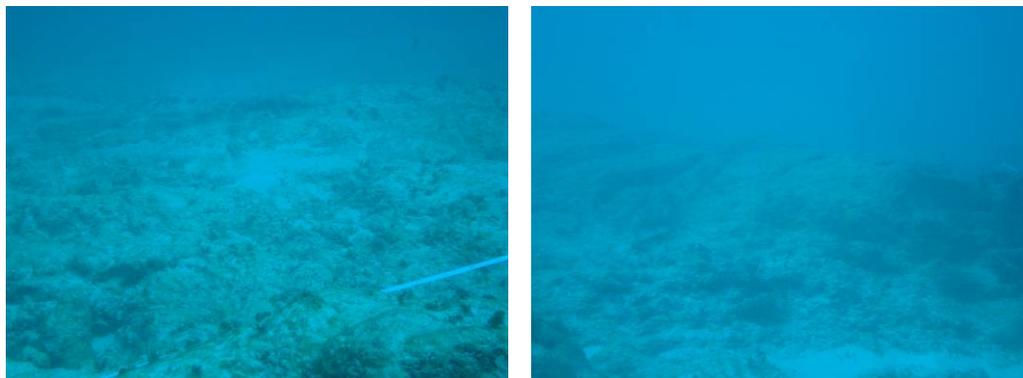
11/10/2008

N 21° 48.771'

W 160° 15.035'

Pavement

Depth: 16.2–17.7 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement with ~ 15 cm of sand in some locations and scattered boulders.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (68.0%) with scattered coral colonies (0.8%), including *Pocillopora meandrina* and individuals of *Halimeda discoidea*. Overall, crustose coralline red algal cover was low (0.8%), as was macroalgal cover (8.0%). Sand comprised 21.6% of the substrate.

Coral: Belt transects were not conducted in 2008.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Halimeda discoidea*, species of *Padina*, *Dictyota*, and *Sargassum*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*.

Inverts: Overall biodiversity of invertebrates was low at this site. *Echinostrephus aciculatus* was the dominant urchin along this transect. One *Holothuria whitmaei* was recorded as well as a small octopus.

Fish: The first 2 transects spanned relatively flat terrain with intermittent complexity, while the third traversed a higher complexity boulder habitat. Likewise, the fish abundance and diversity reflected this difference. The most common fish species were *Sufflamen bursa* and *Parupeneus pleurostigma*, with many young-of-the-year present. Moderate-sized fishes included *Bodianus bilunulatus*, *Scarus rubroviolaceus*, *Scarus psittacus*, *Cephalopholis argus*, *Acanthurus olivaceus*, *Parupeneus cyclostomus*, and *Coris gaimard*. Also noted in the area were *Zanclus cornutus*, *Chaetodon auriga*, *Zebrasoma flavescens*, and *Apolemichthys arcuatus*.

NII-07

11/09/2008

N 22° 00.413'

W 160° 04.750'

Pavement

Depth: 10.7–11.9 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (68.8%) and macroalgae (11.6%) with scattered coral colonies, including *Montipora capitata*, *Pocillopora meandrina*, *P. eydouxi*, and *Porites lobata* (9.2%). Overall crustose coralline red algal cover was low (8.4%). The dominant macroalgal species was *Lobophora variegata* (11.2%).

Coral: Relatively low coral cover was documented at this site with colonies of *Pocillopora eydouxi* (44.6%) and *Pocillopora meandrina* (39.9%) being the most common species observed. A total of 3 scleractinian genera were recorded within the belt transect. One case of *Porites trematodiasis* was observed.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Martensia fragilis*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Dictyota ceylanica*, and *Ventricaria ventricosa*.

Inverts: Overall invertebrate biodiversity was moderate at this site, with 13 of the target genera being represented. Echinoderms dominated the survey area, with high numbers of *Echinometra*, *Echinostrephus*, and *Tripneustes* recorded on the transect. Of particular note was the presence of one *Culcita novaeguineae* “pillow star”. The substrate at this site was unsuitable for the installation of ARMS.

Fish: Fish diversity was high with abundant small and medium-sized fishes. Abundant small fishes included *Thalassoma duperrey*, *Chromis vanderbilti*, *Paracirrhites arcatus*, *Plectroglyphidodon johnstonianus*, and *Parupeneus multifasciatus*. Abundant medium-sized fishes included *Naso unicornis*, *Aphareus furca*, *Acanthurus dussumieri*, *Bodianius bilunulatus*, *N. literatus* and *Acanthurus olivaceus*. The largest fish was the green jobfish, *Aprion virescens*.

NII-09

11/08/2008

N 21° 56.746'

W 160° 09.811'

Pavement

Depth: 13.1–14.9 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (71.2%) and macroalgae (16.4%) with scattered coral colonies, including *Montipora capitata*, *Pocillopora meandrina*, and *Porites lobata* (1.2%). Overall, crustose coralline red algal cover was low (7.6%).

Coral: Low coral cover was documented at this site with colonies of *Porites lobata* (29.7%), *Pocillopora meandrina* (20.9%) and *Montipora patula* (20.8%) being the most common species observed. A total of 3 scleractinian genera were recorded within the belt transect. There were no cases of compromised coral health states observed at this site.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Amansia glomerata*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Dictyota ceylanica*, and *Halimeda velasquezii*.

Inverts: Invertebrate diversity was low at this site. The urchin, *Echinostrephus aciculatus*, was the most abundant organism. This species occupied small depressions in the bare carbonate substrate, along with a scattering of *Echinometra mathaei*.

Fish: Fish diversity was high with abundant small and medium-sized fishes. Abundant small fishes included *Thalassoma duperrey*, *Chromis vanderbilti*, *Acanthurus nigrofuscus* and *Haliichoeres ornatissimus*. Abundant medium-sized fishes included *Parupeneus multifasciatus*, *Acanthurus dussumieri*, *Acanthurus blochii*, school of *Lutjanus kasmira*, *Naso literatus* and *Acanthurus olivaceus*. Noteworthy species included 2 *Carcharhinus galapagensis* (one on transect and one off-transect) and a few *Caranx melampygus* (on and off transect).

Independent Fish Sites

NII-50

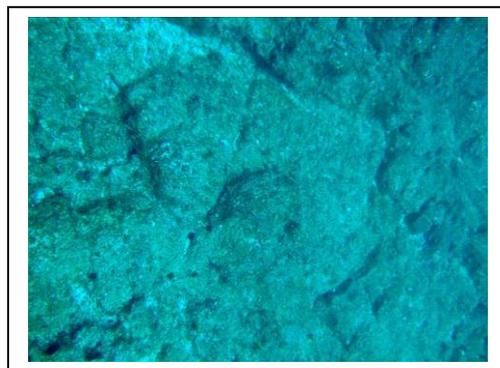
11/8/2008

W 160° 06.903

N 22° 00.260

Forereef

Depth: 22-24 m



General site description

This site is located on the northwestern shore of Ni ihau. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site is characterized by big drop-offs and canyons. The site is located on top, between deep canyons. Coral cover was almost null; complexity was low. Medium-sized fish diversity was moderate, small fishes were almost absent. Notable sightings include *Naso hexacanthus/caesius* schools.

NII-51

11/8/2008

W 160° 09.898

N 21° 56.181

Forereef

Depth: 3-3 m



General site description

This site is located on the western shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site is characterized by highly shaped consolidated substrate. Coral cover was low; complexity was moderate. Fish diversity was moderate. Notable sightings included a few *Parupeneus cyclostomus* and a *Canthigaster amboinensis*.

NII-52

11/8/2008

W 160° 12.184

N 21° 56.102

Forereef

Depth: 22-22 m



General site description

This site is located on the western shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site is characterized by pavement with scattered medium-sized boulders. Coral cover was low-medium; complexity was moderate. Notable sightings included a few large ukus.

NII-53

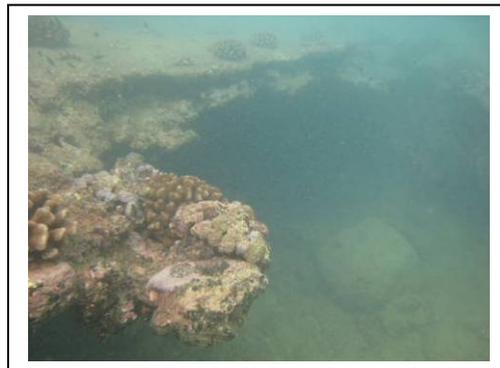
11/8/2008

W 160° 10.812

N 21° 55.661

Forereef

Depth: 5-5 m



General site description

This site is located on the northwestern shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site is characterized by pavement flat precipices and depressions with boulders and some overhangs. Complexity is moderate to high. The dominant algae were *Amansia glomerata*, turfs, and crustose coralline algae. *Pocillopora* sp. were found predominantly in clusters on boulders, and small encrusting corals were scant. Visibility was 10 ft, and still the data showed high species richness and diversity. Medium-sized fishes included *Parupeneus cyclostomus*, especially large *P. insularis*, *Naso lituratus*, *Acanthurus olivaceus*, Kyphosids, *Lutjanus kasmira*, *L. fulvus*, *Bodianus bilunulatus*, and *Caranx melampygus*. Fishes not present on the transect included *Chaetodon auriga*, *Macropharyngodon geoffroy*, *A. achilles*, *Scarus rubroviolaceus*, and *Canthagaster amboinensis*.

NII-54

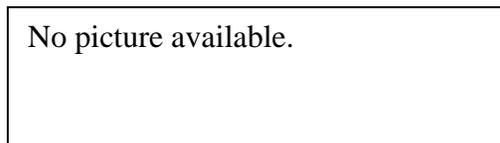
11/9/2008

W 160° 03.457

N 22° 00.000

Forereef

Depth: 25-25 m



General site description

This site is located on the northern shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site is characterized by big drop-offs and canyons. The site is located inside one of the canyons. Coral cover was moderate; complexity was high. Fish diversity was moderate. Notable sightings included a few manta rays.

NII-55

11/9/2008

W 160° 05.556

N 22° 00.402

Forereef

Depth: 3-3 m

No picture available.

General site description

This site is located on the northern shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. It is located between several exposed reefs. The bottom is flat pavement carved by urchin channels. Coral cover was low and complexity moderate. Fish diversity was low. Notable sightings included a few *Thalassoma trilobatum*.

NII-56

11/10/2008

W 160° 15.140

N 21° 49.846

Forereef

Depth: 22-22 m



General site description

This site was located on the southern shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The substrate at this site was very rugose, with large ledges, crevices, pinnacles and overhangs composed mainly of bare rock covered in turf algae. Coral cover was very low, with only scattered *Pocillopora* heads present. Large fishes were numerous at this site, with some individual Acanthurids reaching well over the 20-cm division. Overall fish diversity was moderate.

NII-57

11/10/2008

W 160° 14.015

N 21° 52.591

Forereef

Depth: 5-5 m



General site description

This site was located on the southwest shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The substrate here consisted mostly of large scattered boulders covered in turf algae. Complexity was high, while coral cover was low, with only scattered *Pocillopora* heads present. Fish diversity was moderate. Large fishes were well represented, with Scarids, Acanthurids, Balistids, Labrids, and Kyphosids recorded on the > 20 cm transect. Small fishes recorded were unremarkable.

NII-58

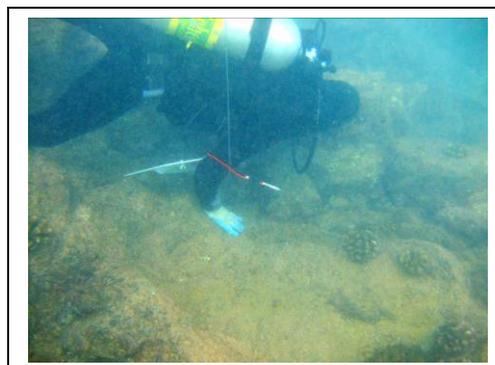
11/10/2008

W 160° 12.319

N 21° 54.598

Forereef

Depth: 5-5 m



General site description

This site was located on the southwest shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The substrate here consisted mostly of large scattered boulders covered in turf algae. Complexity was moderate, while coral cover was low, with only scattered *Pocillopora* heads present. Fish diversity and abundance were low to moderate, with *Chromis vanderbilti* being the most common fish here. Moderate-size fishes were rare and included *Acanthurus olivaceus* and *Bodianus bilunulatus*.

NII-59

11/10/2008

W 160° 12.145

N 21° 56.258

Forereef

Depth: 23-24 m



General site description

This site was located on the southern shore of Ni`ihau. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The substrate at this site was moderately complex with large boulders, ledges, crevices, and overhangs composed mainly of bare rock covered in turf algae. Coral cover was very low, with only scattered *Pocillopora* heads present. Overall fish diversity was moderate; large fishes outnumbered the smaller fishes and included a

large *Monotaxis grandoculis* over 40 cm. Schools of the bluelined snapper, *Lutjanus kasmira*, were counted on transect, while schools of *Naso hexacanthus* hovered just off the transect. Of interest, a single bandit anglefish *Apolemichthys arcuatus* was seen darting under a boulder.

NII-60

11/10/2008

W 160° 12.178

N 21° 55.371

No picture available.

Forereef

Depth: 13-13 m

General site description

This site was located on the southern side of Ni`ihau. It was established by the REA fish team as a new sampling location in the moderate depth forereef stratum. This site exhibited low complexity, dominated by a flat pavement with occasional boulders and shallow relief. The substrate was dominated by algae with sparse *Pocillopora* and scant small encrusting corals. Fishes were not numerous, although 3 large *Caranx melampygus* were seen, as well as a large *Aprion virescens* and *Parupeneus cyclostomus*. The most common fish was *Sufflamen bursa*.

H.3 Benthic Environment

H.3.1 Algae

Benthic communities around Ni`ihau were dominated by the turf algal functional group (Table H.3.1.1) with a low percent cover of all other functional groups. Turf algae percent cover exceeded that of other functional groups at all 5 of the survey sites (Table H.3.1.1). Macroalgae percent cover range was 2.8% to 16.4%, and coral percent cover range was 0.8% to 9.2% across all sites (Table H.3.1.1). A combined total of 11 species of macroalgae were observed (4 chlorophytes, 5 ochrophytes, 2 rhodophytes) from the 5 sites surveyed (Tables H.3.1.2, H.3.1.3). *Lobophora variegata* was documented at all survey sites and dominated the macroalgal community at 4 of the 5 sites with a percent cover range of 0.8% to 11.2% (Table C). *Halimeda discoidea* was the most prevalent macroalgal species at site NII-06 with a percent cover of 6% but was absent from the other 4 sites (Table H.3.1.3).

Table H.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at Ni`ihau.

Site	Macroalgae	Turf Algae	Coralline Red Algae (crustose + upright)	Cyanobacteria	Coral
NII-04	2.8%	83.6%	7.2%	0.4%	2.8%
NII-05	5.6%	76.4%	2.8%	-	7.2%
NII-06	8.0%	68.0%	0.8%	0.8%	0.8%
NII-07	11.6%	68.8%	8.4%	1.6%	9.2%
NII-09	16.4%	71.2%	7.6%	0.4%	1.2%

Table H.3.1.2.--Additional species recorded at each site at Ni`ihau during roving diver survey.

Site	Chlorophyta
NII-09	<i>Halimeda velasquezii</i>
NII-04	<i>Neomeris</i> sp.
NII-05	
NII-06	
NII-07	
NII-09	
NII-07	<i>Ventricaria ventricosa</i>
	Ochrophyta
NII-07	<i>Dictyota ceylanica</i>
NII-09	
	Rhodophyta
NII-05	<i>Haloplegma duperreyi</i>
NII-05	<i>Martensia fragilis</i>

Table H.3.1.3.--Percent cover of macroalgal species at long-term monitoring sites at Ni`ihau. Sum totals for each row equal the percent cover of macroalgae recorded in Table H.3.1.1.

Site	<i>Halimeda discoidea</i>	<i>Dictyota</i> sp	<i>Lobophora variegata</i>	<i>Padina</i> sp	<i>Sargassum</i> sp
NII-04	-	-	2.8%	-	-
NII-05	-	-	2.8%	-	-
NII-06	6.0%	0.4%	0.8%	0.4%	0.4%
NII-07	-	-	11.2%	-	-
NII-09	-	-	9.6%	-	-

H.3.2 Corals

H.3.2.1 Coral Populations

Line-point intercept surveys indicate low coral cover ($4.2 \pm 1.7\%$) at REA sites around Ni`ihau in 2008 (Fig. H.3.2.1.1, left). Benthic habitat included pavement and large boulders. line-point intercept surveys were completed at 6 sites, while belt transects were only surveyed at 3 sites. Species richness varied between sites with 7 genera (6 scleractinian and 1 zoanthid) being represented within belt transect surveys. Coral composition (Fig. H.3.2.1.1, right) was dominated by branching colonies of *Pocillopora* (61.8%) and encrusting colonies of *Porites* (22.4%) and *Montipora* (10.4%). Relative abundance indicates *Porites lobata* (38.4%), *Montipora capitata* (14.9%), *Psammocora stellata* (13.2%), and *M. patula* (10.9%) were the most common species observed (Table H.3.2.1.1).

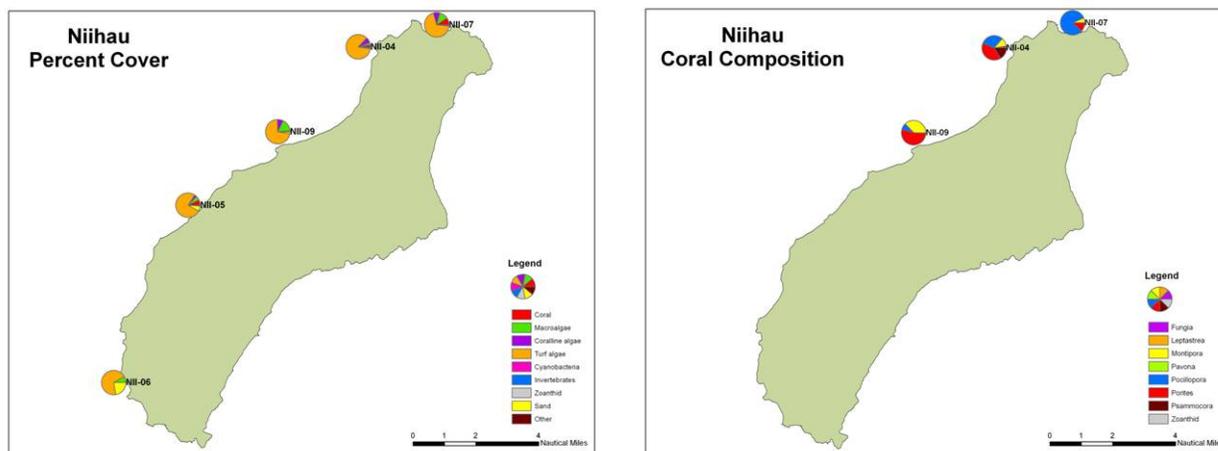


Figure H.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around Ni`ihau in 2008.

Table H.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around Ni`ihau in 2008.

Taxon Name	No. of Colonies	Relative Abundance
<i>Cyphastrea ocellina</i>	10	1.58
<i>Cycloseris</i> sp.	15	2.38
<i>Montipora capitata</i>	94	14.90
<i>Montipora flabellata</i>	9	1.43
<i>Montipora incrassata</i>	1	0.16
<i>Montipora</i> sp.	2	0.32
<i>Montipora patula</i>	69	10.94
<i>Palythoa</i> sp.	2	0.32
<i>Porites brighami</i>	16	2.54
<i>Pocillopora eydouxi</i>	1	0.16
<i>Psammocora haimeana</i>	1	0.16
<i>Porites lobata</i>	242	38.35
<i>Pocillopora meandrina</i>	33	5.23
<i>Pocillopora</i> sp.	43	6.81
<i>Porites</i> sp.	7	1.11
<i>Psammocora</i> sp.	3	0.48
<i>Psammocora stellata</i>	83	13.15

H.3.2.2 Coral Health

During 2008 REA surveys, occurrence of compromised coral health states was low (1.3%). Only members of the genera *Pocillopora* (6.1%) and *Porites* (2.5%) were found to be affected (Fig. H.3.2.2.1). Predation (6.1%) was the only case of compromised coral health states observed on *Pocillopora* colonies (Fig. H.3.2.2.1). Fungal infections (1.2%), algal interactions (0.4%), *Porites* trematodiasis (0.4%), and subacute tissue loss (0.4%) were documented on colonies of *Porites* (Fig. H.3.2.2.1). Coral bleaching was not observed in 2008 around Ni`ihau.

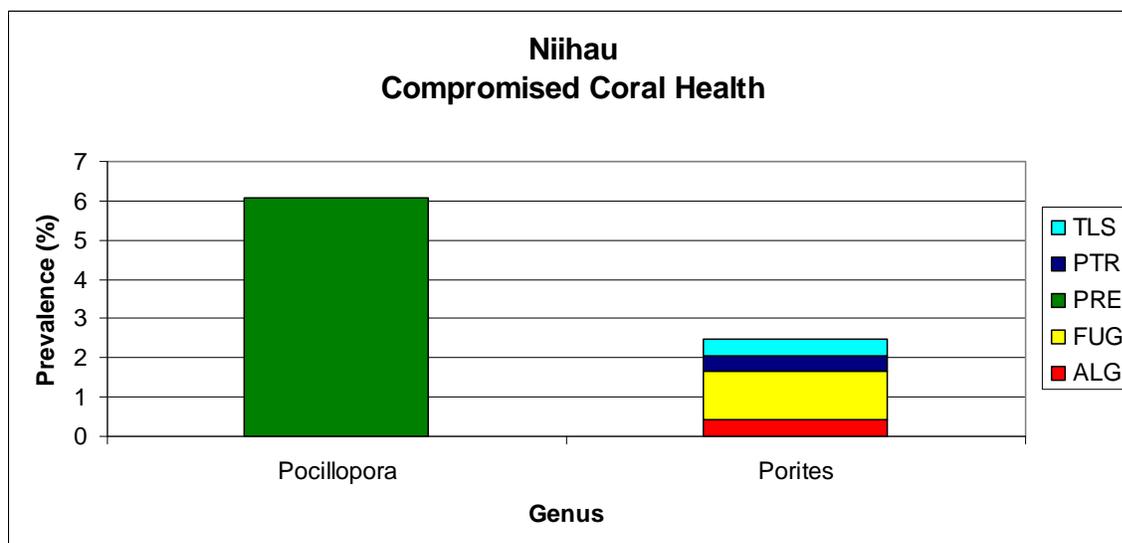


Figure H.3.2.2.1.--Prevalence of compromised coral health states by taxon around Ni`ihau in 2008.

Percent mortality of tissue on colonies surveyed during 2008 varied between genera (Fig. H.3.2.2.2). Colonies of *Psammocora* (2.5%), *Pocillopora* (1.1%), and *Porites* (1.0%) were observed to have only small amounts of dead tissue. Other genera, such as *Montipora*, *Cyphastrea* and *Cycloseris* were found to have 100% live tissue.

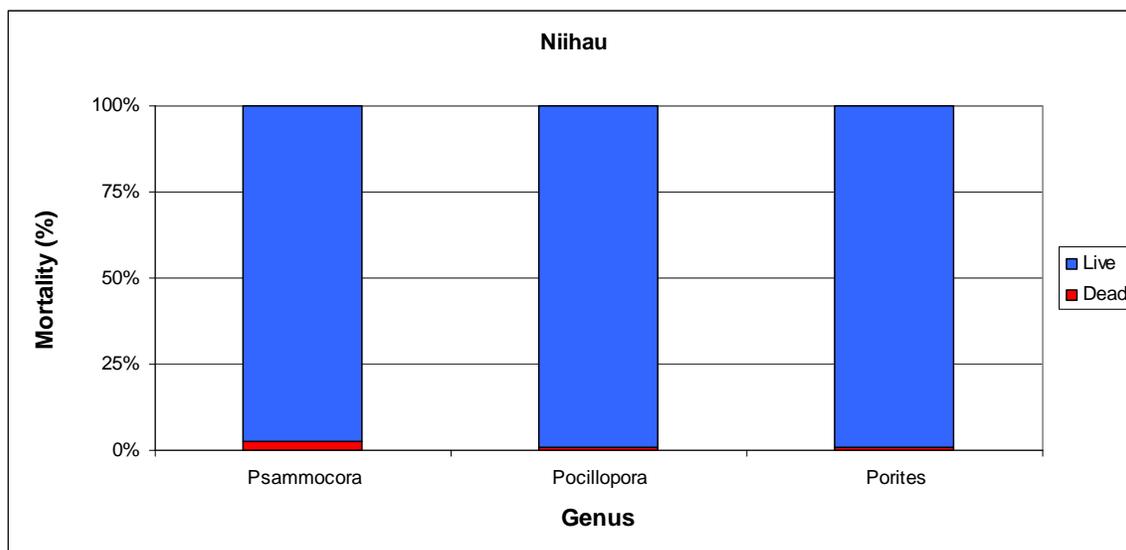


Figure H.3.2.2.2.--Mean percent of live versus dead tissue for various coral genera at Ni ihau in 2008.

H.3.3. Noncoral Invertebrate Surveys

A total of 1567 individuals of benthic invertebrate target species or taxa group were enumerated from 10 belt transects at 5 sites. Echinoids dominated the counts of benthic macroinvertebrates, as the 3 most abundant organisms recorded on the transects were urchins. The rock-boring urchin, *Echinometra mathaei*, was found in exceedingly high numbers at certain sites. The highest densities were recorded at sites NII-04, NII-07, and NII-09 (5.53, 2.54, and 0.28/m², respectively). The urchin, *Echinostrephus aciculatus*, was also very abundant. Densities of 1.09, 0.95, 0.94/m² were recorded at sites NII-04, NII-07, and NII-09, respectively. *Tripneustes gratilla* was the third highest macroinvertebrate in overall average abundance, although it was only recorded at 2 of the 5 survey sites. Of note was the presence of one pillow star, *Culcita novaeguinea*, along the transect at site NII-07. This individual was the sole Asteroid representative (apart from the non-enumerated ophiocomids). Additionally, *Spondylus* clams were widespread, found at 4 out of 5 sites.

H.3.3.1 Urchin Measurements

Figure H.3.3.1.1 reveals the average test diameter of urchins from the genera *Echinometra*, *Echinostrephus*, *Echinothrix*, and *Tripneustes* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented.

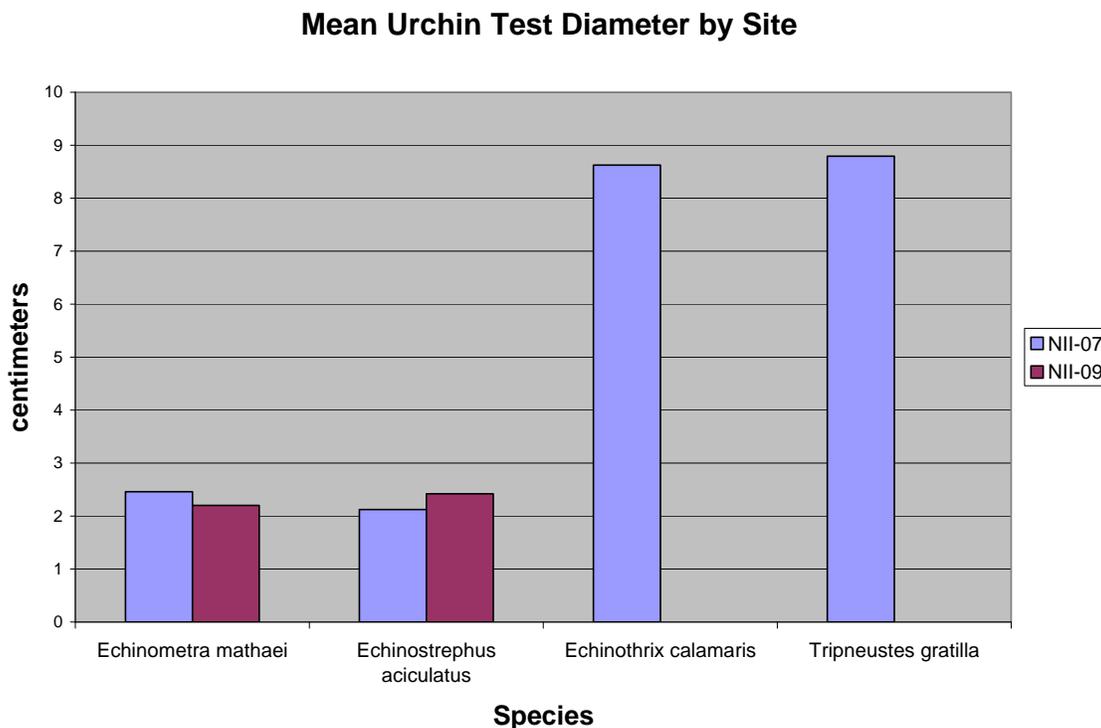


Figure H.3.3.1.1.--Mean test size of urchins by site.

H.3.3.2 ARMS Deployment

ARMS were not deployed on the island of Ni`ihau. The substrate was not conducive to driving stakes.

H.3.4 Towed-diver Benthic Surveys

A total of 10 towed-diver surveys were conducted off the coast of Ni`ihau in 2008. Surveys coverage was split between the north (3 tows), northwest (3 tows), west (3 tows), and northeast regions (1 tow, Fig. H.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.

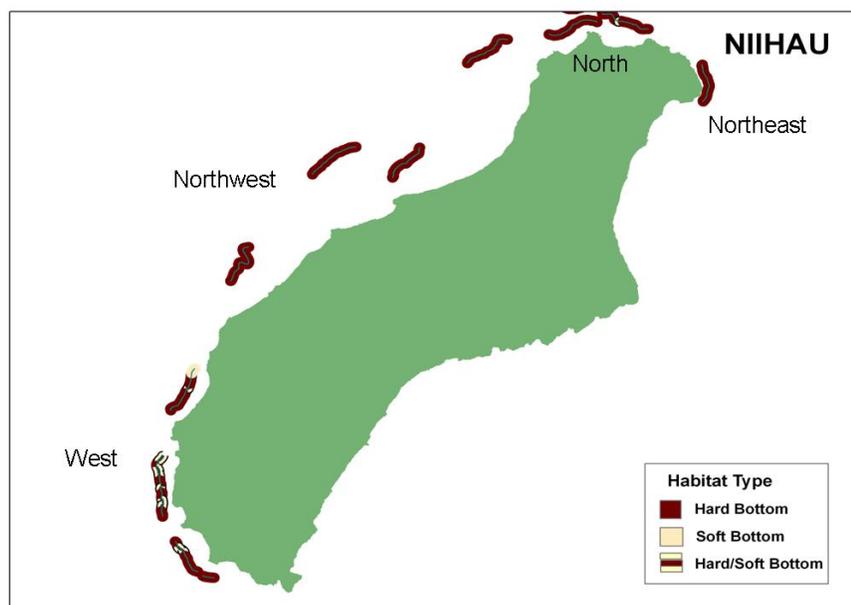


Figure H.3.4.1.--Locations of 10 towed-diver surveys around Ni`ihau in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Habitat varied both within tows and between regions. The majority of the habitat covered by towed-diver surveys consisted of pavement and rock boulders, especially within the northwest region. The northeast tow covered highly complex bottom cover with bedrock pinnacles rising from about 80 ft to within 20 ft of the surface, while the western tows had very low habitat complexity consisting of mostly pavement with interspersed sand flats. Hard coral cover was low in all regions surveyed although it was slightly higher in the north and northeast regions. In addition, black coral was commonly seen growing on the bedrock walls within the northeast region. Stressed coral values were low throughout the regions surveyed. Due to limited area coverage with regards to the island as a whole, island averages are not presented. Instead, means (percent cover) and total (invertebrate counts) values are presented for each region. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in Table H.3.4.1 and Figure H.3.4.2.

Macroalgae was also low in all regions while coralline algae cover was only slightly higher. Patches of *sarragassum* sp. were observed in the west region growing on the substrate and were also common in the water column during one tow. The most common macroinvertebrate observed was the sea urchin. Urchins, both free and boring, were most common in the northwest region. COTs were rare in all regions.

Table H.3.4.1.--Mean percent cover and macroinvertebrate totals by tow region.

Region	Hard Coral	Stress Coral	Macro-algae	Coralline Algae	COTs	Free Urchins	Boring Urchins	Sea Cucumbers
North	4	0	1	8	8	7551	949	103
Northeast	6	1	1	8	1	263	200	132
Northwest	1	1	3	9	11	13489	1178	58
West	0	0	6	5	2	765	151	10

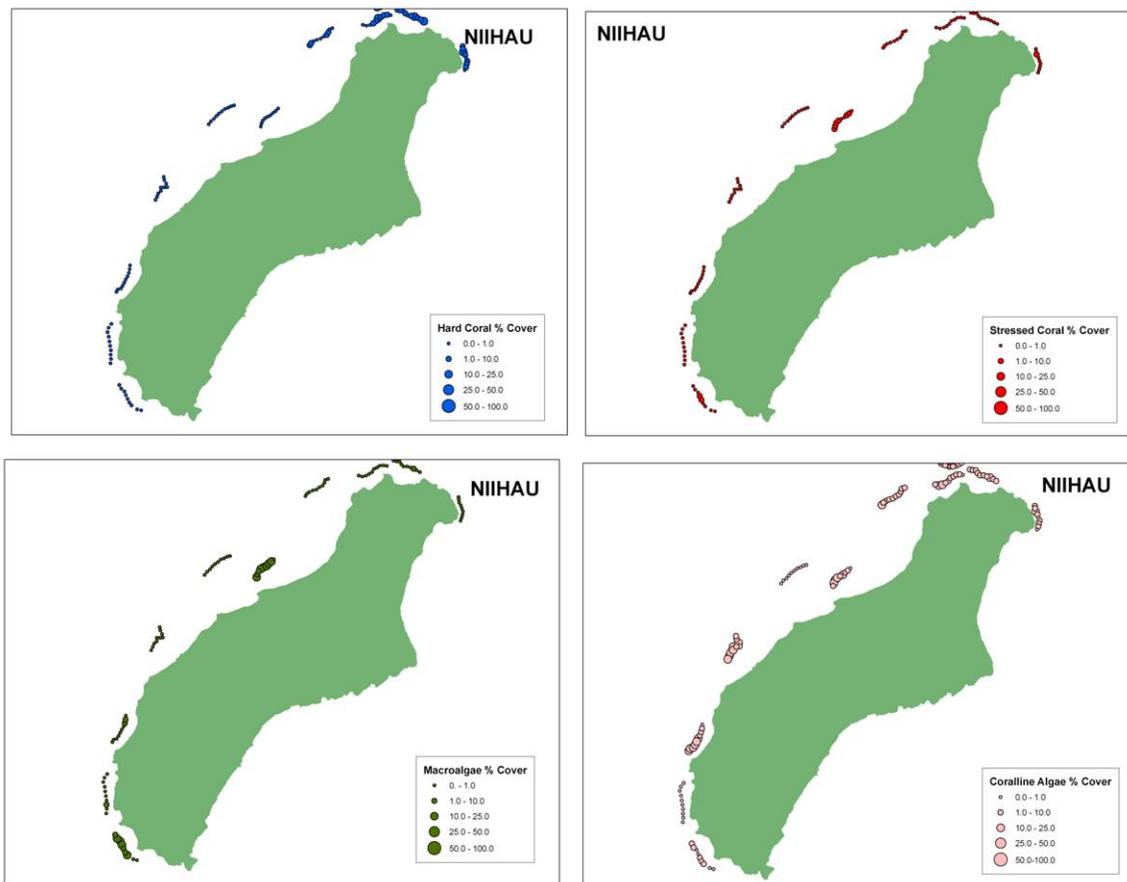


Figure H.3.4.2.--Distribution of coral cover, stressed coral, macroalgae, and coralline algae around Ni`ihau in 2008.

H.4. Fish

H.4.1. REA Fish Surveys

Belt transect data

During the survey period, belt transect surveys were conducted at 16 sites around Ni`ihau. Surgeonfish were the largest contributor to total biomass with 2.52 kg 100 m⁻². Snappers were the second largest contributor to total biomass with 1.19 kg 100 m⁻², followed by parrotfish at 0.59 kg 100 m⁻² (Table H.4.1.1, Fig. H.4.1.1).

Overall Observations

A total of 114 fish species were observed during the survey period by all divers. The average total fish biomass around Ni`ihau during the survey period was 6.66 kg 100 m⁻² for the belt transect surveys (Table H.4.1.1).

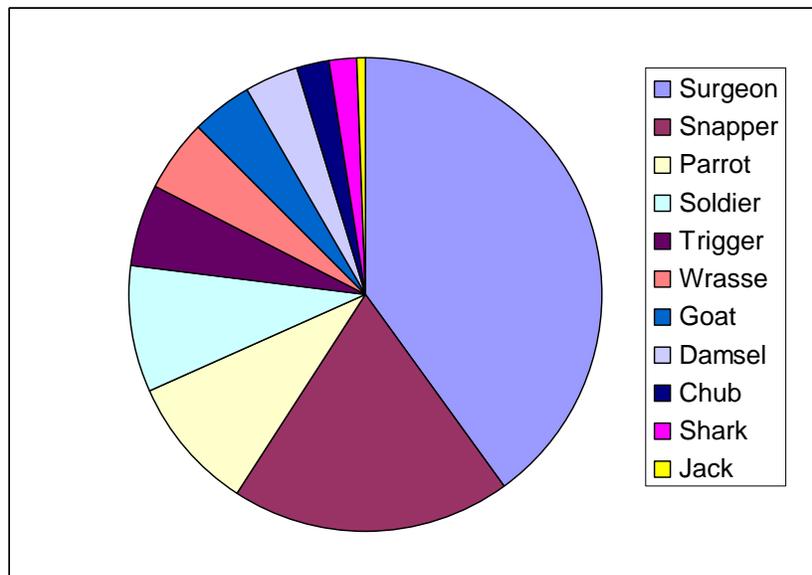


Figure H.4.1.1.--Total fish biomass composition by family.

Table H.4.1.1.--Coral reef fish biomass (kg 100 m⁻²) at sites around Ni`ihau.

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	NII-50	6.37	0.00	0.00	0.02	0.00	0.48	0.00	0.79	2.14	1.65	0.54	0.45
Deep	NII-52	7.38	0.00	0.04	0.22	0.00	0.47	0.00	3.40	0.00	1.24	0.98	0.46
Deep	NII-54	13.25	0.25	0.56	0.42	0.00	1.63	0.00	0.22	4.10	5.01	0.27	0.34
Deep	NII-56	7.76	0.00	0.08	0.26	0.00	0.47	0.00	0.54	1.13	4.09	0.41	0.39
Deep	NII-59	9.90	0.00	0.00	0.28	0.00	0.75	0.00	4.05	0.12	3.26	0.20	0.20
Mid	NII-04	4.10	0.00	0.06	0.29	0.00	0.14	0.00	1.25	0.60	0.88	0.02	0.14
Mid	NII-05	4.86	0.06	1.17	0.23	0.00	0.03	0.00	0.88	0.00	2.10	0.03	0.09
Mid	NII-06	2.47	0.00	0.02	0.42	0.00	0.29	0.00	0.00	0.08	0.42	0.24	0.39
Mid	NII-07	8.47	0.00	0.31	0.38	0.00	0.61	0.00	0.27	0.10	5.78	0.49	0.37
Mid	NII-09	14.48	0.14	0.11	0.22	0.26	2.67	1.94	0.07	0.04	7.30	0.23	0.64
Mid	NII-60	3.34	0.00	0.00	0.39	0.00	0.00	0.00	1.21	0.00	1.25	0.43	0.02
Shallow	NII-51	4.48	1.23	0.10	0.00	0.00	1.59	0.00	0.07	0.00	1.32	0.00	0.11
Shallow	NII-53	10.48	0.17	0.18	0.78	0.29	0.15	0.00	5.91	0.00	2.44	0.00	0.37
Shallow	NII-55	1.36	0.00	0.13	0.02	0.00	0.00	0.00	0.00	0.00	0.77	0.23	0.13
Shallow	NII-57	6.04	0.48	0.56	0.04	0.00	0.16	0.00	0.43	0.00	2.13	1.52	0.47
Shallow	NII-58	1.81	0.00	0.25	0.11	0.00	0.00	0.00	0.00	0.24	0.66	0.03	0.49
	Total	6.66	0.15	0.22	0.26	0.03	0.59	0.12	1.19	0.53	2.52	0.35	0.32

H.4.2 Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED towed-diver team completed 14 surveys at Ni`ihau covering 28.4 km (28.4 ha) of ocean floor (Table H.4.2.1). Mean survey length was 2 km with a maximum length of 2.9 km and a minimum of 0.4 km. Mean survey depth was 15.4 m with a maximum depth of 18.5 m and a minimum of 11.6 m. Mean temperature on these surveys was 26.1 °C with a maximum temperature of 26.2 °C and a minimum of 25.9 °C.

H.4.2.1. Survey statistics for towed-diver sampling during the SE-08-10 MHIRAMP cruise.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

One-hundred fifteen individual large-bodied reef fish (> 50 cm in total length) of 13 different species and 11 different families were encountered at Ni`ihau (Table H.4.2.1). Overall numeric density for reef fishes was 0.041 #/100 m² (4.051 #/ha) with a biomass density of 0.126 kg/100 m² (0.013 t/ha). Numeric and biomass density were both dominated by *Scarus rubroviolaceus*. The most prevalent families in terms of numeric density were Scarids (60%), Acanthurids (13%), Carangids (11%), and Lutjanids (8%) (Fig. H.4.2.1). Biomass was dominated by Scarids (53%), Lutjanids (17%), and Myliobatids (11%). (Fig. H.4.2.2). Biomass and diversity of large-bodied reef fish appears to decrease slightly from north to south along the western coast of the island. We were not able to survey the eastern/windward coast of the island this year due to high wind and waves. (Fig. H.4.2.3).

Table H.4.2.1.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed at Ni`ihau during the SE-08-10 MHIRAMP cruise CRED towed-diver surveys.

Species	#	#/100m ²	#/ha	Biomass (kg)	kg/100m ²	t/ha
Acanthurus_xanthopterus	1	0.000	0.035	3.144545962	0.001	0.000
Aetobatus_narinari	1	0.000	0.035	38.19597958	0.013	0.001
Aluterus_scriptus	1	0.000	0.035	0.275	0.000	0.000
Aprion_virescens	9	0.003	0.317	61.42984081	0.022	0.002
Aulostomus_chinensis	2	0.001	0.070	0.392790018	0.000	0.000
Caranx_melampygus	13	0.005	0.458	31.81219514	0.011	0.001
Carcharhinus_amblyrhyncho	1	0.000	0.035	0.642833828	0.000	0.000
Chlorurus_perspicillatus	9	0.003	0.317	22.95	0.008	0.001
Gymnothorax_sp	1	0.000	0.035	1.482995886	0.001	0.000
Monotaxis_grandoculis	1	0.000	0.035	3.130761611	0.001	0.000
Naso_hexacanthus	14	0.005	0.493	29.69617007	0.010	0.001
Parupeneus_cyclostomus	1	0.000	0.035	1.55	0.001	0.000
Scarus_rubroviolaceus	61	0.021	2.149	162.0539069	0.057	0.006
Grand Total	115	0.041	4.051	356.757	0.126	0.013
# of Species	13					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Niihau During 2008 CRED Towed-Diver Surveys

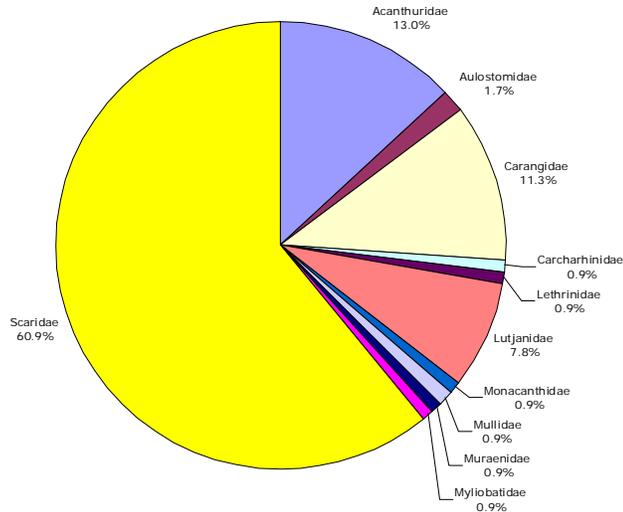


Figure H.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Niihau During 2008 CRED Towed-Diver Surveys

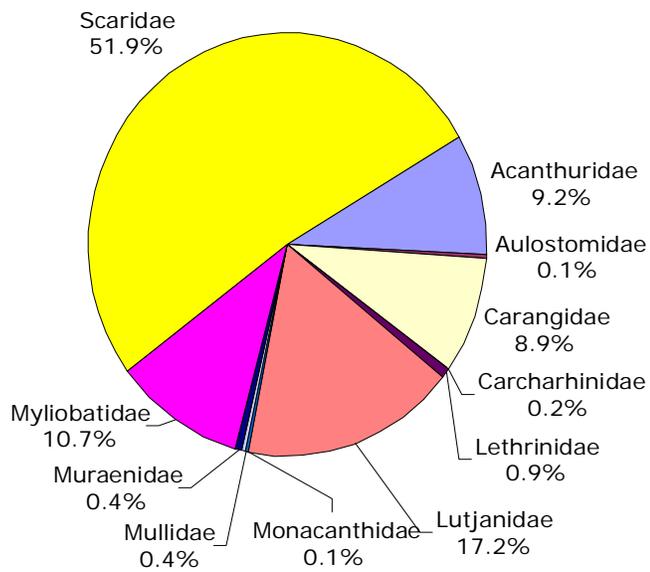


Figure H.4.2.2.--Biomass density by family.

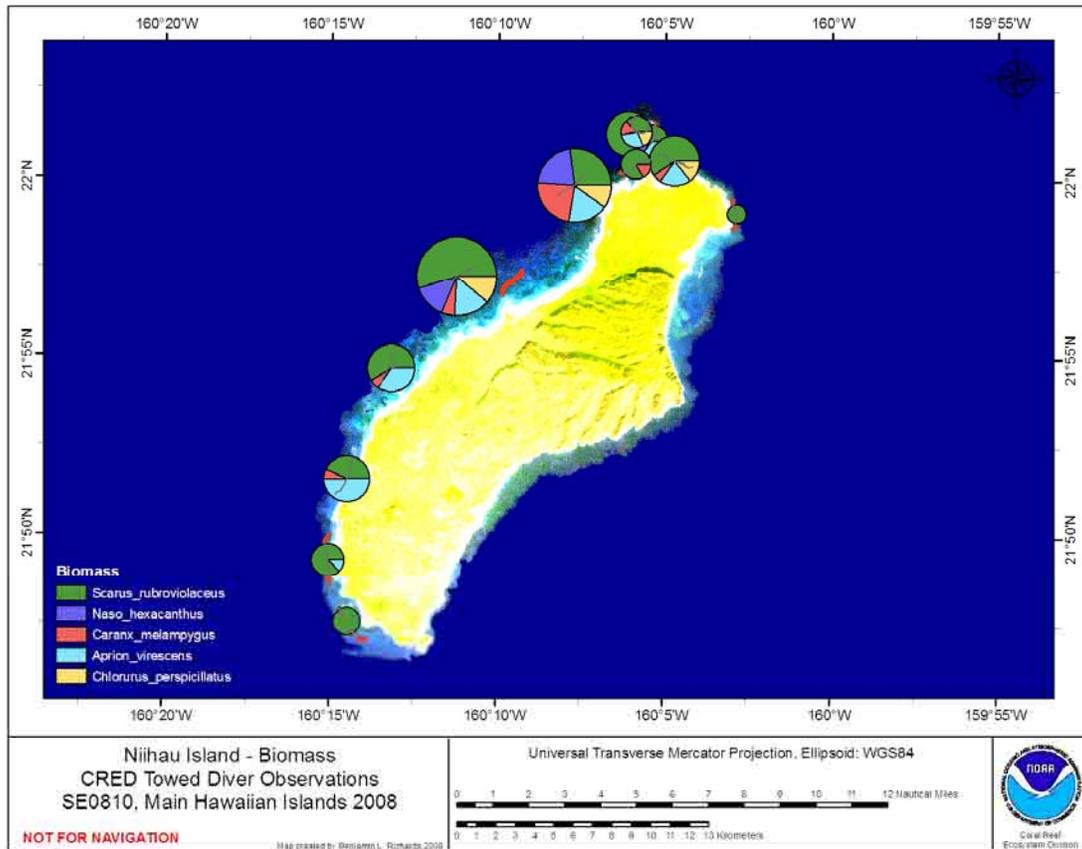


Figure H.4.2.2.--Geographic distribution of biomass around Ni`ihau. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.

Appendix I: Lehua

I.1. Oceanography and Water Quality

Refer to Appendix H: Ni`ihau

I.2. Rapid Ecological Assessment (REA) Site Descriptions

A total of 22 REA surveys were conducted at Lehua Rock on 9 November 2008. Complete REA surveys (benthic and fish) were conducted at 2 sites established in 2006; 2 new additional haphazardly selected sites were surveyed by fish scientists only. For site locations refer to Figure H.2.1 (Appendix H: Ni`ihau); physical and biological characteristics for each site are described below.

REA Site Descriptions

LEH-01

11/09/2008

N 22° 00.975'

W 160° 05.481'

Pavement

Depth: 14.3–17.4 m



Survey Notes: Original global positioning system (GPS) point indicated that site was located on land. The site was moved offshore and a new GPS point taken.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (58.8%) and macroalgae (28.4%) with scattered coral colonies, including *Pocillopora meandrina* and *Porites lobata* (5.6%). Overall crustose coralline red algal cover was low (5.6%). The dominant macroalgal species was *Lobophora variegata* (26.8%).

Coral: Although low coral cover was found at this forereef site, there were 10 genera represented (9 scleractinian and 1 anthozoan). The most common species observed included *Pocillopora molokensis* (49.2%), *Porites lobata* (29.4%), and *Pocillopora meandrina* (13.3%). A variety of other species were observed including members of *Pavona*, *Fungia*, *Psammocora*, *Palythoa*, *Leptoseris*, *Cycloseris* and *Cirrhopathes* genera. Most colonies were observed to be healthy. One case of pink line syndrome (0.6%) and discoloration other than bleaching (0.6%) were observed on *Porites* colonies.

Algae: Algae documented by the line-point intercept survey: crustose coralline red algae, *Amansia glomerata*, *Dictyota ceylanica*, a species of *Padina*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Gibsmithia hawaiiensis*, *Styopodium flabelliforme*, and *Ventricaria ventricosa*.

Inverts: This site was characterized by large numbers of the urchin *Echinostrephus aciculata*. Overall invertebrate biodiversity was moderate. Of note was the record of one *Mithrodia fisheri* sea star, and 2 *Pinctada* pearl oysters on the transect.

Fish: Fish diversity was very high and abundant with small and medium-sized fishes. Abundant small fishes included planktivores such as *Chromis vanderbilti*, *C. ovalis* and *C. verater*. Additional abundant small-sized species included *Thalassoma duperrey* and *Acanthurus nigrofuscus*. Abundant medium-sized species included *Scarus rubroviolaceus*, *Acanthurus thompsoni*, *Kyphosis biggibus*, *Naso literatus* and *Aphareus furca*. Large fishes were also moderately abundant on and off transect including *Manta* spp., *Seriola dumerili*, *Monotaxis granducolis*, *Carcharhinus galapagensis*, *Aprion virescens* and *Caranx melampyngus*.

LEH-02

11/09/2008

N 22° 01.306'

W 160° 05.649'

Pavement

Depth: 15.8–17.1 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (66.4%) and macroalgae (18.0%) with scattered coral colonies, including *Pocillopora meandrina*, *Montipora capitata*, and *Porites lobata* (3.6%). Overall crustose coralline red algal cover was low (7.6%). The dominant macroalgal species was *Lobophora variegata* (15.6%).

Coral: Low coral cover was observed at this site (3.6%). A total of 6 genera were represented (5 scleractinian and 1 anthozoan). The most common species found were *Porites lobata* (34.0%) and *Montipora patula* (28.6%). Most colonies were healthy with only one colony of *Porites* being infected with *Porites* trematodiasis (0.6%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Amansia glomerata*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Peyssonnelia*, *Dictyota ceylanica*, and *Portieria hornemannii*.

Inverts: Overall invertebrate biodiversity was low at this site. Very high numbers of the rock-boring urchin, *Echinometra mathaei*, were recorded, along with high numbers of *Echinostrephus aciculatus*. The urchin, *Eucidaris metularia*, was also recorded here in relatively high numbers. The substrate was unsuitable for the installation of ARMS.

Fish: Fish diversity was high with abundant small and medium-sized fishes. The most abundant small fishes included *Chromis ovalis* and *C. vanderbilti*. The most abundant medium-sized fish species included *Bodianus bilunulatus*, *Acanthurus olivaceus*, *A. blochii* and *Scarus rubroviolaceus*. Notable species included a large school of *Monotaxis granducolis* and a male *Scarus dubius* seen off transect.

Independent Fish Sites

LEH-50

11/9/2008

W 160° 05.798

N 22° 00.872

Forereef

Depth: 3-4 m



General site description

This site was located on the southern shore of Lehua, outside the crater. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The site was characterized by complex consolidated substrate. Coral cover was moderate and complexity moderate-high. Fish diversity was relatively high. Notable sightings include a few blue fin trevallies and yellow saddle goatfish.

LEH-51

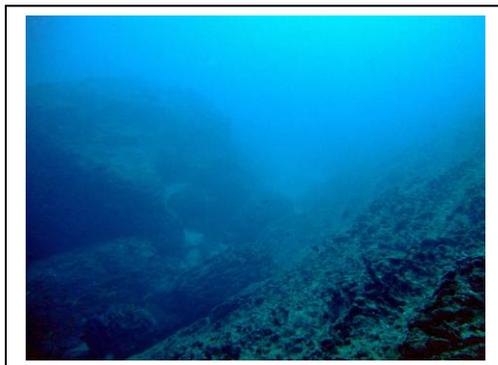
11/9/2008

W 160° 05.905

N 22° 01.757

Forereef

Depth: 22-24 m



General site description

This site was located on the northern shore of Lehua, on the sunken rim of the crater. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The bottom was composed of a large spur constituting the underwater remnant of the crater rim. Complexity was low and coral cover was low. Some soft coral was present. Notable sightings include a small gray reef shark and an eagle ray.

I.3. Benthic Environment

I.3.1. Algae

Benthic communities around Lehua Rock were dominated by turf and macroalgal functional groups (Table I.3.1.1). Turf algae were documented with the highest percent cover at both sites surveyed, and macroalgae was documented with the second highest percent cover at both sites, 58.8% to 66.4% and 18% to 28.4%, respectively (Table I.3.1.1). A combined total of 10 species of macroalgae were observed (2 chlorophytes, 4 ochrophytes, 4 rhodophytes) from the 2 sites

surveyed (Tables I.3.1.2 and I.3.1.3). *Lobophora variegata* dominated the macroalgal community at both sites with a percent cover range of 15.6% to 26.8% (Table I.3.1.3). *Dictyota ceylanica* and *Padina* sp. were encountered during the line-point intercept survey at LEH-01 and covered 0.4% of the substrate at that site (Table I.3.1.1).

Table I.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at Lehua Rock.

Site	Macroalgae	Turf Algae	Coralline Red Algae (crustose + upright)	Cyanobacteria	Coral
LEH-01	28.4%	58.8%	5.6%	1.6%	5.6%
LEH-02	18.0%	66.4%	7.6%	2.0%	3.6%

Table I.3.1.2.--Additional species recorded at each site at Lehua Rock during roving diver survey.

Site	Chlorophyta
LEH-01	<i>Neomeris</i> sp.
LEH-02	
LEH-01	<i>Ventricaria ventricosa</i>
	Ochrophyta
LEH-02	<i>Dictyota ceylanica</i>
LEH-01	<i>Styopodium flabelliforme</i>
	Rhodophyta
LEH-02	<i>Amansia glomerata</i>
LEH-01	<i>Gibsmithia hawaiiensis</i>
LEH-02	<i>Peyssonnelia</i> sp.
LEH-02	<i>Portieria hornemannii</i>

Table I.3.1.3.--Percent cover of macroalgal species at long-term monitoring sites at Lehua Rock. Sum totals for each row equal the percent cover of macroalgae recorded in Table A.

Site	<i>Dictyota ceylanica</i>	<i>Lobophora variegata</i>	<i>Padina</i> sp
LEH-01	0.4%	26.8%	0.4%
LEH-02	-	15.6%	-

I.3.2. Corals

I.3.2.1 Coral Populations

Line-point intercept surveys indicate relatively high coral cover (4.6 ± 1.0 %) at REA sites around Lehua in 2008 (Fig. I.3.2.1.1, left). Benthic habitat was recorded as pavement and species richness varied between the 2 sites with 11 genera (10 scleractinian and 1 zoanthid) were represented within belt transect surveys. Coral composition was dominated by *Pocillopora* (40.1%), *Porites* (38.4%), and *Montipora* (17.9%) colonies (Fig. I.3.2.1.1, right). The most common scleractinian species observed included *Porites lobata* (38.0%) and *Montipora patula* (13.3%) and *Pocillopora* sp. (13.2%; Table I.3.2.1.1).

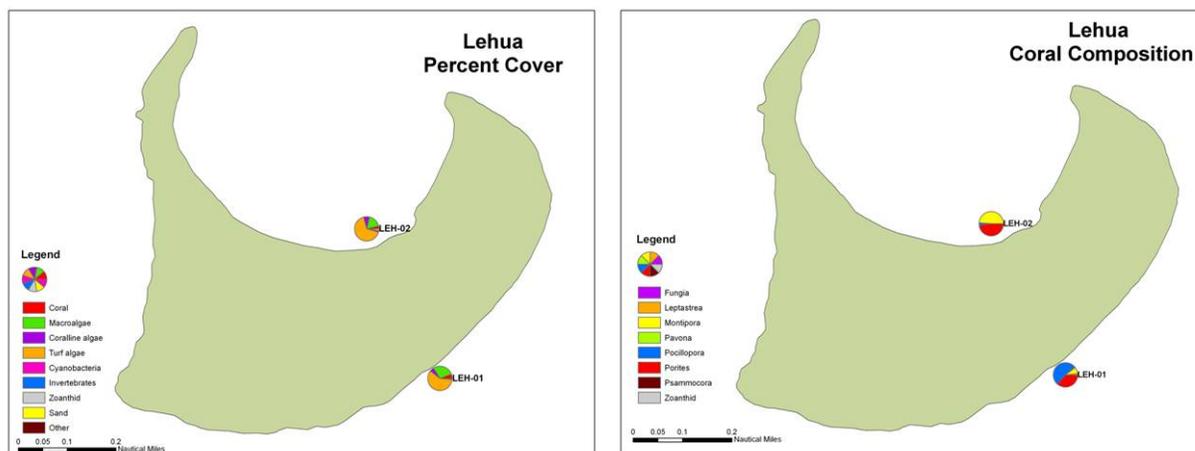


Figure I.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around Lehua in 2008.

Table I.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around Lehua in 2008.

Taxon Name	No. of Colonies	Relative Abundance
<i>Cirrhopathes anguina</i>	1	0.12
<i>Cycloseris vaughani</i>	1	0.12
<i>Fungia granulosa</i>	1	0.12
<i>Fungia scutaria</i>	1	0.12
<i>Fungia</i> sp.	11	1.34
<i>Leptoseris incrustans</i>	2	0.24
<i>Leptastrea purpurea</i>	2	0.24
<i>Leptastrea transversa</i>	9	1.10
<i>Montipora capitata</i>	95	11.60
<i>Montipora patula</i>	191	23.32
<i>Palythoa</i> sp.	6	0.73
<i>Porites brighami</i>	4	0.49
<i>Porites compressa</i>	7	0.85
<i>Pavona duerdeni</i>	11	1.34
<i>Porites evermanni</i>	1	0.12
<i>Porites lobata</i>	311	37.97
<i>Pavona maldivensis</i>	2	0.24
<i>Pocillopora meandrina</i>	29	3.54
<i>Pocillopora molokensis</i>	1	0.12
<i>Pocillopora</i> sp.	108	13.19
<i>Porites</i> sp.	13	1.59
<i>Psammocora stellata</i>	11	1.34
<i>Pavona varians</i>	1	0.12

I.3.2.2. Coral Health

During 2008 REA surveys, occurrence of compromised coral health states was relatively low (1.0%). Only members of the genus *Porites* were found to show symptoms of compromised health states (2.6%). Algal interactions (1.6%) were most commonly observed while discolorations other than bleaching, *Porites* line syndrome and *Porites* trematodiasis were observed on one colony each (0.3%; Fig. I.3.2.2.1).

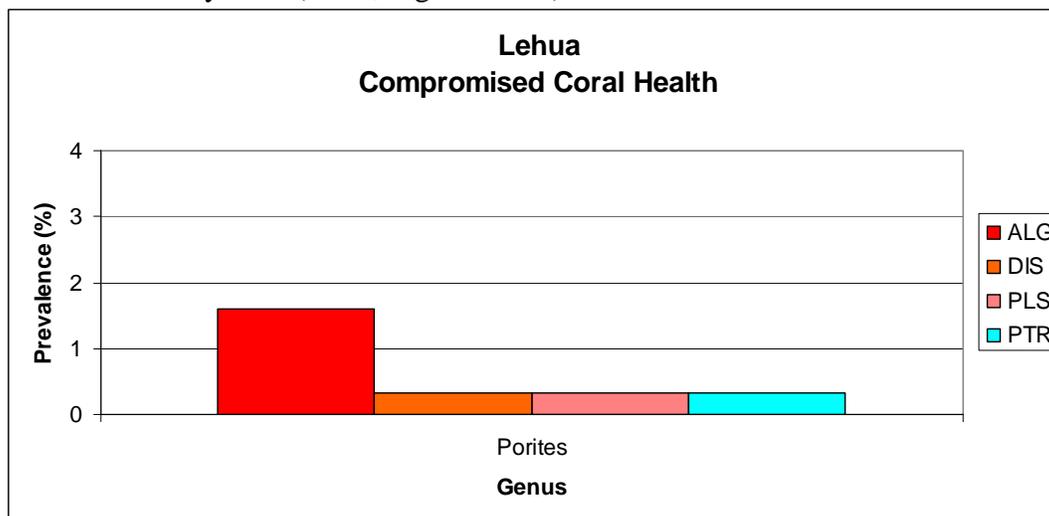


Figure I.3.2.2.1.--Prevalence of compromised coral health states by taxon around Lehua in 2008.

Percent mortality of colonies surveyed during 2008 was very low among sites around Lehua. Colonies of *Porites* were found to exhibit 10.4% of dead tissue while all other genera were found to have healthy tissue (Fig. I.3.2.2.2).

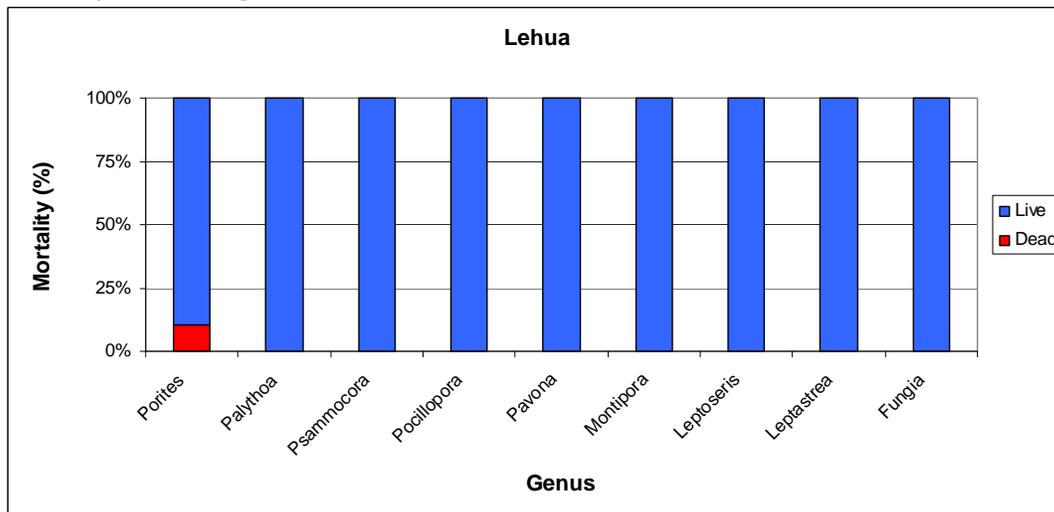


Figure I.3.2.2.2.--Mean percent of live versus dead tissue for various coral genera at Lehua in 2008.

I.3.3. Noncoral Invertebrate Surveys

A total of 778 individuals of benthic invertebrate target species or taxa group were enumerated from 4 belt transects at 2 sites. Invertebrate abundance was very high, mostly due to high echinoid counts. The most abundant macroinvertebrates here were the rock-boring urchins, *Echinometra mathaei* and *Echinostrephus aciculatus*, respectively. Overall echinoid diversity was high for the low sample size, with 5 genera being represented. *E. mathaei* was most abundant at site LEH-02, with a density of 3.1/m². *E. aciculatus* was most abundant at site LEH-01, with a density of 1.75/m². The urchin, *Eucidaris metularia*, was the third-most abundant echinoid at Lehua Rock, with the highest density occurring at site LEH-02 (0.11/m²). Spondylus clams were common at site LEH-01, with a density of 0.16/m². Of note were the sightings of 2 pearl oysters, *Pinctada margaritifera*, and 1 Mithrodia sea star at site LEH-01.

I.3.3.1 Urchin Measurements

Figure I.3.3.1.1 reveals the average test diameter of urchins from the genera *Echinometra*, *Echinostrephus*, and *Echinothrix* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented.

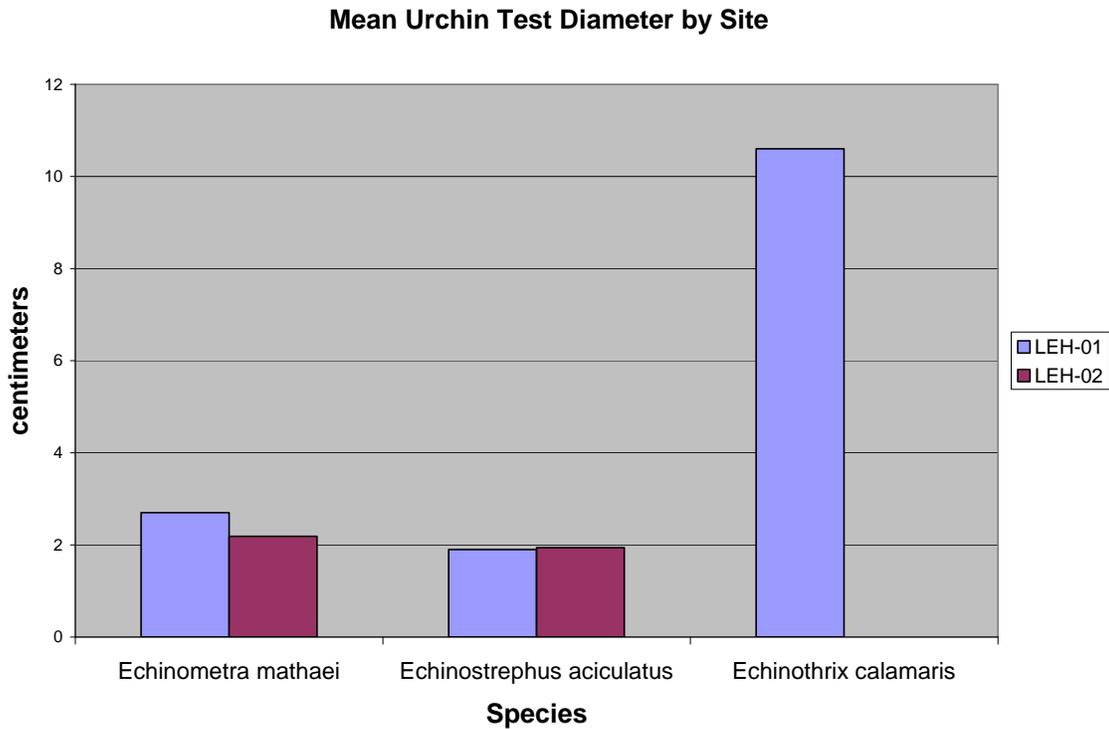


Figure I.3.3.1.1.--Mean test size of urchins by site.

I.3.3.2 ARMS Deployment

No ARMS were deployed at Lehua Rock. The substrate here was not conducive to driving stakes.

I.3.4 Towed-diver Benthic Surveys

A total of 3 towed-diver surveys were conducted off the coast of Lehua in 2008 (Fig. I.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.

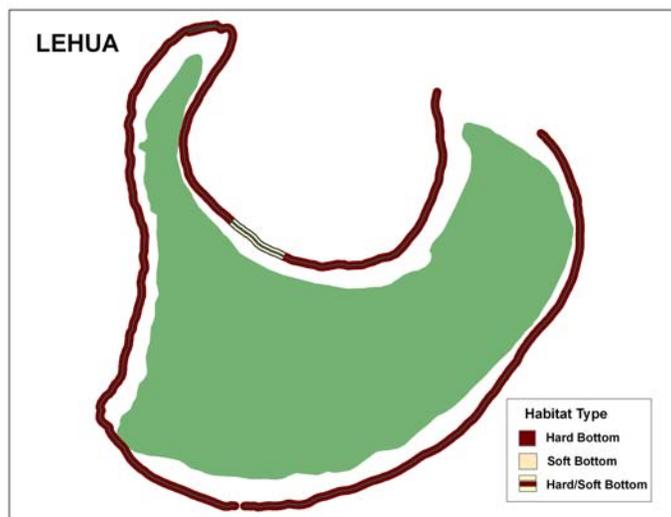


Figure I.3.4.1.--Locations of 3 towed-diver surveys around Lehua in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Habitat type was mostly hard bottom with steep walls along the west side of the rock and gave way to pavement and rock boulders on the south and east sides. The inside of the crescent was dominated by pavement with a small section of mixed hard and soft bottom. Hard coral cover was low in all habitats around the island (mean: 4 %) with *Pocillopora meandrina* and *Porites lobata* being the most common corals at the rock. Some predation of *Pocillopora meandrina* was noted but both numbers of COTs and percent stress was relatively low. An extensive mat of *Sinularia* sp. was seen at the northwest point of Lehua. Macroalgae and coralline algae were also low, as the predominant habitat was almost entirely covered with turf algae. Free urchins were the most common macroinvertebrate seen while a total of 21 COTs were observed. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in the Table I.3.4.1 and Figure I.3.4.2

Table I.3.4.1.--Mean percent cover and macroinvertebrate totals by tow region.

Hard Coral	Stress Coral	Macroalgae	Coralline Algae	COTs	Free Urchins	Boring Urchins	Sea Cucumbers
4	1	1	11	21	9161	153	15

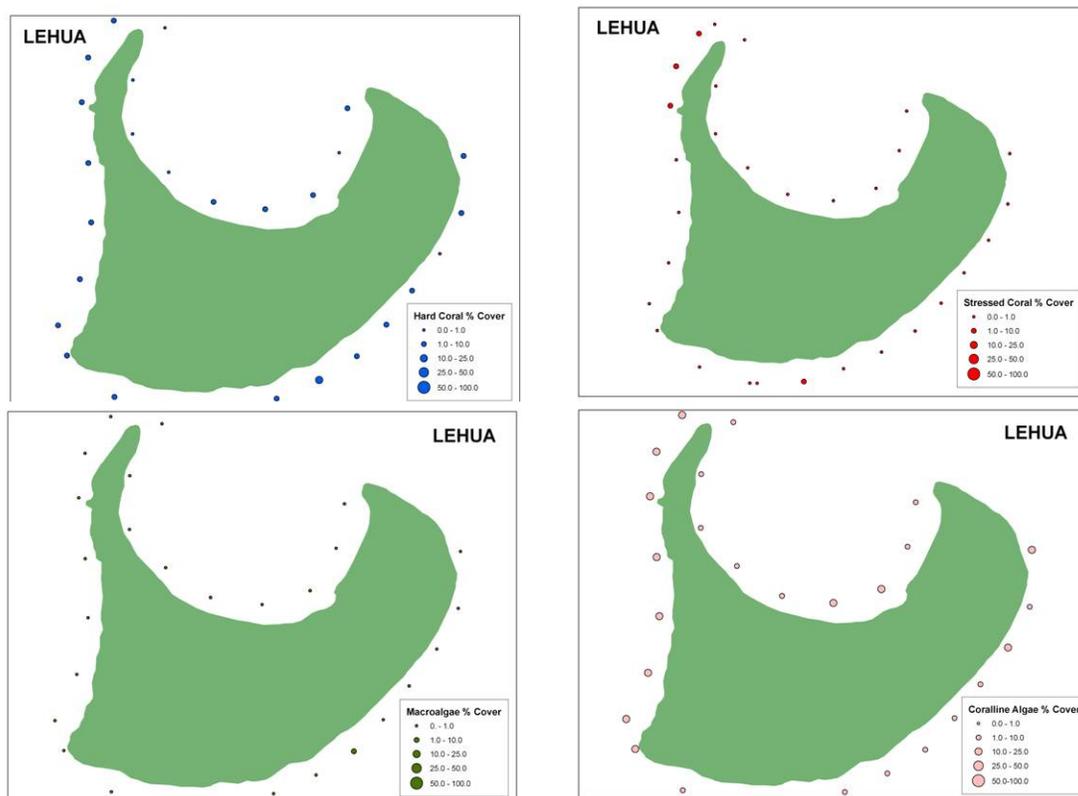


Figure I.3.4.2.--Distribution of coral cover, stressed coral, macroalgae, and coralline algae around Lehua in 2008.

I.4. Fish

I.4.1. REA Fish Surveys

Belt transect data

During the survey period, belt transect surveys were conducted at 4 sites around Lehua.

Surgeonfish were the largest contributor to total biomass with $4.53 \text{ kg } 100 \text{ m}^{-2}$. Parrotfish were the second largest contributor to total biomass with $0.87 \text{ kg } 100 \text{ m}^{-2}$, followed by damselfish at $0.74 \text{ kg } 100 \text{ m}^{-2}$ (Fig. I.4.1.1, Table I.4.1.1).

Overall Observations

A total of 106 fish species were observed during the survey period by all divers. The average total fish biomass around Lehua during the survey period was $9.12 \text{ kg } 100 \text{ m}^{-2}$ for the belt transect surveys (Table I.4.1.1).

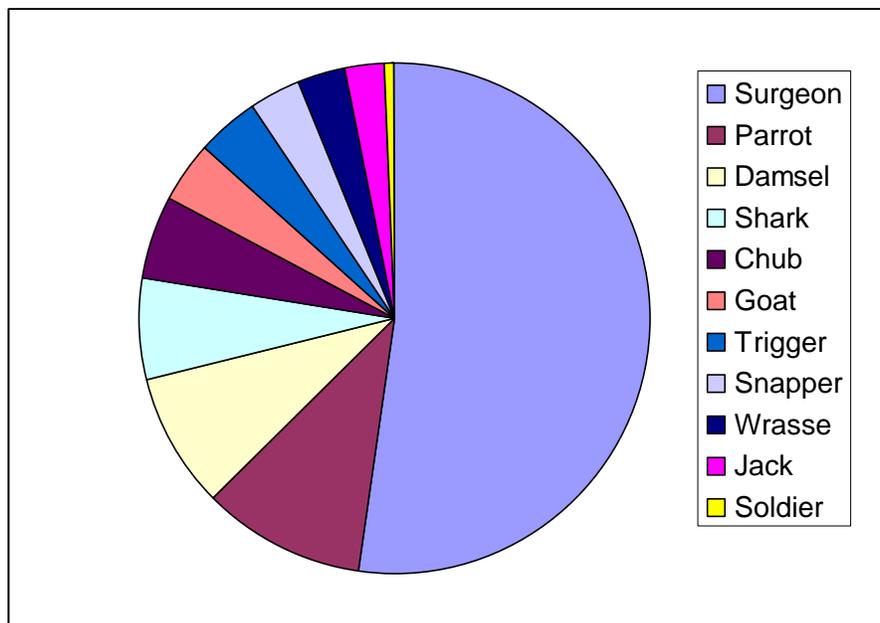


Figure I.4.1.1.--Total fish biomass composition by family.

Table I.4.1.1.--Coral reef fish biomass (kg 100 m⁻²) at sites around Lehua.

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	LEH-51	7.21	0.21	0.27	0.00	0.90	1.72	0.00	0.66	0.00	2.21	0.42	0.10
Mid	LEH-01	11.43	0.91	2.01	0.20	0.00	1.08	2.27	0.38	0.17	2.90	0.42	0.36
Mid	LEH-02	10.03	0.63	0.53	0.86	0.00	0.68	0.00	0.15	0.02	6.32	0.17	0.30
Shallow	LEH-50	7.81	0.07	0.16	0.28	0.00	0.01	0.00	0.00	0.00	6.68	0.32	0.25
	Total	9.12	0.45	0.74	0.33	0.23	0.87	0.57	0.30	0.05	4.53	0.33	0.25

I.4.2. Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED Tow board team completed 3 surveys at Lehua Rock covering 6.5 km (6.5 ha) of ocean floor (Table I.4.2.1). Mean survey length was 2.2 km with a maximum length of 2.2 km and a minimum of 2.0 km. Mean survey depth was 13.9 m with a maximum depth of 15.2 m and a minimum of 13.0 m. Mean temperature on these surveys was 26 °C with a maximum temperature of 26.1 °C and a minimum of 25.9 °C.

I.4.2.1.--Survey statistics for Tow board sampling during the SE-08-10 MHIRAMP cruise.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

Forty-four individual large-bodied reef fish (> 50 cm in total length) of 14 different species and 9 different families were encountered at Lehua Rock (Table I.4.2.2). Overall numeric density for this class of reef fishes was 0.068 #/100 m² (6.785 #/ha) with a biomass density of 1.773 kg/100 m² (0.177 t/ha). Numeric density was dominated by *Scarus rubroviolaceus*, while biomass density was dominated by *Manta birostris*. The most common families in terms of numeric density were Scarids (37%), Carcharhinids (16%), Carangids (11%), and Mobulids (11%) (Fig. I.4.2.1). Biomass was dominated by Mobulids (80%) and Carcharhinids (8%). (Fig. I.4.2.2). Biomass for large-bodied reef fish was dominated by *Manta birostris* and concentrated in the southeast channel between Lehua Rock and Niihau Island. (Fig. I.4.2.3).

Table I.4.2.2.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed at Lehua Rock during the SE-08-10 MHIRAMP cruise CRED Towed-Diver surveys.

Species	#	#/100m ²	#/ha	Biomass (kg)	kg/100m ²	t/ha
<i>Aetobatus narinari</i>	1	0.002	0.154	24.40589308	0.038	0.004
<i>Aprion virescens</i>	3	0.005	0.463	10.62375846	0.016	0.002
<i>Aulostomus chinensis</i>	1	0.002	0.154	0.372741195	0.001	0.000
<i>Caranx ignobilis</i>	2	0.003	0.308	22.27305723	0.034	0.003
<i>Caranx melampygus</i>	1	0.002	0.154	2.122234353	0.003	0.000
<i>Carcharhinus amblyrhyncho</i>	6	0.009	0.925	60.30070426	0.093	0.009
<i>Chlorurus perspicillatus</i>	2	0.003	0.308	5.1	0.008	0.001
<i>Fistularia commersonii</i>	3	0.005	0.463	3.603960305	0.006	0.001
<i>Manta birostris</i>	5	0.008	0.771	923.812	1.425	0.142
<i>Naso annulatus</i>	2	0.003	0.308	5.427304647	0.008	0.001
<i>Naso hexacanthus</i>	1	0.002	0.154	2.121155005	0.003	0.000
<i>Scarus rubroviolaceus</i>	14	0.022	2.159	38.25185581	0.059	0.006
<i>Seriola dumerili</i>	2	0.003	0.308	24.59774229	0.038	0.004
<i>Triaenodon obesus</i>	1	0.002	0.154	27.02554293	0.042	0.004
Grand Total	44	0.068	6.785	1150.038	1.773	0.177
# of Species	14					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Lehua Rock During 2008 CRED Towed-Diver Surveys

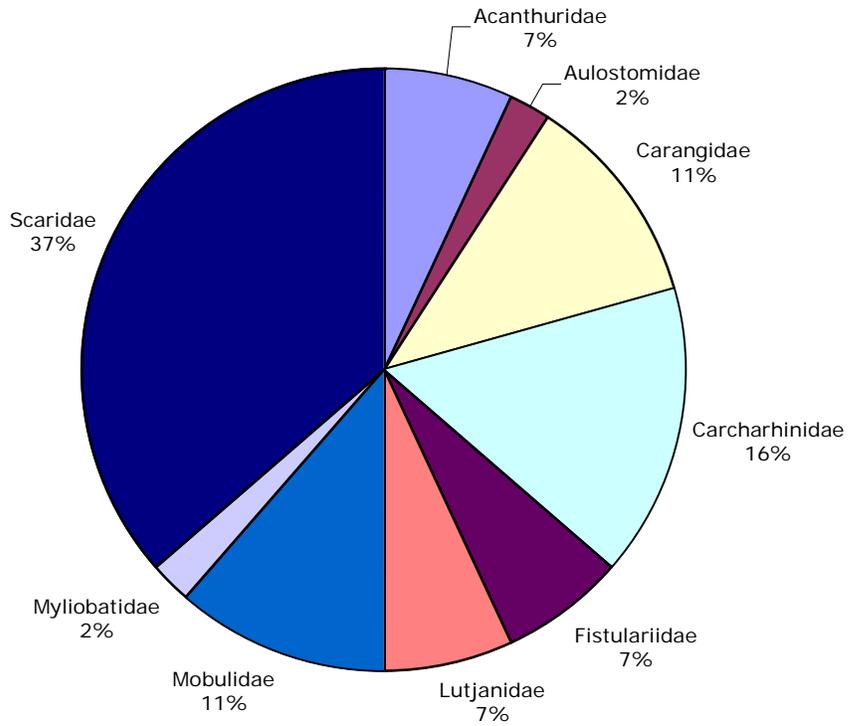


Figure I.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Lehua Rock During 2008 CRED Towed-Diver Surveys

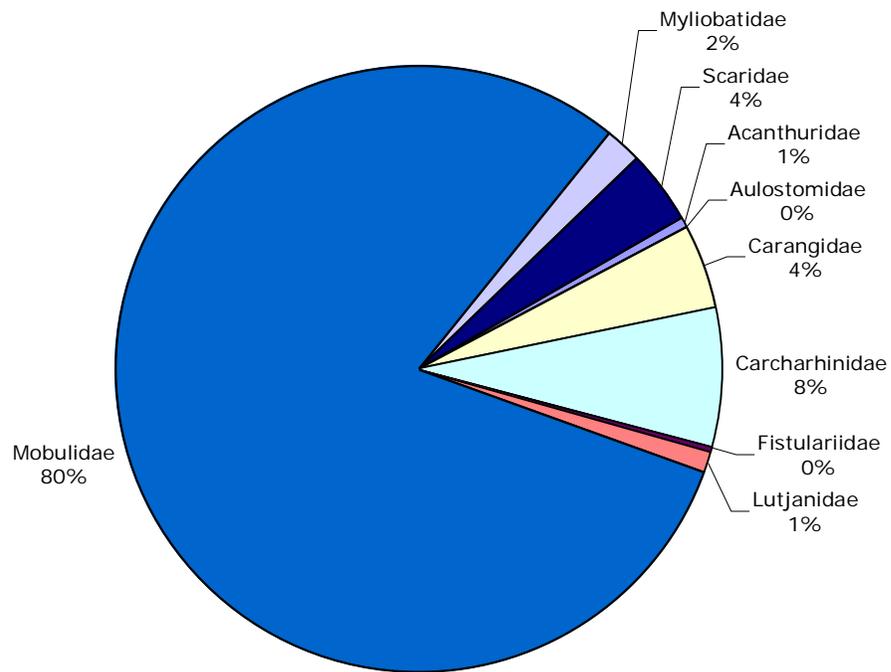


Figure I.4.2.1.--Biomass density by family.

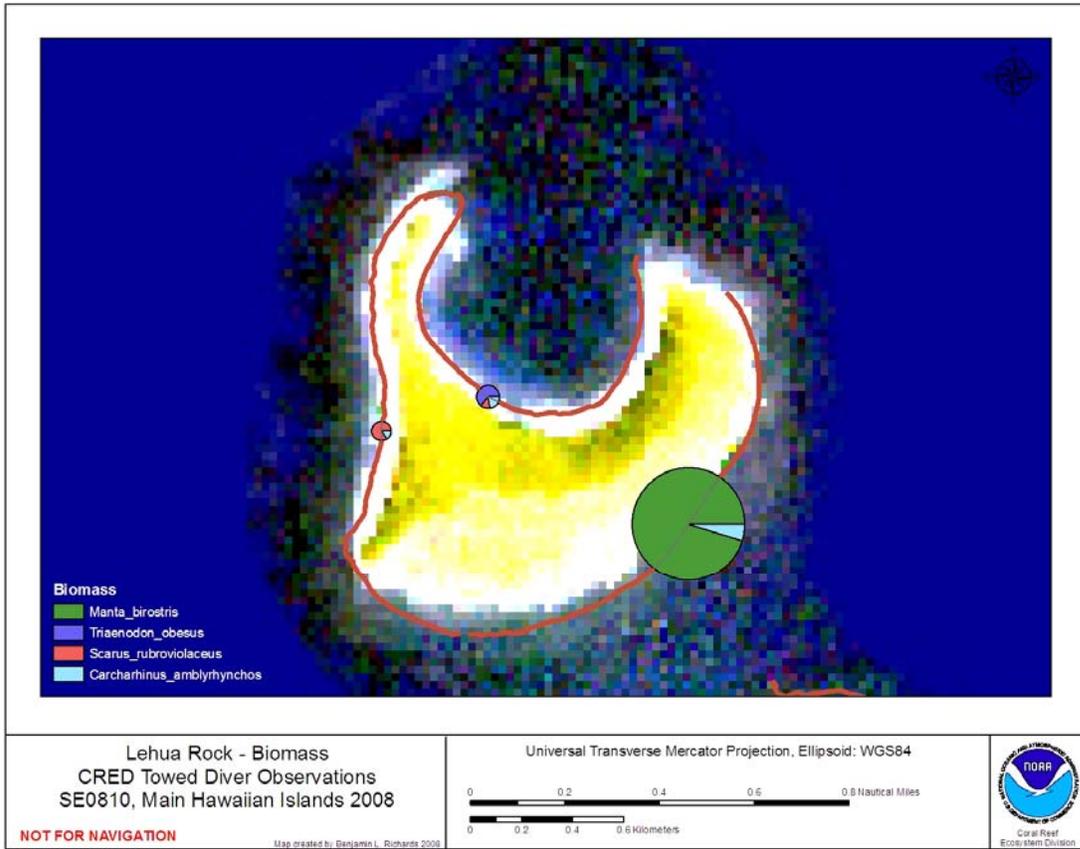


Figure I.4.2.3.--Geographic distribution of biomass around Lehua Rock. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.

Appendix J: O`ahu

J.1. Oceanography and Water Quality

One subsurface temperature recorder (STR) was recovered and one deployed at O`ahu. No new mooring deployments were established.

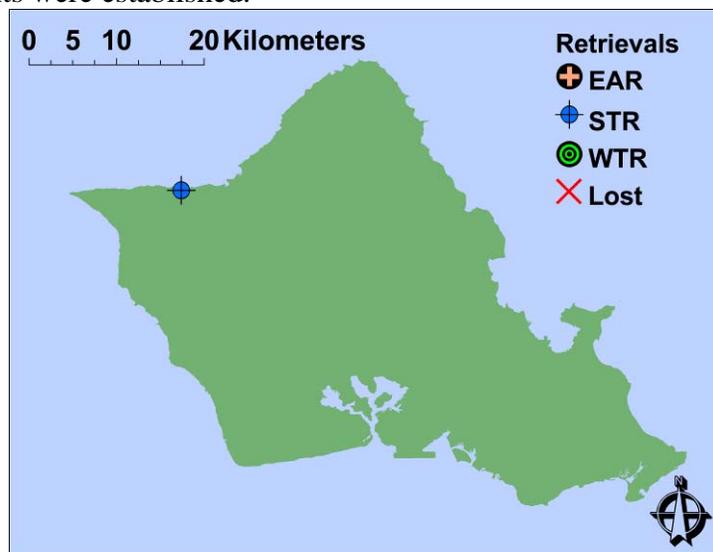


Figure J.1.1.--Retrieved moored oceanographic instrumentation map for O`ahu.

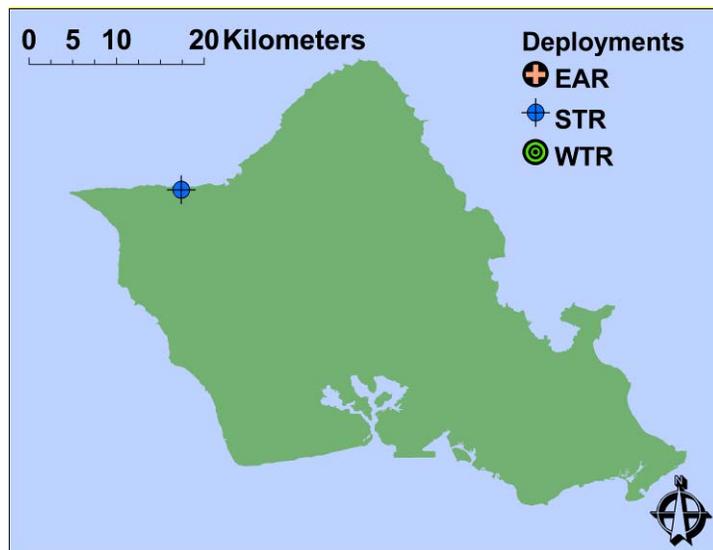


Figure J.1.2.--Deployed moored oceanographic instrumentation map for O`ahu.

Table J.1.1.--Moored oceanographic instrumentation table for O`ahu.

Instrument	Action	Serial number	Latitude	Longitude	Action Date	Depth (m)
STR	Deployment	39327181113	21.58086	-158.16851	11/12/2008	5.49
STR	Retrieval	39368591669	21.58086	-158.16851	11/12/2008	5.49

Water Quality

A total of 6 shallow-water conductivity, temperature and depth (CTD) casts were conducted at the 30-m isobath around O`ahu using an SBE 19*plus* with additional dissolved oxygen (DO) and transmissometer sensors attached (Fig. J.1.3.). A total of 2 shallow-water CTD casts were taken for use with microbial water samples.

A total of 38 discrete water samples (including 1 duplicate) were collected concurrently with shallow-water CTD casts at 3 of the shallow-water CTD sites using a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m and will later be analyzed for nutrient and chlorophyll. Nutrient and chlorophyll were processed and stored according to protocol and were sent out for analysis when the cruise returned. Eight of the discrete water samples were processed for microbial analysis.

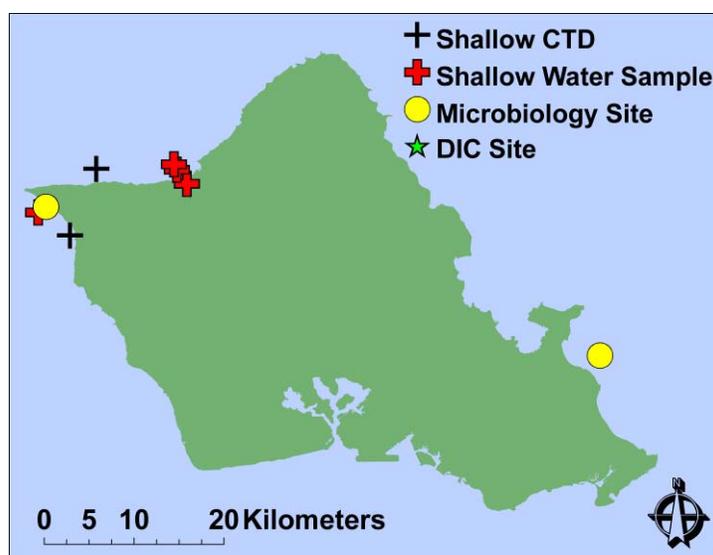


Figure J.1.3.--Shallow-water CTD and water sampling locations around O`ahu.

J.2. Rapid Ecological Assessment (REA) Site Descriptions

Between October 26 and November 2, 2008, 15 REA surveys were conducted around forereefs of O`ahu. Full REA surveys (benthic and fish) were conducted at 6 long-term stations established in 2005 and 2006, and 2008 (OAH-14, OAH-15). Nine additional haphazardly selected sites were surveyed by fish scientists only. Site locations are plotted in Figure J.2.1, and physical and biological characteristics for each site are described below.

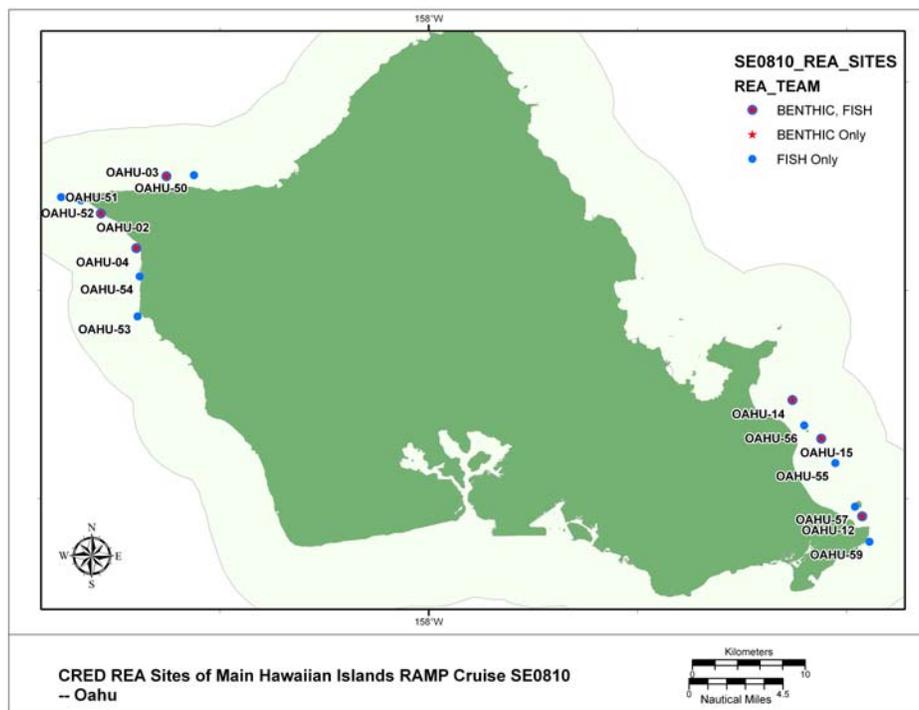


Figure J.2.1.--Locations of 2008 REA sites on O`ahu.

REA Site Descriptions

OAH-02

11/12/2008

N 21° 33.686'

W 158° 15.690'

Pavement

Depth: 7.3–10.1 m



Survey Notes: Original global positioning system (GPS) point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (66.8%) and macroalgae (22.4%), primarily *Amansia glomerata* and *Halimeda discoidea*. Overall coral percent cover was low (4.0%) and included *Leptastrea bewickensis*, *Pocillopora meandrina*, and *Porites lobata*. Overall crustose coralline red algal cover was low (6.0%).

Coral: Low coral cover was documented at this forereef site with large colonies of *Porites lobata* (50.8%), *Pocillopora meandrina* (17.4%), and *Montipora patula* (15.1%) being the most common species observed. A total of 5 genera (4 scleractinian and 1 anthozoan) were recorded

within the belt transect. Overall coral health was good with one colony displaying signs of *Porites trematodiasis*.

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Amansia glomerata*, *Halimeda discoidea*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Galaxaura*, *Dictyota ceylanica*, and a cyanobacteria.

Inverts: Invertebrate diversity was low at this site. However, abundance of urchins was very high, with 5 species represented in significant numbers. *Echinometra mathaei* and *Echinostrephus* were the most numerous, with numbers sometimes reaching above 100 individuals per species, per 5 m segment.

Fish: Fish diversity and abundances were moderate. The parrotfish *Scarus rubroviolaceus* was the largest fish recorded; smaller fishes such as *Thalassoma duperrey*, *Acanthurus nigrofuscus* and *Chromis vanderbilti* were more common. Also common, and of interest were the juvenile Balistids (*Rhinecanthus rectangulus*, *Sufflamen franaetum*, and *S. bursa*) seen on the pavement flat.

OAH-03

11/12/2008

N 21° 35.474'

W 158° 12.557'

Forereef

Depth: 15.2–18.0m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (49.4%) and coral (32.6%), including *Montipora capitata*, *M. patula*, *Pocillopora meandrina*, and *Porites lobata*. Overall, macroalgal percent cover was moderate (11.6%), and crustose coralline red algal cover was low (3.4%).

Coral: Relatively high coral cover was documented at this forereef site with large colonies of *Porites lobata* (32.7%), *Montipora capitata* (31.1%) and *Montipora patula* (20.1%) being the most common species observed. A total of 6 genera (5 scleractinian and 1 anthozoan) were recorded within the belt transect. Overall coral health was good with 0.8% of colonies displaying compromised health states such as barnacle infestation (0.4%) and subacute tissue loss (0.4%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Amansia glomerata*, *Asparagopsis taxiformis*, *Halimeda discoidea*, and *Portieria hornemannii*. Additional algae documented by the Roving Diver survey include species of *Neomeris* and *Padina*, *Lobophora variegata*, *Martensia fragilis*, *Dotyella hawaiiensis*, *Laurencia galtosoffii*, and cyanobacteria.

Inverts: Invertebrate biodiversity was very low at this site. The urchins *Echinostrephus* sp. and *Echinometra mathaei* comprised the majority of organisms recorded here. Of special note was the presence of one *Octopus* sp. on the transect.

Fish: Fish diversity was relatively high, while abundances were moderate. Acanthurids were common, from medium-sized *Naso unicornis*, *N. hexacanthus*, *Acanthurus olivaceus*, to smaller *A. nigrofuscus*. Small schools of *Lutajanus kasmira*, *Myripristis berndti*, and *Mulloidichthys flavolineatus* were observed under ledges on the second transect.

OAH-04

11/12/2008

N 21° 32.019'

W 158° 13.995'

Pavement

Depth: 11.3–11.9 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (64.4%) and macroalgae (18.4%). Overall coral percent cover was low (9.2%) and included *Pocillopora meandrina*, and *Porites lobata*. Overall crustose coralline red algal cover was low (3.6%).

Coral: Relatively low coral cover was documented at this forereef site with large colonies of *Porites lobata* (49.7%) and *Pocillopora meandrina* (31.0%) being the most common species observed. A total of 5 scleractinian genera were recorded within the belt transect. Overall coral health was good with 1.0% of colonies displaying compromised health states such as hyperpigmentation (0.5%) and algal interactions (0.5%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Amansia glomerata*, *Halimeda discoidea*, a cyanobacteria, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris* and *Gibsmithia hawaiiensis*.

Inverts: Invertebrate biodiversity was very low at this site. The most numerous invert recorded was the urchin *Echinothrix* spp. Several hermit crabs were also recorded. Of note was the presence of one *Heterocentrotus mammilatus* urchin.

Fish: Fish diversity at this site overall was moderately high, proportionate to the habitat complexity. The first transect traversed 3 ‘skylights’ into open cavernous formations. This area had the highest fish abundance and diversity. The second and third transects ran along flat pavement with low complexity. These areas had low abundance and richness. The watercolumn was decorated with schooling *Chromis ovalis*, *C. verator*, *Chaetodon milliaris*, *Dascyllus albisella*, and transient *Naso hexacanthus*. The pavement areas were teeming with recently recruited young-of-the-year, including *Sufflamen bursa*, *S. fraenatus*, *Rhinecanthus rectangulus*, *Naso brevirostris*, *N. hexacanthus*, *Ostracion meleagris*, and *Parupeneus pleurostigma*. Of notable interest, a *Malacanthus brevirostris* was counted.

OAH-12

11/13/2008

N 21° 19.172'

W 157° 39.235'

Forereef

Depth: 8.2–11.9 m



Survey Notes: Original GPS point used and updated to reflect position of dive buoy marking transect lines.

Habitat: Forereef with ledge dropping to coral rubble field on northeast side of transects.

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (54.8%) and coral (23.2%), including *Pavona duerdeni*, *Montipora patula*, *Leptastrea bewickensis*, *Pocillopora meandrina*, and *Porites lobata*. Overall crustose coralline red algal cover was moderate (12.0%) and macroalgal percent cover was low (8.4%).

Coral: High coral cover was documented at this forereef site with large colonies of *Pocillopora meandrina* (43.4%) and *Porites lobata* (35.0%) being the most common species observed. A total of 8 genera (7 scleractinian and 1 anthozoan) were recorded within the belt transect. Overall coral health was good with only 0.8% of colonies displaying compromised health states such as subacute tissue loss (0.4%) and *Porites* trematodiasis (0.4%).

Algae: Algae documented by the line-point intercept survey include crustose coralline red algae, *Dictyota ceylanica*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include a species of *Neomeris*, *Turbinaria ornata*, *Haloplegma duperreyi*, *Halimeda velasquezi* and *Caulerpa peltata*.

Inverts: No invertebrate surveys were conducted at this site. The oceanography team assisted in ARMS installation and were successful in installing 3 units. Depth of installation was ~ 15 m.

Fish: Fish diversity was moderate. A relatively moderate amount of medium-sized fishes were counted (e.g., *Scorpaenopsis rubroviolaceus*, *Melichthys niger*, etc.). Some large-sized fish were seen off transect (e.g., *Monotaxis grandoculis*).

OAH-14

11/13/2008

N 21° 24.733'

W 157° 42.588'

Pavement

Depth: 13.7–14.6 m



Survey Notes: New site established in 2008.

Habitat: Pavement

Benthic Cover: Benthos was dominated by coral (49.7%), including *Montipora patula*, *M. capitata*, *M. flabellata*, *Pocillopora meandrina*, *Porites compressa*, and *P. lobata*, macroalgae (25.2%), and turf algae colonized on pavement (21.3%). Overall crustose coralline red algal cover was low (3.9%).

Coral: High coral cover was documented at this forereef site with large colonies of *Montipora capitata* (30.2%), *Porites lobata* (25.6%) and *Montipora patula* (23.0%) being the most common species observed. A total of 3 scleractinian genera were recorded within the belt transect. Overall coral health was fair with 8.0% of colonies displaying symptoms of compromised health states such as skeletal growth anomalies (3.1%) and algal interactions (3.1%).

Algae: Algae species documented by the line-point intercept survey include crustose coralline red algae, a species of *Padina*, *Halimeda discoidea*, *Haloplegma duperreyi*, *Asparagopsis taxiformis*, *Acanthophora pacifica*, *Caulerpa taxifolia*, *Dictyota ceylanica*, *Amansia glomerata*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include species of *Neomeris*, *Wrangelia*, and *Martensia*, *Halimeda opuntia*, *Dictyosphaeria cavernosa*, *Portieria hornemannii* and *Gibsmithia hawaiiensis*.

Inverts: No invertebrate surveys were conducted at this site. The oceanography team assisted in ARMS installation and successfully installed one unit at this site. Depth was ~ 13.7 m.

Fish: Fish diversity was low and mainly composed of small fishes. Almost no medium-large fish were observed. Notable sightings include one medium *Calotomus carolinus*.

OAH-15

11/13/2008

N 21° 22.878'

W 157° 41.205'

Pavement

Depth: 13.1–14.0m



Survey Notes: New site established in 2008.

Habitat: Pavement

Benthic Cover: Benthos was dominated by turf algae colonized on pavement (42.4%) and coral (40.8%), including *Montipora patula*, *M. capitata*, *M. flabellata*, *Pocillopora meandrina*, and *Porites lobata*. Overall crustose coralline red algal cover was low (6.0%). Macroalgal percent cover was also low (7.2%).

Coral: High coral cover was documented at this forereef site with large colonies of *Montipora patula* (46.5%), *M. capitata* (24.3%) and *Porites lobata* (22.2%) being the most common species observed. A total of 3 scleractinian genera were recorded within the belt transect. Overall coral health was good with only a few colonies showing signs of skeletal growth anomalies (0.9%), hyperpigmentation (0.5%), *Porites* trematodiasis (0.5%), and predation (0.5%).

Algae: Algae species documented by the line-point intercept survey include crustose coralline red algae, *Halimeda discoidea*, *Haloplegma duperreyi*, and *Lobophora variegata*. Additional algae documented by the Roving Diver survey include species of *Neomeris*, *Padina*, *Wrangelia*, and *Martensia*, *Turbinaria ornata*, *Amansia glomerata*, and *Gibsmithia hawaiiensis*.

Inverts: No invertebrate surveys were conducted at this site. The oceanography team assisted in ARMS installation and successfully installed 2 units. Depth of installation was ~ 13.7 m.

Fish: Fish diversity was fairly low and mostly composed of small fishes. Very few medium-large fishes were observed. Notable sightings include one large *Scarus rubroviolaceus*.

Independent Fish Sites

OAH-50

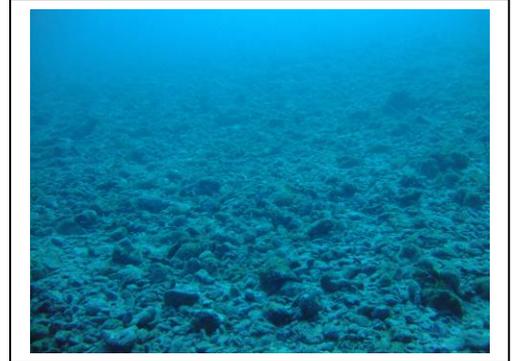
11/12/2008

W 158° 11.232

N 21° 35.527

Forereef

Depth: 22-22 m



General site description

This site is located off Mokuleia, in front of the small airfield. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The forereef ended at about 70 ft, followed by small rubble area, and followed by sand. There appears to be some nice patch reefs beyond the sandy area. The transect lines were placed on the rubble area at the base of the forereef, which was the targeted depth. Coral cover was low, as well as complexity. Fish diversity was low. Notable sightings include a large marble ray and a shark (most likely a Galapagos).

OAH-51

11/12/2008

W 158° 17.593

N 21° 34.477

Forereef

Depth: 20-22 m



General site description

This site is located directly off Kaena point. It was established by the REA fish team as a new sampling location in the deep forereef stratum. The site was characterized by a complex reef with moderate coral cover and high complexity. Current was calculated at 2 knots, which prevented quantitative data collection. Fish diversity was relatively high. Notable sightings include a large school ~ 50 large chubs and large schools of *Naso hexacanthus*. This site should be attempted only between tides.

OAH-52

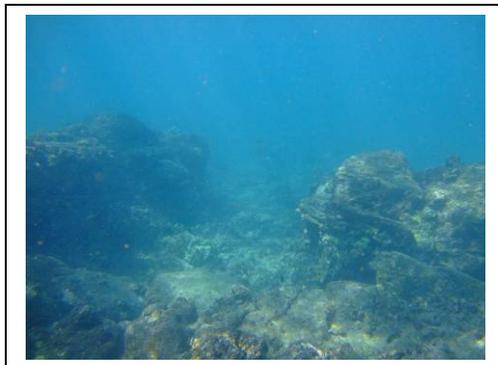
11/12/2008

W 158° 16.637

N 21° 34.324

Forereef

Depth: 4-5 m



General site description

This site is located on the southern section of Kaena point. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. Coral cover was moderate; complexity was medium-high. Fish diversity was moderate. Few medium-large fishes were recorded. No notable sightings.

OAH-53

11/12/2008

W 158° 13.931

N 21° 28.753

Forereef

Depth: 22-22 m

No picture available.

General site description

This site is located north of Makaha. It was established by the REA fish team as a new sampling location in the deep forereef stratum. Visibility was very poor but cleared quickly at the 80 ft depth contour. The site is characterized by a moderate drop-off with nice arches/caves followed by a rubble/sand field and some patch reefs offshore. Transects were laid at the base of the drop-off in the rubble area. Coral cover was low; complexity moderate. Fish diversity was low, with very little medium-large fishes. Almost no fish larger than 20 cm were observed, on or off transect.

OAH-54

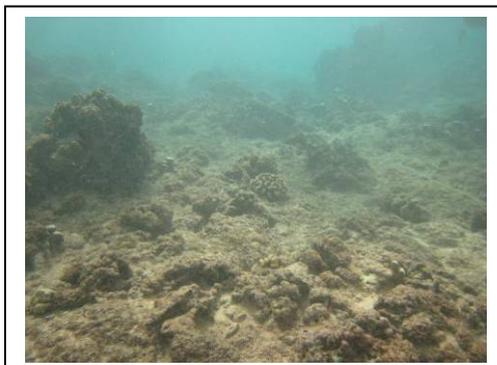
11/12/2008

W 158° 13.828

N 21° 30.667

Forereef

Depth: 3-4 m



General site description

This site was located southeast of Kaena Point, in front of a lone house on the beach. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The substrate was shallow spur and groove with moderate to high complexity. There was a high abundance of *Echinometra mathei*, adding an additional level of complexity to the reef. There was abundant *Amansia glomerata*, crustose coralline algae, and turf algae. Fish abundance and diversity was low, dominated by smaller fishes including *Thalassoma duperrey*, *Chromis vanderbilti*, *Stethojulis balteata*, and *Acanthurus nigrofuscus*. One *T. ballieui* was counted on the transect. Of notable interest was the abundance of young-of-the-year present at this site, including *A. triostegus*, *A. olivaceus*, *Naso unicornis*, *N. lituratus*, *Parupeneus multifasciatus*, and *P. pleurostigma*.

OAH-55

11/13/2008

W 157° 40.530

N 21° 21.708

Forereef

Depth: 21-21 m



General site description

This site was located southeast of Kaena Point, in front of a lone house on the beach. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. The substrate was made up of pavement with low relief, mostly large rubble and coral outcroppings of *Porites lobata* and *Pocillopora meandrina*. Turf algae with sand patches covered much of the pavement. Fish diversity and abundances were relatively low, with small fishes being dominant. The fish assemblage was unremarkable.

OAH-56

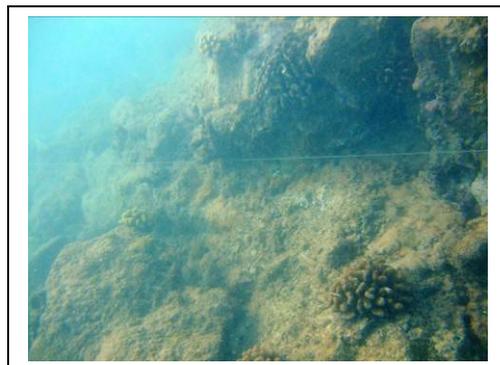
11/13/2008

W 157° 42.020

N 21° 23.519

Forereef

Depth: 3-3 m



General site description

This site was located on the southeast shore of O`ahu, on the inland side of the northern Mokulua Island. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. Coral cover here was low, consisting primarily of small patches of *Pocillopora*

heads, *Montipora* sp., and *Porites lobata*. The substrate was mostly pavement covered in turf, with small boulders and rocks providing some relief. Fish abundance and diversity were low, with the small *Plectroglyphidodon imparipennis* dominating. *Staegastes fasciolatus*, and *Thalassoma duperrey* were also common.

OAH-57

11/13/2008

W 157° 39.587

N 21° 19.618

Forereef

Depth: 4-4 m



General site description

This site was located off the southeastern most area of O`ahu on the west (inland) facing side of Rabbit Rock. It was established by the REA fish team as a new sampling location in the shallow forereef stratum. This site is characterized by having high coral cover dominated by medium-sized *Porites* spp. mounds, with a variety of corals present, including *Pocillopora* spp., *Montipora* spp., *Pavona varians*, and various zoanths. There was a noticeable abundance of *Echinothrix* spp. Algae were inconspicuous, save for turfs, crustose coralline algae, and *Amansia glomerata* in crevices. Fish abundance and richness were moderate, represented primarily by smaller fishes. The moderate-sized fishes included *Scarus rubroviolaceus*, *Naso lituratus* and *Gymnomuraena zebra*. Additionally, a *Cheilio inermis* and a *Fistularia commersonii* were sighted on the present swim. The most common fishes counted were *Stegastes fasciolatus*, *Acanthurus nigrofuscus*, *Thalassoma duperrey*, and *Chromis vanderbilti*. Also, schooling *Abudefduf abdominalis* and *A. vaigiensis* were present in the water column.

OAH-59

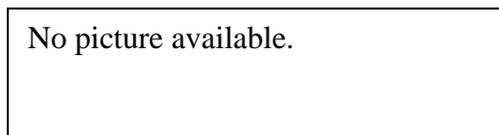
11/13/2008

W 157° 38.891

N 21° 17.933

Forereef

Depth: 21-21 m



General site description

This site was located off the Makapuu lighthouse in the deep forereef stratum. The bottom was a mix of boulders, pavement, and complex reef structure. Coral cover was low with moderate complexity. Fish diversity was relatively high. Medium-large fishes were moderately abundant (e.g., *Cephalopholis argus*, *Coris flavovittata*).

J.3. Benthic Environment

J.3.1 Algae

Benthic communities around O`ahu were dominated by the turf algal functional group (Table J.3.1.1). Turf algae were documented with the highest percent cover at 5 of the 6 sites surveyed with a percent cover range of 21.3% to 66.8%. Coral percent cover exceeded that of other functional groups at site OAH-14 and had the second highest percent cover at 3 of the 6 sites with a percent cover range of 4% to 49.7% (Table J.3.1.1). The macroalgal functional group also had the second highest percent cover at 3 of the survey sites with a percent cover range of 7.2% to 25.2%. A combined total of 22 species of macroalgae were observed (7 chlorophytes, 4 ochrophytes, 11 rhodophytes) from the 6 sites surveyed (Tables J.3.1.2, J.3.1.3). *Lobophora variegata* was ubiquitous across all sites and *Halimeda discoidea* was a prominent component of the macroalgal community at 5 of the 6 sites. Both *L. variegata* and *H. discoidea* dominated the macroalgal community at 2 of the 6 sites with equal percent cover at a fifth site. Percent cover range across all sites was 1.3% to 7.6% for *L. variegata* and 0% to 13.5% for *H. discoidea* (Table J.3.1.3). *Asparagopsis taxiformis* was the most prevalent macroalgal species at site OAH-03 with a percent cover of 6.4% but was absent from 4 of the 5 other sites (Table J.3.1.3).

Table J.3.1.1.--Percent cover of algal functional groups at long-term monitoring sites at O`ahu.

Site	Macroalgae	Turf Algae	Coralline Red Algae (crustose + upright)	Cyanobacteria	Coral
OAH-02	22.4%	66.8%	6.0%	-	4.0%
OAH-03	11.6%	49.4%	3.4%	-	32.6%
OAH-04	18.4%	64.4%	3.6%	2.4%	9.2%
OAH-12	8.4%	54.8%	12.0%	0.8%	23.2%
OAH-14	25.2%	21.3%	3.9%	-	49.7%
OAH-15	7.2%	42.4%	6.0%	1.2%	40.8%

Table J.3.1.2.--Additional species recorded at each site at O`ahu during roving diver survey.

Site	Chlorophyta
OAH-12	<i>Caulerpa peltata</i>
OAH-14	<i>Dictyosphaeria cavernosa</i>
OAH-14	<i>Halimeda opuntia</i>
OAH-12	<i>Halimeda velasquezii</i>
OAH-02	<i>Neomeris sp.</i>
OAH-03	
OAH-04	
OAH-12	
OAH-14	
OAH-15	
	Ochrophyta

OAH-02	<i>Dictyota ceylanica</i>
OAH-03	<i>Lobophora variegata</i>
OAH-03 OAH-15	<i>Padina</i> sp.
OAH-12 OAH-15	<i>Turbinaria ornata</i>
	Rhodophyta
OAH-15	<i>Amansia glomerata</i>
OAH-03	<i>Dotyella hawaiiensis</i>
OAH-02	<i>Galaxaura</i> sp.
OAH-04 OAH-14 OAH-15	<i>Gibsmithia hawaiiensis</i>
OAH-12	<i>Haloplegma duperreyi</i>
OAH-03	<i>Laurencia galtsoffii</i>
OAH-03	<i>Martensia fragilis</i>
OAH-14 OAH-15	<i>Martensia</i> sp.
OAH-14	<i>Portieria hornemannii</i>
OAH-14 OAH-15	<i>Wrangelia</i> sp.

Table J.3.1.3.--Percent cover of macroalgal species at long-term monitoring sites at O`ahu. Sum totals for each row equal the percent cover of macroalgae recorded in Table A.

Site	<i>Caulerpa taxifolia</i>	<i>Halimeda discoidea</i>	<i>Dictyota ceylanica</i>	<i>Lobophora variegata</i>	<i>Padina</i> sp.	<i>Asparagopsis taxiformis</i>	<i>Haloplegma duperreyi</i>	<i>Laurencia galtsoffii</i>	<i>Portieria hornemannii</i>
OAH-02	-	3.6%	-	3.6%	-	-	-	-	-
OAH-03	-	1.3%	-	1.3%	-	6.4%	-	1.3%	0.4%
OAH-04	-	4.4%	-	2.8%	-	-	-	-	-
OAH-12	-	-	0.8%	7.6%	-	-	-	-	-
OAH-14	1.3%	13.5%	0.6%	1.3%	0.6%	3.2%	1.9%	-	-
OAH-15	-	2.8%	-	3.6%	-	-	0.8%	-	-

J.3.2. Corals

J.3.2.1 Coral Populations

Line-point intercept surveys indicated relatively high coral cover (26.6 ± 7.3 %) at REA sites around O`ahu in 2008 (Fig. J.3.2.1.1, left). Benthic habitat was dominated by forereef. Species richness varied between sites with 8 genera (7 scleractinian and 1 zoanthid) being represented

within belt transect surveys. Coral composition was dominated by encrusting colonies of *Montipora* (49.9%), both branching and encrusting *Porites* (35.3%) colonies and branching *Pocillopora* (12.3%) heads (Fig. J.3.2.1.1, right). Relative abundance indicates colonies of *Porites lobata* (35.0%), *Montipora capitata* (19.9%) and *M. patula* (18.1%) were the most common species observed (Table J.3.2.1.1).

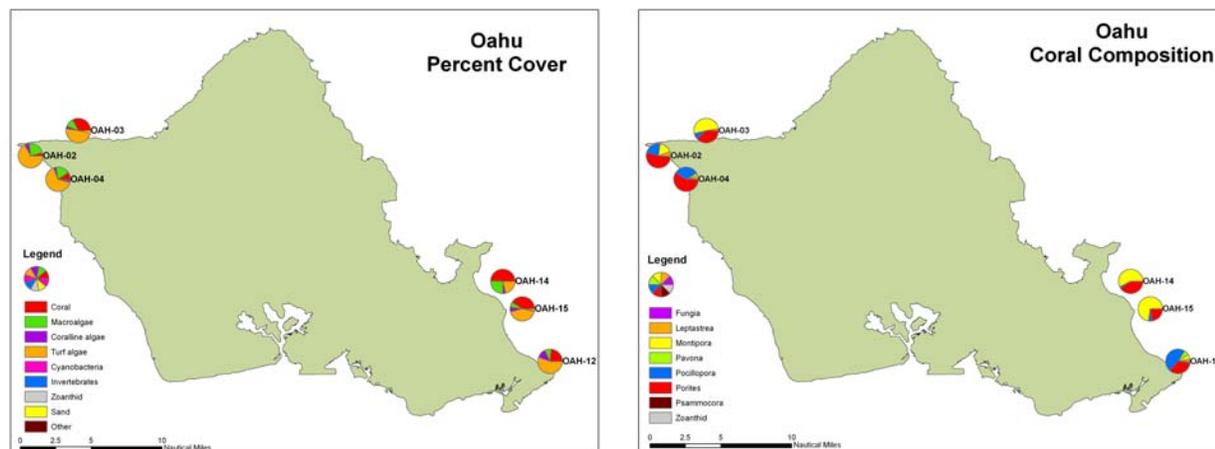


Figure J.3.2.1.1.--Spatial distribution of benthic cover (left) and coral composition (right) for REA sites around O`ahu in 2008.

Table J.3.2.1.1.--Relative percentage of coral taxon enumerated within belt transects for benthos around O`ahu in 2008.

Taxon Name	No. of Colonies	Relative Abundance
<i>Cycloseris</i> sp.	1	0.08
<i>Leptastrea bewickensis</i>	7	0.58
<i>Leptastrea purpurea</i>	6	0.49
<i>Leptastrea transversa</i>	4	0.33
<i>Montipora capitata</i>	242	19.90
<i>Montipora flabellata</i>	17	1.40
<i>Montipora incrassata</i>	2	0.16
<i>Montipora</i> sp.	1	0.08
<i>Montipora patula</i>	220	18.09
<i>Palythoa</i> sp.	15	1.23
<i>Porites brighami</i>	3	0.25
<i>Porites compressa</i>	7	0.58
<i>Pavona duerdeni</i>	20	1.64
<i>Porites evermanni</i>	18	1.48
<i>Pocillopora ligulata</i>	1	0.08
<i>Porites lobata</i>	426	35.03
<i>Pocillopora meandrina</i>	130	10.69
<i>Pocillopora</i> sp.	61	5.02
<i>Porites</i> sp.	28	2.30
<i>Psammocora stellata</i>	5	0.41
<i>Pavona varians</i>	2	0.16

J.3.2.2 Coral Health

During 2008 REA surveys, occurrence of compromised coral health states was low (2.1%). Only members of the genera *Montipora* (0.9%) and *Porites* (49.1%) were found to be affected (Fig. J.3.2.2.1). Subacute tissue loss (33.6%) and skeletal growth anomalies (11.8%) were observed on *Porites* colonies, while only skeletal growth anomalies (0.9%) were observed on *Montipora* colonies. Coral bleaching was not observed in 2008 around O`ahu.

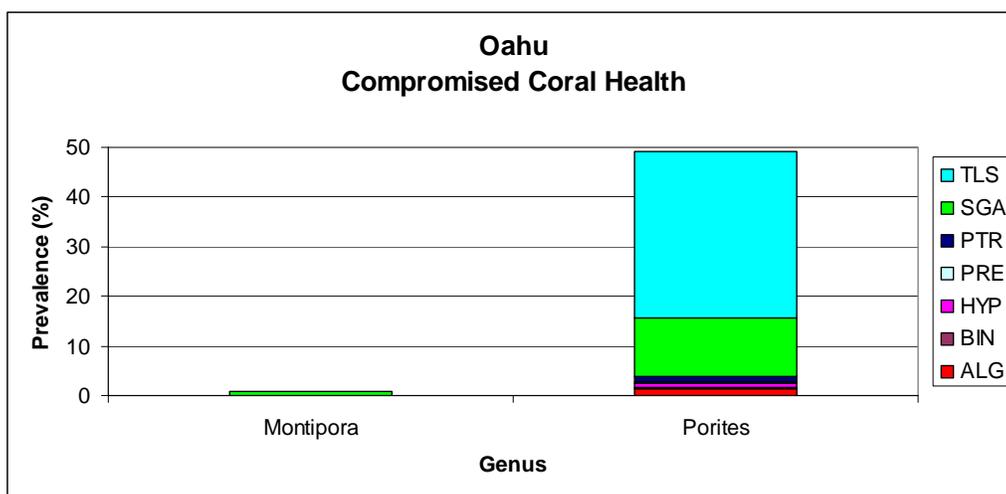


Figure J.3.2.2.1.--Prevalence of compromised coral health states by taxon around O`ahu in 2008.

Percent mortality of colonies surveyed during 2008 varied between genera (Fig. J.3.2.2.2). In 2008, *Pavona* colonies observed in belt transects were found to have a little over 30% of dead tissue. Dead tissue was also observed on colonies of *Porites* (8.7%) and *Leptastrea* (6.3%). Other genera, such as *Cycloseris* and *Psammocora*, were observed to have 100% live tissue.

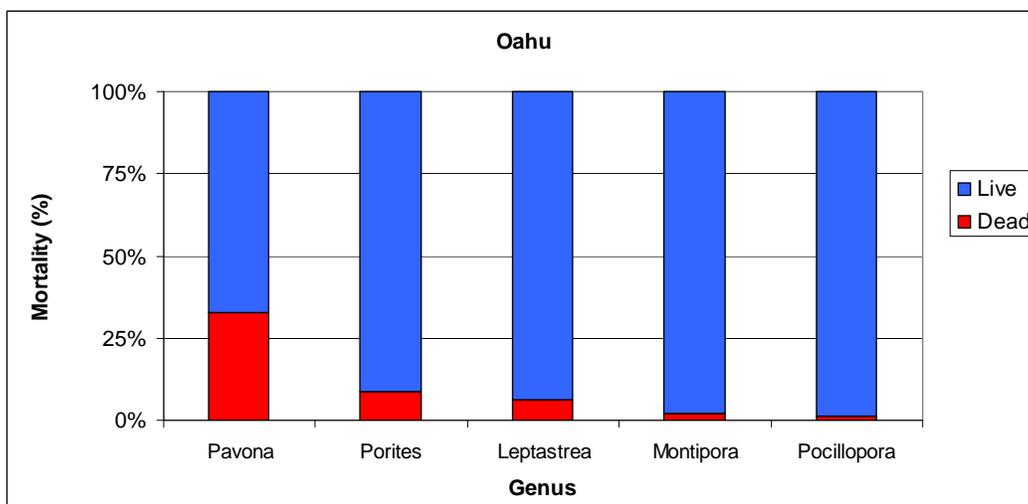


Figure J.3.2.2.2.--Mean percent of live versus dead tissue for various coral genera at O`ahu in 2008.

J.3.3. Noncoral Invertebrate Surveys

A total of 1378 individuals of benthic invertebrate target species or taxa group were enumerated from 6 belt transects at 3 sites. High numbers of individuals were recorded despite the small sample size. Echinoids dominated the counts of benthic macroinvertebrates, as the 3 most abundant organisms recorded on the transects were urchins. The rock-boring urchin *Echinometra mathaei* was found in exceedingly high numbers. The highest density was recorded at site OAH-02, where 6.24 individuals per m² were observed. The urchin, *Echinostrephus aciculatus*, was also very abundant. A density of 5.55/m² was recorded at site OAH-02. *Echinothrix* sp. was the third highest macroinvertebrate in overall average abundance. Of note was the presence of one *Octopus* sp. at OAH-03. Very few generalizations can be made about the overall species composition of O`ahu invertebrates due to the small number of sites surveyed.

J.3.3.1. Urchin Measurements

No urchin measurements were made for the island of O`ahu.

J.3.3.2. ARMS Deployment

OAH-14

Deployed 1 ARM ~ 13.7 m. Substrate very hard.
21 24.724' N 157 42.580' W; 13-NOV-2008

OAH-15

Deployed 2 ARMS ~ 13.7 m
21 22.887' N 157 41.195' W; 13-NOV-2008

OAH-12

Deployed 3 ARMS ~ 15 m
21 19.172' N 157 39.235' W; 13-NOV-2008

J.3.4. Towed-diver Benthic Surveys

A total of 12 towed-diver surveys were conducted off the coast of O`ahu in 2008. Surveys coverage was split between northwest O`ahu (2 tows in northwest region and 4 tows in west region) and east O`ahu (6 tows, Fig. J.3.4.1). For information on survey area (tow length), average depth, and average water temperature, please see the Towed-diver Fish Section.



Figure J.3.4.1.--Locations of 12 towed-diver surveys around O`ahu in 2008. Colors represent habitat bottom type (hard, soft, or hard/soft).

Tows in the east region were conducted mostly over hard bottom habitat which consisted of pavement, continuous reef, and rock boulders. Tows in the northwest region covered continuous reef and pavement with some high relief pinnacles occurring fairly regularly. The west region consisted of mostly pavement with several areas of sand flats. Due to limited area coverage with regards to the island as a whole, island averages are not presented. Instead, means (percent cover) and total (invertebrate counts) values are presented for each region. The overall averages for substrate composition and macroinvertebrate population densities are illustrated in the Table J.3.4.1 and Figure J.3.4.2.

Coral cover was highest within the northwest region (mean: 21%). Coral cover was quite low throughout the west region except for slightly higher cover near Kaena Point. Stressed coral estimates were low for all regions. Macroalgae was highest in the northwest and west regions while coralline algae percent cover was relatively low in all regions. The most common macroinvertebrate was free urchins which were abundant in both the east and west regions. Few COTs were observed with only 5 individuals seen in the east region and 11 observed in the west.

Table J.3.4.1.--Mean percent cover and macroinvertebrate totals by tow region.

Region	Hard Coral	Stress Coral	Macro-algae	Coralline Algae	COTs	Free Urchins	Boring Urchins	Sea Cucumbers
East	13	1	9	7	5	5255	2505	11
Northwest	21	2	27	2	0	96	8	3
West	5	0	17	4	11	5040	668	10

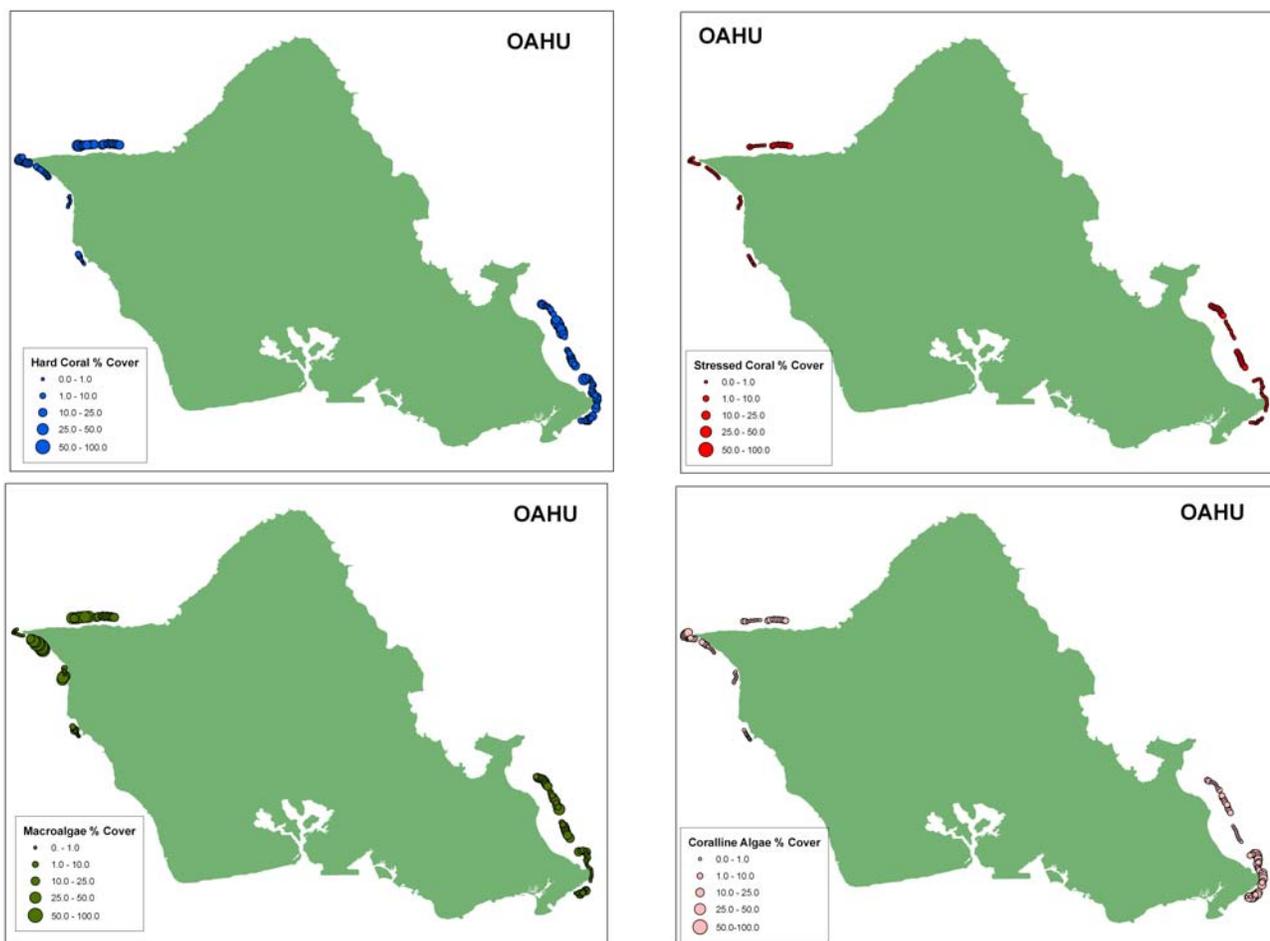


Figure J.3.4.2.--Distribution of coral cover, stressed coral, macroalgae, and coralline algae around O`ahu in 2008.

J.4 Fish

J.4.1 REA Fish Surveys

During the survey period, belt transect surveys were conducted at 14 sites around O`ahu. Surgeonfish were the largest contributor to total biomass with $0.93 \text{ kg } 100 \text{ m}^{-2}$. Triggerfish were the second largest contributor to total biomass with $0.43 \text{ kg } 100 \text{ m}^{-2}$, followed by parrotfish at $0.33 \text{ kg } 100 \text{ m}^{-2}$ (Table J.4.1.1 and Fig. J.4.1.1).

Overall Observations

A total of 130 fish species were observed during the survey period by all divers. The average total fish biomass around O`ahu during the survey period was $2.75 \text{ kg } 100 \text{ m}^{-2}$ for the belt transect surveys (Table J.4.1.1).

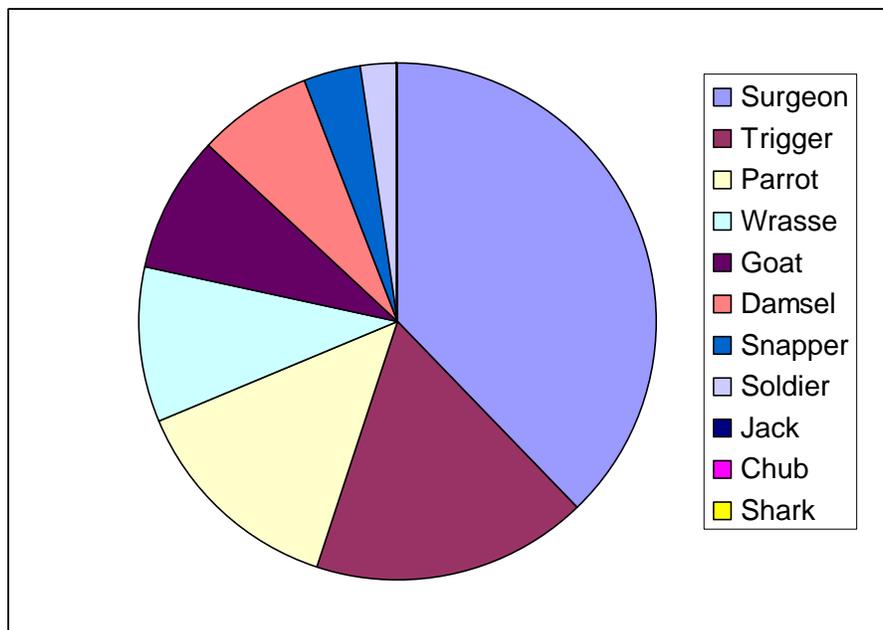


Figure J.4.1.1.--Total fish biomass composition by family.

Table J.4.1.1.--Coral reef fish biomass (kg 100 m⁻²) at sites around O`ahu.

Depth	Site	Total	Chub	Damsel	Goat	Jack	Parrot	Shark	Snapper	Soldier	Surgeon	Trigger	Wrasse
Deep	OAH-50	0.74	0.00	0.01	0.04	0.04	0.00	0.00	0.00	0.00	0.12	0.39	0.12
Deep	OAH-53	0.38	0.00	0.00	0.03	0.00	0.02	0.00	0.00	0.00	0.01	0.10	0.12
Deep	OAH-55	0.83	0.00	0.02	0.01	0.00	0.01	0.00	0.00	0.01	0.22	0.29	0.18
Deep	OAH-59	4.06	0.00	0.11	0.09	0.00	0.83	0.00	0.00	0.00	1.76	0.19	0.65
Mid	OAH-02	3.57	0.00	0.18	0.30	0.00	1.00	0.00	0.00	0.00	1.20	0.62	0.20
Mid	OAH-03	9.32	0.00	0.67	1.55	0.00	0.07	0.00	1.08	0.68	3.59	0.40	0.24
Mid	OAH-04	5.15	0.00	0.09	0.77	0.00	0.01	0.00	0.21	0.00	1.88	1.39	0.10
Mid	OAH-12	4.11	0.00	0.38	0.02	0.00	0.22	0.00	0.00	0.00	1.16	1.89	0.21
Mid	OAH-14	0.68	0.00	0.03	0.06	0.00	0.12	0.00	0.00	0.00	0.15	0.11	0.16
Mid	OAH-15	2.26	0.00	0.03	0.00	0.00	0.94	0.00	0.00	0.00	0.70	0.14	0.14
Shallow	OAH-52	1.46	0.00	0.20	0.08	0.00	0.17	0.00	0.00	0.00	0.64	0.07	0.17
Shallow	OAH-54	1.51	0.00	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.73	0.28	0.29
Shallow	OAH-56	1.27	0.00	0.19	0.00	0.00	0.36	0.00	0.00	0.00	0.34	0.00	0.32
Shallow	OAH-57	3.13	0.00	0.44	0.00	0.00	0.90	0.00	0.00	0.00	0.48	0.07	0.44
	Total	2.75	0.00	0.17	0.22	0.00	0.33	0.00	0.09	0.05	0.93	0.43	0.24

J.4.2. Towed-diver Fish Surveys

During the SE-08-10 MHIRAMP cruise, the CRED towed-diver team completed 12 surveys at O`ahu covering 27 km (27 ha) of ocean floor (Table J.4.2.1). Mean survey length was 2.3 km with a maximum length of 2.8 km and a minimum of 1.6 km. Mean survey depth was 15.2 m with a maximum depth of 16.7 m and a minimum of 13.8 m. Mean temperature on these surveys was 25.7 °C with a maximum temperature of 26.3 °C and a minimum of 25.2 °C.

Table J.4.2.1.--Survey statistics for towed-diver sampling during the SE-08-10 MHIRAMP cruise.

Island/Atoll/Reef	#	Length (km)					Depth (m)				Temperature (°C)				Numeric Density (#/ha)	Biomass Density (t/ha)
		Sum	Mean	Max	Min	SD	Mean	Max	Min	SD	Mean	Max	Min	SD		
Kure	14	32	2.3	2.7	1.8	0.02	8.2	16.5	0.9	5.9	26.8	27.3	25.5	0.4	5.361	0.028
Midway	16	39	2.4	3.2	1.9	0.03	9.0	16.9	0.7	5.9	27.2	28.0	26.9	0.3	10.456	0.035
Pearl & Hermes	27	63	2.3	3.1	1.3	0.03	10.3	16.3	1.2	5.2	27.3	27.9	26.8	0.3	13.214	0.090
Lisianski	12	24.7	2.1	2.3	1.7	0.02	10.0	14.2	1.6	3.9	28.0	28.2	27.8	0.1	1.944	0.011
Laysan	5	11.5	2.3	2.5	2.1	0.01	11.8	13.6	9.2	1.5	27.9	28.0	27.8	0.1	5.524	0.027
Maro Reef	11	23.4	2.1	2.4	1.7	0.01	13.3	16.5	9.5	1.8	28.2	28.4	27.9	0.1	2.308	0.039
French Frigate	26	56.5	2.2	2.9	1.4	0.03	11.5	17.1	1.8	4.5	27.6	28.3	26.9	0.2	5.824	0.051
Lehua Rock	3	6.5	2.2	2.2	2.0	0.08	13.9	15.2	13.0	1.0	26.0	26.1	25.9	0.1	6.785	0.177
Niihau	14	28.4	2.0	2.9	0.4	0.5	15.4	18.5	11.6	2.1	26.1	26.2	25.9	0.1	4.051	0.013
Kauai	18	42.2	2.3	2.8	1.8	0.02	14.5	19.8	11.2	2.4	26.0	26.4	25.7	0.2	2.229	0.012
Oahu	12	27	2.3	2.8	1.6	0.03	15.2	16.7	13.8	0.9	25.7	26.3	25.2	0.4	1.372	0.016
Molokai	12	30	2.5	3.4	1.9	0.04	14.8	16.2	13.1	0.9	25.8	26.2	25.3	0.3	3.963	0.017
Maui	28	65	2.3	3.0	1.4	0.3	14.1	17.0	9.5	1.4	25.6	26.4	24.8	0.4	2.373	0.007
Lanai	12	32	2.7	3.4	2.2	0.3	14.1	16.1	12.4	1.2	26.0	26.4	25.5	0.3	1.804	0.005
Hawaii	41	91	2.2	2.9	0.8	0.4	13.9	16.6	11.7	1.2	25.6	26.2	25.3	0.2	3.556	0.016

At O`ahu, 37 individual large-bodied reef fish (> 50 cm in total length) of 11 different species and 10 different families were encountered (Table J.4.2.2). Overall numeric density of reef fishes was 0.014 #/100 m² (1.372 #/ha) with a biomass density of 0.164 kg/100 m² (0.016 t/ha).

Numeric density was dominated by *Scarus rubroviolaceus*, while biomass density was dominated by *Chanos chanos*. The most common families in terms of numeric density were Scarids (32%), Chanids (19%), and Myliobatids (16%) (Fig. J.4.2.1). Biomass was dominated by Chanids (42%), Myliobatids (31%), and Carcharhinids (15%). (Fig. J.4.2.2). The 2008 surveys around O`ahu were limited to Kaena Point at the far northwestern tip of the island and Makapu`u Point at the eastern tip. As such, not much can be said about the geographic distribution of biomass around the island. At this time, it appears that biomass was similar at these 2 locations while species composition differed (Fig. J.4.2.3). *Chanos chanos* was encountered only during the western surveys while *Triodon obesus* was encountered only in the east.

Table J.4.2.2.--Species numeric and biomass density for large-bodied reef fish (> 50 cm in total length) observed at O`ahu during the SE-08-10 MHIRAMP cruise CRED Towed-Diver surveys.

Species	#	#/100m ²	#/ha	Biomass (kg)	kg/100m ²	t/ha
Aetobatus_narinari	6	0.002	0.223	134.0615227	0.050	0.005
Aprion_virescens	1	0.000	0.037	10.03766097	0.004	0.000
Aulostomus_chinensis	1	0.000	0.037	0.196395009	0.000	0.000
Bodianus_bilunulatus	1	0.000	0.037	1.825	0.001	0.000
Chanos_chanos	7	0.003	0.260	182.0287533	0.068	0.007
Fistularia_commersonii	4	0.001	0.148	0.66984372	0.000	0.000
Gymnothorax_flavimarginatu	1	0.000	0.037	7.797685395	0.003	0.000
Gymnothorax_meleagris	1	0.000	0.037	2.1	0.001	0.000
Naso_unicornis	1	0.000	0.037	2.567473762	0.001	0.000
Scarus_rubroviolaceus	12	0.004	0.445	32.14579815	0.012	0.001
Triadenodon_obesus	2	0.001	0.074	68.07683314	0.025	0.003
Grand Total	37	0.014	1.372	441.507	0.164	0.016
# of Species	11					

Numeric Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Oahu During 2008 CRED Towed-Diver Surveys

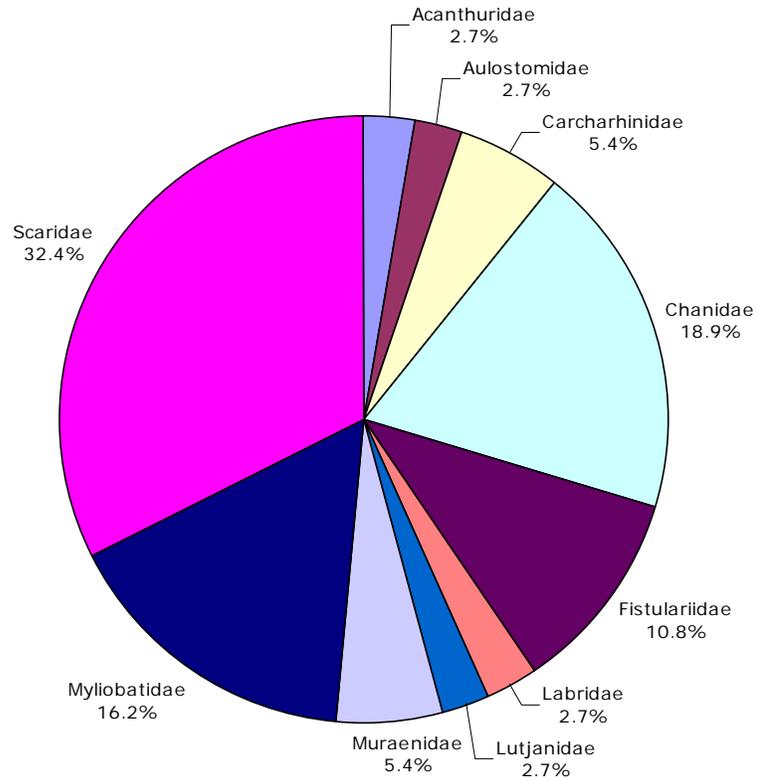


Figure J.4.2.1.--Numeric density by family.

Biomass Density Contribution by Family for Large-Bodied Reef Fish (>50cmTL) observed at Oahu During 2008 CRED Towed-Diver Surveys

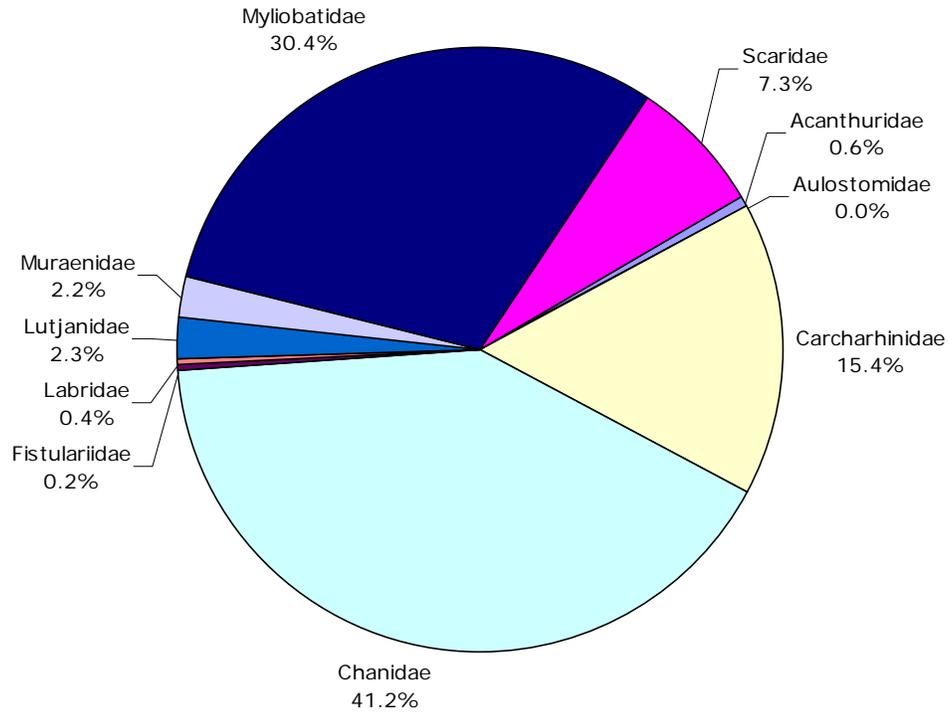


Figure J.4.2.2.--Biomass density by family.

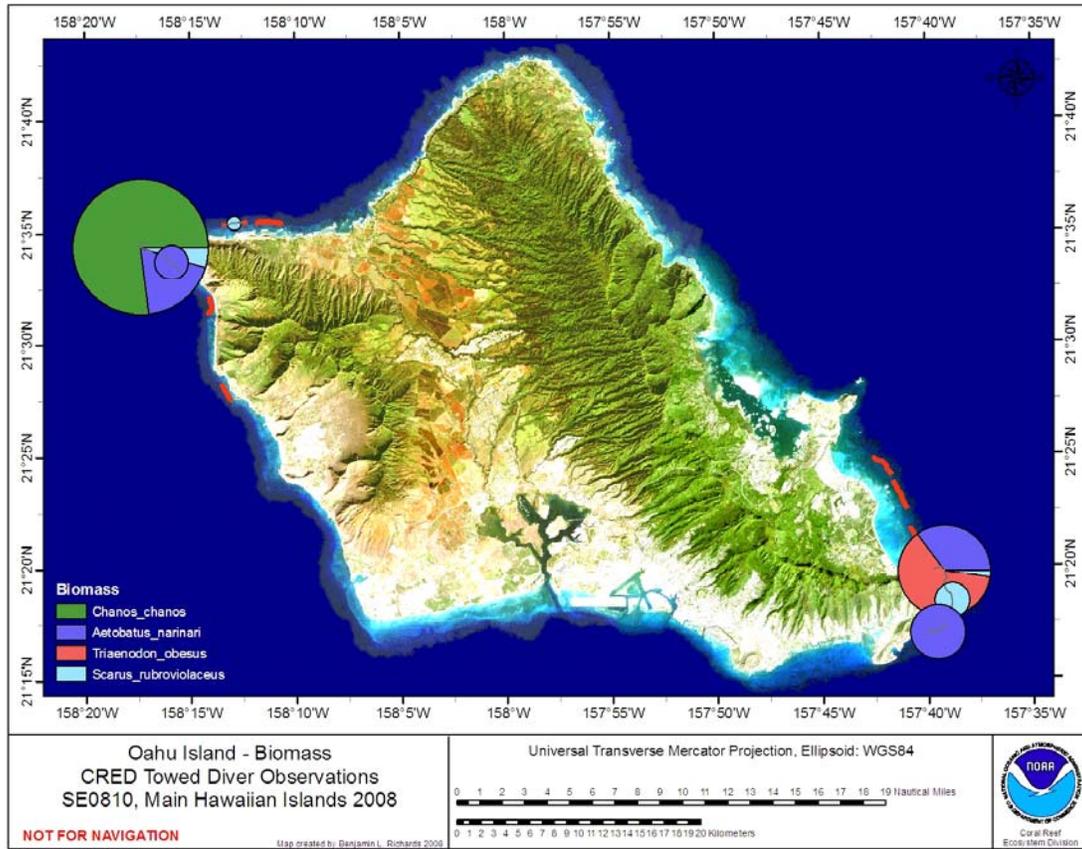


Figure J.4.2.3.--Geographic distribution of biomass around O`ahu. Each species is represented by a legend color. Diameter of pie chart is proportional to total biomass of all species encountered on the underlying survey.