

December 2, 2004 F/PIC:PSV:FLF
CR0401HI-1.PSV

CRUISE REPORT

**VESSEL:
CRUISE** *Hi`ialakai*, Cruise 04-01 (Fig. 1)

PERIOD: 13 September-17 October 2004

**AREA OF
OPERATION:** Northwestern Hawaiian Islands

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

ITINERARY:

13-14 September Start of cruise. Embarked Randy Kosaki (fish), Craig Musburger (fish), Darla White (fish), Greta Aeby (coral), Jean Kenyon (coral), Ranya Henson (invertebrates), Peter Vroom (algae), Erin Looney (algae), Joe Laughlin (towboard/fish), Brian Zgliczynski (towboard/fish), Molly Timmers (towboard/habitat), Casey Wilkinson (towboard/habitat), Stephani Holzwarth (moorings/tow), Kyle Hogrefe (moorings/tow), Danny Merritt (moorings/tow), Elizabeth Keenan (moorings/tow), Scott Ferguson (QTC/TOAD/CTD), Susan Middleton (Educational), Dan Suthers (Terrestrial), David Liistchswager, and June Firing (data management). Departed Snug Harbor at 0900 for small boat drills. Departed Oahu at 2000 en route to French Frigate Shoals to commence cruise.

15 September Arrived at French Frigate Shoals in late afternoon. Conducted small boat launch and recovery and unconscious diver rescue.

16 September Began work at French Frigate Shoals. Completed four tows on northern fore- and backreefs. Conducted three fish and benthic REA surveys in forereef and lagoonal areas on the northwestern

area of the atoll. Deployed new CREWS buoy anchor and CREWS buoy. No night operations.

- 17 September Continued work at French Frigate Shoals. Completed four tows: three in the northern lagoon, one east backreef. Conducted three fish and benthic REA surveys in lagoonal areas northeast of Tern Island. Recovered two and deployed three STRs and completed five shallowwater CTDs. The educational team photographed organisms around La Perouse Pinnacle.
- 18 September Continued work at French Frigate Shoals. Completed four tows along the northeastern forereef. Conducted two benthic REA surveys: one northern backreef and one lagoonal patch reef. Fish collections occurred at three lagoonal sites. The mooring team completed deployment of the CREWS buoy by securing shackles and placing settlement plates around the base, then completed seven shallowwater CTDs, two radiometer casts, and water was sampled at two sites (with a total of six samples at each site). The educational team spent the day on Tern Island photographing juvenile sea turtles. Night operations included three TOAD surveys and two deepwater CTDs.
- 19 September Continued work at French Frigate Shoals. Completed five tows along the southeastern fore- and backreefs. Conducted three REA surveys: one southern forereef and two lagoonal patch reefs. The mooring team recovered and replaced one STR and recovered another STR that was unreachable on September 17. Two radiometer casts, three shallowwater CTDs, and one water sampling protocol were also completed. Departed for Gardner Pinnacles at 1800 and completed one deepwater CTD southeast of Gardner Pinnacles.
- 20 September Arrived at Gardner Pinnacles. Completed two tows around the pinnacles, and three REA surveys at both ends and on the leeward side of the exposed rocks. The mooring team recovered and replaced one STR and conducted nine CTD casts. Water samples were collected at two sites. Departed for Maro Reef at 1800 conducting one deepwater CTD en route slightly southeast of Maro.
- 21 September Arrived at Maro Reef and began scientific monitoring on the south side. Very murky conditions hampered some activities. Four towed-diver surveys were completed. REA teams conducted three surveys. The mooring team collected and replaced two STRS, completed two water samples, and eight shallowwater CTDs. Night operations occurred on the windward side of reef. Four TOAD surveys and two deepwater CTDs were completed.

- 22 September Continued work at Maro Reef. Conducted three REA surveys at northern sites, although the normal benthic sampling regime was not possible at site R9 because of strong current. Four towed-diver surveys were completed, and the mooring team deployed a new CREWS buoy anchor and retrieved the old anchor and buoy. Eight shallowwater CTD casts were made and one water sampling station visited. Five TOAD surveys and two deepwater CTDs were completed.
- 23 September Continued work at Maro Reef. Conducted three REA surveys at sites located toward the center of the reef. Four towed-diver surveys were completed in the central portion of the reef. The mooring team completed deployment of the new CREWS buoy and conducted three shallowwater CTD casts. Departed for Laysan Island at 1800 conducting one deep water CTD en route slightly southeast of the island.
- 24-25 September Arrived at Laysan Island. Because of heavy swells, all three REA sites were located on the leeward and south sides of the island. Five towed-diver surveys were completed. The mooring team retrieved and replaced two STRs, retrieved and replaced an SST buoy, and completed eight shallowwater CTDs. Four TOAD surveys and one deepwater CTD were completed. Began transit to Pearl and Hermes Reef.
- 26 September One deepwater CTD was completed southeast of the atoll during early morning hours. Arrived at Pearl and Hermes Reef. Completed five tows on eastern fore- and backreefs. Conducted three fish and benthic REA surveys in forereef, backreef, and lagoonal areas in the southeastern part of the atoll. Retrieved and replaced CREWS buoy and CREWS buoy anchor. Five TOAD surveys and two deepwater CTDs were completed.
- 27 September Continued work at Pearl and Hermes Atoll. Completed five tows on northeastern side of atoll: three forereef and one backreef. Conducted three fish and benthic REA surveys in forereef, backreef, and lagoonal areas in the northern part of the atoll. The mooring team deployed an STR and coral settlement plates at the CREWS buoy and recovered and replaced an additional two STRs at northern areas of the atoll. Seventeen shallowwater CTDs, 3 radiometer casts, and 9 chlorophyll/water samples were completed. The educational team conducted one dive to photograph reef organisms. Night operations included six TOAD surveys and two deepwater CTDs, one of which was aborted after accidentally hitting bottom.
- 28 September Continued work at Pearl and Hermes Atoll. The towed-diver team completed three tows on southern side of atoll, transferred 150

gallons of fuel from the Casitas, and made two fish collection dives. The benthic REA team completed three REA surveys in one forereef and two backreef areas on the southern part of the atoll. The fish REA team collected fish for DNA analyses. Both REA teams visited possible wrecks of the Pearl and Hermes during their surface intervals. The mooring team replaced 1 STR and deployed another, conducted 11 shallowwater CTDs, 3 radiometer casts, and 1 water sample. Night operations included five TOAD surveys and two deepwater CTDs.

- 29 September Continued work at Pearl and Hermes Atoll. The towed-diver team completed five tows on the southwestern side of atoll: two on the forereef and three on the backreef. The REA teams completed three surveys in one forereef and two backreef areas on the southwestern part of the atoll. The mooring team replaced 1 STR, conducted 10 shallowwater CTDs, 3 radiometer casts, and 1 water sample. Night operations included six TOAD surveys and two deepwater CTDs.
- 30 September Continued work at Pearl and Hermes Atoll. A severe thunderstorm in the morning resulted in a small boat recall until after lunch, and scientific activities were reduced as a result. The towed-diver team completed three tows on the northwestern side of atoll: one on the forereef and two on the backreef. The benthic REA team completed two surveys in one forereef and one backreef area on the northernwestern part of the atoll, while the fish REA team collected fish for DNA analyses. The mooring team replaced one STR, conducted five shallowwater CTDs, one radiometer cast, and one water sample, and released back onto the reef fish that had been collected for the educational team. Completed six TOADs and departed for Midway Atoll.
- 1 October Arrived at Midway Atoll. Poor weather somewhat impacted scientific activities. The towed-diver team completed five tows at various locations around the atoll: one on the forereef and four on the backreef. The REA teams completed three surveys in lagoonal and northern backreef areas. The mooring team replaced one SST, installed larval coral settlement plates, replaced three STRs, and conducted two shallowwater CTD casts. No night operations occurred.
- 2 October Continued work at Midway Atoll. The towed-diver team completed three tows along the west to southwest forereef. The REA teams completed two surveys: one western forereef and one southern backreef. The mooring team spent considerable time hunting for the ODP, and found it wedged upside down under an overhang in 90 ft of water. Attempts at recovery failed. An

injured-diver drill occurred after lunch. No night operations occurred.

- 3 October Continued work at Midway Atoll. The towed-diver team completed two tows along the east and southeast backreef. The REA teams completed one survey on a southeastern backreef, while the mooring team continued retrieval efforts on the ODP (again with no success). Night operations consisted of five TOAD surveys and two deepwater CTDs.
- 4 October Continued work at Midway Atoll. The towed-diver team completed five dives: three forereefs on the east to southeast sides, one lagoonal reef, and one tow in the channel. The REA teams conducted surveys on three forereef sites on the south side of the atoll. The mooring team successfully retrieved the ODP, conducted 10 shallowwater CTDs, 6 radiometer casts, and 7 water samples. Night operations consisted of five TOAD surveys and two deepwater CTDs. Departed for Kure Atoll.
- 5 October Arrived at Kure Atoll. The towed-diver team completed five backreef dives around the atoll. The REA teams conducted surveys on two forereef sites and one backreef site on the north/northwest side of the atoll. The mooring team successfully replaced the CREWS buoy and associated STR and deployed new coral settlement plates. One shallowwater CTD was also completed. Night operations included six TOAD surveys and two deepwater CTDs.
- 6 October Continued work at Kure Atoll. The towed-diver team completed four forereef dives around the east and north sides of atoll. The REA teams conducted surveys on one forereef, one backreef, and one lagoonal site. The mooring team swapped two WTRs, completed seven shallowwater CTDs, five radiometer casts, and one water sample. Night operations included six TOAD surveys and two deepwater CTDs.
- 7-8 October Continued work at Kure Atoll. The towed diver team completed four forereef dives. The REA teams conducted surveys on one forereef site and two backreef sites. The mooring team swapped 2 STRs, completed 19 shallowwater CTDs, 2 radiometer casts, and 2 water samples. One shallowwater CTD was also completed. Night operations included six TOAD surveys. Departed for Lisianski Island.
- 9 October Arrived Lisianski Island. The REA teams completed three fish and benthic surveys. The towed diver team completed four tows around Lisianski Island, and the mooring team replaced a WTR and an STR, conducted nine shallowwater CTDs, three radiometer

casts, and one water sample. Night operations consisted of six TOAD surveys and two deepwater CTDs.

- 10 October Continued work at Lisianski Island. The REA teams completed three fish and benthic surveys. The towed-diver team completed three tows and one dive to collect fish. The mooring team swapped a WTR and an SST, installed new coral settlement plates around the SST anchor, and deployed one STR on the SST anchor. Night operations consisted of seven TOAD surveys and two deepwater CTDs.
- 11-13 October Continued work at Lisianski Island. The REA teams completed three fish and benthic surveys. The towed diver team completed four tows. The mooring completed 19 shallowwater CTDs, 2 radiometer casts, and collected 2 water samples. No night operations. Began 2-day transit to Mokumanamana. Conducted a CTD calibration test en route.
- 14 October Arrived at Mokumanamana and conducted six TOAD survey operations. Adverse weather conditions prevented small boat launches or diver surveys. Began transit to Nihoa.
- 15 October Arrived Nihoa. Adverse weather conditions prevented small boat launches or diver surveys. Began transit to Honolulu.
- 16 October Arrive in Honolulu.

Table 1: Cruise statistics for the Northwestern Hawaiian Islands.

CRUISE STATISTICS:

	FFS	Gardner Pinnacles	Maro Reef	Laysan Island	Pearl and Hermes Reef	Midway Atoll	Kure Atoll	Lisianski Island	Mokumanamana	Nihoa	Totals
Towed diver habitat/fish surveys	17	2	12	5	21	15	13	11	0	0	96
Fish rapid ecological assessments	9	3	9	3	9	9	9	9	0	0	60
Benthic rapid ecological assessments	11	3	9	3	14	9	9	9	0	0	67
Radiometer casts	4	0	0	0	9	4	5	5	0	0	27
Water sample stations	4	2	3	2	6	3	3	3	0	0	24
SST buoys deployed	0	0	0	1	0	1	0	1	0	0	3
SST buoys recovered	0	0	0	1	0	1	0	1	0	0	3
STR deployed	5	1	3	2	7	4	3	2	0	0	27
STR recovered	4	1	2	2	5	4	3	1	0	0	22
CREWS buoys deployed	1	0	1	0	1	0	1	0	0	0	4
CREWS buoys recovered	1	0	1	0	1	0	1	0	0	0	4
TOAD drop camera surveys	3	0	7	3	25	9	15	13	6	0	81
Deepwater CTDs	2	1	5	2	8	3	4	4	0	0	29
Shallowwater CTDs	15	9	19	8	44	12	27	28	0	0	162
scuba dives	143	32	90	34	167	104	94	120	0	0	784

MISSIONS AND RESULTS:

- A. Established quantitative methods were used to estimate numerical abundance of fishes and fish species richness. This effort constitutes a second year of monitoring for temporal changes in the NWHI using consistent protocols. Sampling was stratified by three habitat types (forereef, backreef, lagoonal/patch reef). Where possible, three surveys in each habitat type were conducted on the leeward side of each island or atoll (French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Lisianski Island/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll). See Appendix A for individual site descriptions.
1. Sixty historical stations throughout the NWHI were resurveyed for fishes by the three-diver fish REA team. Ocean conditions precluded the establishment of three new stations at Nihoa. Resurveying historical stations confirmed the continued presence of high standing biomass fish assemblages dominated by carangid (jack) and shark apex predators. Fish assemblages continued to be numerically dominated by medium-bodied herbivores (primarily acanthurids) and by large numbers of small-bodied planktivores (primarily pomacentrids, but also chaetodontids and anthiine basslets). Endemic Hawaiian species rarely encountered on shallow reefs in the main Hawaiian Islands (e.g. *Genicanthus personatus*, *Epinephelus quernus*) were regularly seen at the northern three atolls. Species representing faunal links to southern Japan, including *Centropyge interrupta*, were observed at the northern three atolls but were not recorded during transects.
- B. Conducted surveys to document the species composition, relative abundance, percent cover, size distribution, and general condition of the shallowwater corals at eight reef systems in the Northwestern Hawaiian Islands (Appendix B).
1. REA surveys were conducted at 67 sites between French Frigate Shoals and Kure Atoll. Of the 57 scleractinian species documented from the NWHI, 25 species were enumerated within belt transects. *Porites lobata* is a dominant coral at all eight reef locations visited, with *Pocillopora meandrina* or *Montipora capitata* each co-dominating at four of the eight reef locations. Second to *Porites lobata*, corals in the genus *Acropora* were the next most abundant taxon at the sites surveyed at French Frigate Shoals. Percent cover of live coral, as determined by the line-intercept method, varied from 1% at five sites distributed among atoll forereef, backreef, and patch reef habitats, to 82.4% on a patch reef site at Pearl & Hermes Atoll. Although size distributions vary among the eight locations visited, the majority (75.3%) of coral colonies have a maximum diameter smaller than 20 cm.
 2. A milder bleaching event than that documented from the NWHI in 2002 was in progress at numerous sites visited during 2004. Affected species were *Montipora patula*, *M. capitata*, *Porites evermanni*, *P. lobata*, *P. compressa*, *Pocillopora meandrina*, and *P. damicornis*. The incidences of bleaching

varied among species at the eight locations surveyed, with *M. patula* the taxon most affected at Maro, Laysan, and Lisianski (68.8%, 35.5%, and 56.3% of colonies affected, respectively). At the three northern atolls, bleaching was lowest on the forereef and substantially higher in backreef and lagoon patch reef habitats; as in 2002 *M. capitata* and pocilloporids were the most frequently affected corals at these atolls. At Pearl & Hermes and at Midway Atolls, the proportion of bleached colonies in these taxa rivaled the proportions documented in 2002; however, the visual impression was not as dramatic because there was less live coral surviving from 2002 to bleach. Thick algal turf and macroalgae covered the dead skeletons of *M. capitata* at many backreef sites that experienced acute bleaching in 2002, and the shallow (3-4 ft) portion of a central lagoon patch reef at Kure that had been severely bleached in 2002 had also become overgrown with thick algal growth.

- C. Used quantitative photoquadrat sampling method to collect species composition and baseline abundance data of reef algae at all 10 islands and atolls in the NWHI to compare with previously collected qualitative samples (Appendix C).
1. A total of 66 sites were visited (11 @ FFS, 3 @ GAR, 8 @ MAR, 3 @ LAY, 14 @ PHR, 9 @ MID, 9 @ KUR, 9 @ LIS). Quantitative analyses were successfully completed at 60 of these sites, producing 714 algal photoquadrats with accompanying field-ranked species lists and voucher specimens. Qualitative analyses occurred at 6 sites. Although turf algae was ubiquitous throughout the island chain, and macroalgal cover was high, especially in forereef areas where the green alga *Microdictyon setchellianum* predominated. At least 22 species of green, 34 species of red, and 9 species of brown macroalgae were observed at the 10 islands. Although species composition remained relatively similar across the island chain, brown algal species were considerably more prevalent in the 3 northwesternmost atolls than in other regions. While not as diverse as red algal genera, green algal genera (particularly *Microdictyon setchellianum* and species of *Halimeda*) composed the bulk of macroalgal biomass seen.
- D. The non-coral marine invertebrate fauna of coral reefs represents a group of animals that are numerically dominant in their habitat and in some cases represent taxonomic groups that are represented only in the marine environment. This group of organisms is surveyed and monitored for the purpose of identifying changes to reef communities. This is accomplished through procedures that quantify a set of target organisms and which also gradually build an inventory of species to document biodiversity. Macroinvertebrate surveys were conducted to record species composition and abundance at eight islands and atolls in the Northwestern Hawaiian Islands in order to establish baseline data to monitor non-coral invertebrate fauna of each reef system (Appendix D).
1. A total of 62 sites were visited between French Frigate Shoals and Kure Atoll. All 38 target taxa chosen for monitoring were observed across the island chain. Species data is preliminary at this point and involves non-coral species quantified from field observations, which represented six phyla. Despite the

surveys being conducted in multiple habitats *Echinostrephus* was the dominant macroinvertebrate found at all islands. At the southern islands of French Frigate Shoals, Gardner, Maro, and Laysan the second most common invertebrate was *Arca* shells. While at the northern islands of Lisianski, Pearl and Hermes Reef, Midway and Kure *Echinometra* was the second most common invertebrate. Hermit and trapezid crabs were commonly found at sites that had an abundance of *Pocillopora* heads. Macroinvertebrates were a major component of the reefs at all islands except Maro and Lisianski.

- E. Used benthic and fish towed-diver survey methods at NWHI to provide a general description of reef habitat, invertebrates, and reef fishes over a large spatial scale. The methods provided assessments and the foundation for monitoring large-scale disturbances and general distribution and abundance patterns of macro-invertebrates and reef fishes over 50 cm total length (Appendix E).
1. A total of 81 towed-diver surveys were conducted totaling approximately 184 km of habitat.

Fish Observations:

The giant trevally (*Caranx ignobilis*) was the most commonly observed fish larger than 50 cm Total Length (TL) at all islands/reefs. Surveys were conducted along multiple habitats and *C. ignobilis* dominated most of the surveys regardless of habitat. Preliminary quantitative results yielded low shark densities at all reef/island locations during the survey period. Other frequently observed large fishes were the spectacled parrotfish (*Chlorurus perspicillatus*) and the green jobfish (*Aprion virescens*).

Benthic Observations:

Spatial distribution seemed to have no effect on the incidence of coral appearing pale and white throughout the chain. *Pocillopora* dominated backreef zones and appeared to have a higher occurrence of bleaching than other zones. Maro Reef and Neva Shoals (Lisianski) seemed to have a higher occurrence of corals appearing pale. A total of 165 crown-of-thorns starfish (COTS), *Acanthaster planci*, were recorded during this cruise, 126 of them sighted at Pearl and Hermes Reef.

- F. The Oceanography Team deployed a variety of surface and subsurface oceanographic instruments and conducted near- and offshore oceanographic surveys and at French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Lisianski Island / Neva Shoal, Mokumanamana (Necker) Island, and Nihoa Island. These activities were intended to quantify and assess the overall hydrographic environment in the NWHI (Appendix F).
1. Four Coral Reef Early Warning System (CREWS) buoys, 5 Sea Surface Temperature (SST) buoys, 2 Ocean Data Platforms (ODPs), 4 Wave and Tide Recorders (WTR)s, 27 Subsurface Temperature Recorders (STRs), 7

Recruitment Plate Arrays, and 1 Semipermeable Membrane Device were deployed throughout the Northwestern Hawaiian Archipelago. Except for the following instruments, all deployments were replacements of existing instrumentation to assure the continuity of data for the assessment of oceanographic conditions. Five of the 27 STRs represent new deployments on the anchors of all CREWS buoys and near a SST buoy to provide additional data to enable temperature profiling and further understanding of coral bleaching events. A sixth new STR was deployed to study a thermocline observed at the shelf break of the southern reef slope of Pearl and Hermes Atoll. The Semi-permeable Membrane Device is an addition to the standard oceanographic sampling scheme of CRED. It was installed in coordination with the USF&W staff on Tern Island to study the settlement of airborne pollutants into the marine environment. Refer to Appendix F for details concerning instrument function and a thorough instrumentation summary (Table 1).

2. Conductivity, Temperature and Depth (CTD) casts were conducted at 127 sites, radiometer casts were conducted at 27 sites, and water samples were collected at 29 sites throughout the Northwestern Hawaiian Archipelago. The radiometer casts were conducted concurrently with CTD casts, and the water samples were collected at CTD/radiometer sites so that radiometer casts are a subset of CTD casts and water sample sites are a subset of the CTD/radiometer cast sites. Seven water samples do not fall into the subset pattern since they were collected while the radiometer was malfunctioning. Refer to appendix F for details concerning instrument function, sample purpose, a thorough cast summary (Table 2) and a methodology summary (Protocol 1).
 3. For the most part, the data collected by the oceanography team require extensive post-cruise processing and analysis not allowing for an immediate summary of findings. However, data from the STRs have been applicable to observations made on this cruise concerning coral bleaching. Jean Kenyon has documented the bleaching of certain corals from sites at French Frigate Shoals, Maro Reef, Laysan Island, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll and Lisianski Island/Neva Shoals. The extent of this bleaching appears to have lessened in step with the decrease of average maximum temperature, demonstrated by graphed STR data, as the cruise has progressed northwest along the archipelago. For more information refer to the section of this report written by Jean Kenyon.
- G. Goals for night operations during HI0401 included deployments of the Towed Optical Assessment Device (TOAD) to videotape portions of the seafloor and shipboard conductivity, temperature and depth (CTD) casts (Appendix G).
1. The TOAD was deployed 94 times during the cruise, resulting in 85 usable transects. Each tow was typically conducted, so the camera sled was on the bottom for 20 minutes. A total of 30 hours of videotape data

were collected, resulting in a total of 73.8 km of bottom coverage. Depths ranged from 17 to 143 m, but tows were typically located on the bank tops in depths of 30 to 50 m.

2. A total of 34 shipboard CTD casts were conducted at stations near each of the primary work sites. Casts were taken at each of the 10 permanent CTD stations along the NWHI chain. Other casts were located around the work sites as time permitted. Where possible, data were collected to the windward and leeward of each island. All casts were lowered to 500 m except for Cast015, which hit bottom at 459 m. Water samples were taken during 24 casts and samples were processed to measure the chlorophyll-*a* content. A Turner Designs self-contained underwater fluorescence apparatus (SCUFA) was integrated with the ship's CTD sensor and collected data starting with Cast021.
- H. Expedition activities were documented through photography and video, and described in daily journal articles posted to an expedition web site. Feature articles on special topics were also written. Notes and interviews have been gathered for future education/outreach activities. In total, 26 journal entries and 6 feature stories published, and about 4,638 digital photographs and over 5 hours of video and audiotape have been gathered.

SCIENTIFIC PERSONNEL:

Randall Kosaki, Ph.D., Co-Chief Scientist, Fish Team, NOS
 Peter Vroom, Ph.D., Co-Chief Scientist, Benthic Team – Algae, UH-JIMAR, PIFSC-CRED
 Erin Looney, Benthic Team – Algae, University of Georgia
 Ranya Henson, Benthic Team – Invertebrates, Bishop Museum
 Jean Kenyon, Ph.D., Benthic Team – Corals, UH-JIMAR, PIFSC-CRED
 Greta Aeby, PhD, Benthic Team – Corals, Hawaii DLNR-DAR
 Craig Musburger, Fish Team, UH Manoa
 Darla White, Fish Team, UH Hilo
 Brian Zgliczynski, Towboard Team – Fish, NOAA-NMFS
 Molly Timmers, Towboard Team – Habitat, UH-JIMAR, PIFSC-CRED
 Joseph Laughlin, Towboard Team – Fish, UH-JIMAR, PIFSC-CRED
 Casey Wilkinson, Towboard Team – Habitat, UH-JIMAR, PIFSC-CRED
 Kyle Hogrefe, Mooring Team, UH-JIMAR, PIFSC-CRED
 Stephani Holzwarth, Mooring Team, UH-JIMAR, PIFSC-CRED
 Elizabeth Keenan, Mooring Team, UH-JIMAR, PIFSC-CRED
 Daniel Merritt, Mooring Team, UH-JIMAR, PIFSC-CRED
 Scott Ferguson, Towed Camera/Deep water CTDs, UH-JIMAR, PIFSC-CRED
 Daniel Suthers, Educational Team, UH Manoa
 Susan Middleton, Educational Team, National Geographic
 David Liitschwager, Educational Team, National Geographic
 June Firing, Data Manager, UH-JIMAR, PIFSC-CRED

DATA COLLECTED:

Digital images of diseased coral
Field notes on signs of coral bleaching or disease
Samples of diseased coral for histopathological analysis
Digital images from algal photoquadrats
Algal voucher specimens
Algal field notes of species diversity and relative abundance
Digital images of the benthic habitat from towboard surveys
Macro-Invertebrate counts from towboard surveys
Quantitative surveys of reef fishes (larger than 50 cm TL) to species level from towboards
Habitat lineation from towboard surveys
Benthic composition estimations from towboard surveys
Videos of the seafloor from TOAD operations
QTC (benthic acoustic signature) data
Acoustic doppler current profiler (ADCP) transects
Conductivity, temperature, and depth (CTD) profiles to 500 m

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Attachments

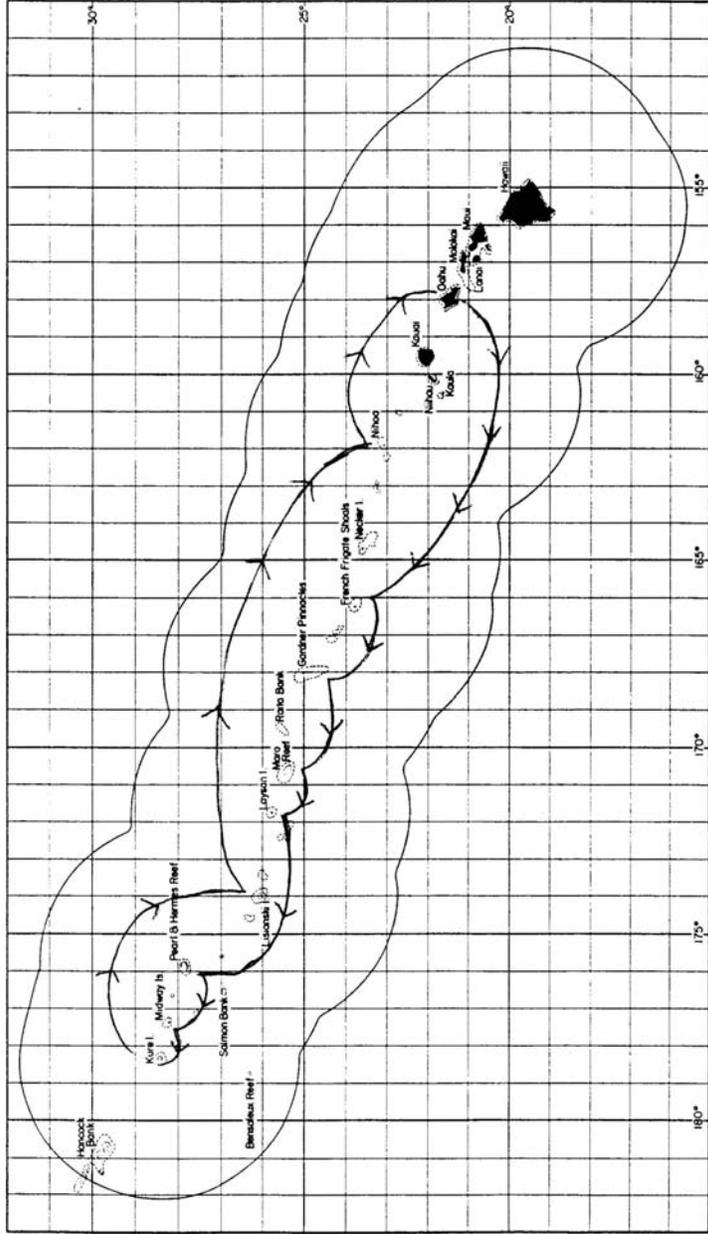


Figure 1.--Track of the Hi'ialakakai Cruise 04-01, September 13 to October 2004.

Appendix A: **Fish REA Team Activity Summary** (*Randall Kosaki, Craig Musburger, Darla White*)

A. Methods

The three-member team of Randall Kosaki (NOAA/NOS), Craig Musburger (NOAA/JIMAR PIFSC), and Darla White (UH Hilo) completed fish surveys using the same protocols that have been used from 2000 to the present in the NWHI. At each station, two of the three divers surveyed all of the noncryptic fishes (day-active, > 2-cm Total Length, TL) observable within three, 25-m long belt (strip) transects totaling 600 m² area. The 3rd diver simultaneously conducted four, 5-min Stationary Point Counts (SPCs) totaling about 1250 m² for larger-bodied fishes > 25 cm TL. The quantitative tallies were complemented by “roving diver swims” throughout the general station area (2000-3000 m², depending on underwater visibility). All observations were used to generate station-specific species lists. Two 45-min. dives at French Frigate Shoals and one at Pearl and Hermes Atoll were used to collect domino damselfish (*Dascyllus albisella*) for trace element analyses of saggital otoliths. Collections of whole small fish and small tissue samples from large fish for stable carbon isotope analyses were also made at French Frigate Shoals and Pearl and Hermes Reef.

B. Results

1. French Frigate Shoals

FFS-21 09/16/04

High cover by *Acropora cytherea*, depth approximately 10 m. Most abundant fishes: *Chaetodon trifascialis*, *Acanthurus nigroris*, *A. nigrofuscus*, *Thalassoma duperrey*, *Canthigaster jactator*.

FFS-H6 09/16/04

Spur and groove forereef in approximately 15 m, northeast of Tern Island. Scattered small colonies of *Acropora cytherea*. Fish assemblage dominated by herbivores (Acanthuridae, Scaridae). Three individuals of the introduced snapper *Lutjanus kasmira* recorded on transect. Several large *Scarus rubroviolaceus* also recorded. Most abundant fishes: *Acanthurus triostegus*, *Thalassoma duperrey*, *Ctenochaetus strigosus*, *Chromis hanui*, *Chromis vanderbilti*.

FFS- 23 09/16/04

Anchor was dropped approximately 100 m from correct coordinates for site 23. *Microdictyon* dominated low-relief backreef in approximately 4 m, east of Tern Island. Fish abundances were low. Most abundant fishes: *Parupeneus multifasciatus*, juvenile fish of several species, including 5-10-cm scarids, *Stethojulis balteata*, and *Thalassoma duperrey*.

FFS-46 09/17/04

La Perouse Pinnacle. Moderate cover by *Acropora cytherea*, *Porites lobata*, *Pocillopora meandrina*. Green sea turtles seen in vicinity. Two *Triaenodon obesus* noted off the

transect, resting in the tunnel through the pinnacle. Most abundant fishes: *Acanthurus nigrofuscus*, *A. triostegus*, *Ctenochaetus strigosus*, *Thalassoma duperrey*, *Naso lituratus*.

FFS-32 09/17/04

Ark shell reef rising from 10 m to near surface. Fine sediment and rubble at base. Several Pocillopora heads off the transect held large numbers of *Dascyllus albisella* recruits. Most abundant fishes: *Naso unicornis*, juveniles carids, *Chaetodon miliaris*, *Bodianus bilunulatus*. Cool jellyfish sighted.

FFS-33 09/17/04

Reef surrounded by sand, about 10 m. *Xyrichtys pavo* juvenile seen in sand outside of transect area. Most abundant fishes: *Ctenochaetus strigosus*, *Chlorurus sordidus*, *Acanthurus triostegus*, *Thalassoma duperrey*, *Chromis ovalis*.

FFS-12 09/19/04

High cover by *Acropora cytherea*, 12 m, southeast corner of French Frigate Shoals. Most abundant fishes: *Ctenochaetus strigosus*, *Chromis hanui*, *C. vanderbilti*, *Lutjanus kasmira*, *Aphareus furca*. *Myripristis* spp. was abundant under *Acropora* (more abundant than represented in these data).

FFS-29 09/19/04

Edge of lagoonal patch reef, 10 m, southeast lagoon. Surgy reef top, silty bottom. Most abundant fishes: *Acanthurus triostegus*, *A. blochii*, *Scarus psittacus*, *Thalassoma duperrey*, *Acanthurus olivaceus*, *Chaetodon miliaris*. *Epibulus insidiator* present on line.

FFS-34 09/19/04

Pavement bottom with moderate relief, 10 m, southeast corner of atoll. In general, few acanthurids and scarids. Most abundant fishes: *Acanthurus olivaceus*, *Chromis vanderbilti*, *Plagiotremus goslinei*, *Coris venusta*, *Macropharyngodon geoffroy*.

2. Gardner Pinnacles

GAR-R6 09/20/04

Northwest tip of islands. 18-m depth, large basalt blocks with low cover by corals and soft corals. Very high abundance of reef fishes and predators. Possible new records for Gardner: *Elops hawaiiensis*, *Alectis ciliaris*. Most abundant fishes: *Chromis ovalis*, *C. vanderbilti*, *Abudefduf vaigiensis*, *Oplegnathus punctatus*, *Thalassoma ballieui*, *Thalassoma duperrey*. Over pavement in deeper water away from pinnacles, numerous small *Carcharhinus galapagensis*, one small *Aetobatus narinari*.

GAR-R3 09/20/04

South tip of islands. Pavement with boulders and low relief, 17 m. Inshore of transects, patches of small boulders hosted a large colony of *Abudefduf vaigiensis*. Most abundant fishes: *Naso brevirostris*, *Acanthurus olivaceus*, *Chaetodon miliaris*, *Stegastes fasciolatus*, *Thalassoma duperrey*, juvenile *Macropharyngodon geoffroy*, *Decapterus macarellus*. Other fishes seen in area: *Elegatis bipinnulatus*, *Euthynnus affinis*, *Seriola dumerili*.

GAR-R5 09/20/04

Large basalt blocks on basalt pavement in 15 m, near island cliff face. High abundance of unidentified baitfish in schools in the surge zone. *Acanthurus nigrofuscus*, *Kyphosus bigibbus*, *Abudefduf vaigiensis*, *Chromis ovalis*. In area around transect, pair of *Aetobatus narinari*, *Carcharhinus galapagensis*, *Katsuwonus pelamis*, large numbers of *Mulloidichthys vanicolensis*, *Kyphosus bigibbus*, *Monachus schauinslandi*.

3. Maro Reef

MAR-R5 09/21/04

Most abundant fishes: Generally low density of fishes. *Acanthurus triostegus*, *Thalassoma duperrey*, *Stegastes fasciolatus*, *Naso unicornis*, *Stethojulis balteata*, *Kyphosus bigibbus*.

MAR-R6 09/21/04

13-m reef, edge sloping off to below 25 m. Slope covered with dense growths of *Halimeda*. Most abundant fishes: *Acanthurus triostegus*, *Carcharhinus galapagensis*, *Thalassoma duperrey*, *Ctenochaetus strigosus*, *Acanthurus nigroris*.

MAR-R8 09/21/04

13-m reef surrounded by a slope to sand and rubble in 17 m. Slope was carpeted with dense *Halimeda* growths. Poor visibility, abundant *Sporochnus*, holes with numerous lobsters. Unidentified wrasse videotaped (same sp. noted at two Lisianski sites); identification pending. Diverse fish community but overall low abundance. Most abundant fishes: *Ctenochaetus strigosus*, *Thalassoma duperrey*, *Stegastes fasciolatus*, *Chromis hanui*, *Aprion virescens*,

MAR-R12 09/22/04

Pinnacles and canyons lead down to coral heads and sand in 17 m. Abundant *Fungia scutaria*. Most abundant fishes: *Stegastes fasciolatus*, juvenile scarids, *Acanthurus triostegus*, *Ctenochaetus strigosus*, *Thalassoma duperrey*, *Mulloidichthys flavolineatus*.

MAR-R9 09/22/04

Northwest tip of Maro on northern exposure of narrow reef. Very high abundance of large *Caranx ignobilis*, many over 50 kg. Strong 1-knot current coming over the reef, pulling to the north. Most abundant fish: *Chromis ovalis*, *Chaetodon unimaculatus*, *Thalassoma duperrey*, *Ctenochaetus strigosus*, *Zebrasoma flavescens*, *Acanthurus nigroris*, *Caranx ignobilis*.

MAR-R3 09/22/04

Canyons to 20 m, encrusting corals on ridges. *Antennarius* spp. collected in canyon. One *Carcharhinus amblyrhynchos* seen. Most abundant fishes: *Chromis ovalis*, *Ctenochaetus strigosus*, *Chlorurus sordidus*, *Thalassoma duperrey*, *Zebrasoma flavescens*.

MAR-8 09/23/04

SPC data only.

MAR-6 09/23/04
SPC data only.

MAR-8 09/23/04
SPC data only.

4. Laysan Island

LAY-R12 09/24/04
Just outside of channel to main camp. Most abundant fishes: *Acanthurus olivaceus*, *Thalassoma duperrey*, *Acanthurus nigrofuscus*, *Stegastes fasciolatus*.

LAY-R9 09/24/04
Southern end of Laysan. Large broken slabs of solution bench beachrock provide the majority of relief in 12 m. Most abundant fishes: *Thalassoma duperrey*, *Stegastes fasciolatus*, *Acanthurus nigroris*, *Naso brevirostris*, *Acanthurus leucopareius*.

LAY-R11 09/24/04
West side of Laysan, High-relief reef surrounded by rubble and rock slabs in 15 m. Scarids were large. Many juvenile wrasses. Most abundant fishes: *Thalassoma duperrey*, *Naso unicornis*, *Ctenochaetus strigosus*, *Acanthurus nigrofuscus*.

5. Pearl and Hermes

PHR-R26 09/26/04
Low-relief spur and groove forereef site with sand channels and pockets; transect depth at 13 m. Most abundant fish species were *Chromis hanui*, *C. vanderbilti*, *C. verater*, *Dascyllus albisella*, *Thalassoma duperrey*, *Chaetodon miliaris*, and *Centropyge potteri*. *Carcharhinus galapagensis*, *Caranx ignobilis*, *C. melampygus*, *Aprion virescens*, and *Triaenodon obesus* were the predators present. An uncommon sighting was *Naso maculatus*. Many species characteristic of NWHI reefs were noted, including *Genicanthus personatus*, *Xanthichthys mento*, and *Pseudanthias thompsoni*.

PHR-R32 09/26/04
Shallow backreef site; transects along a 3-meter isobath. Most abundant species present were *Acanthurus triostegus*, *Coris venusta*, *Stethojulis balteata*, *Thalassoma duperrey*, and *Stegastes fasciolatus*. Uncommon fish sighted was *Taenianotus triacanthus* and *Fistularia commersonii*. Both *Caranx ignobilis* and *C. melampygus* were present.

PHR-R31 09/26/04
Lagoonal steep *Porites compressa* slope; poor visibility; transect along the 10 meter isobath. Most abundant fishes present were juvenile scarids, *Chlorurus sordidus*, *Chaetodon miliaris*, and *Ctenochaetus strigosus*. *Thalassoma duperrey* was present, but not abundant. *Zebrasoma veliferum* and *Chaetodon lunulatus* were highly visible in the area.

PHR-R39 09/27/04

Forereef site; transects at 12- to 16-m depth. The most abundant fishes were *Chromis hanui* and *C. ovalis*, then *Abudefduf abdominalis*, *Chlorurus sordidus*, *Stegastes fasciolatus*, *Thalassoma duperrey*, and *Ctenochaetus strigosus*. Predators present were *Caranx ignobilis*, *Aphareus furca*, and *Aprion virescens*. *Anampses chrysocephalus* and *Thalassoma quinquevittatum* were both noted on the transect.

PHR-6 09/27/04

Shallow backreef site; transect lines along a 2-m isobath. Most abundant fish species present were *Thalassoma duperrey*, *Stegastes fasciolatus*, juvenile scarids, *Chlorurus sordidus*, *Stethojulis balteata* and *Acanthurus triostegus*. Several chaetodonids were present. No predatory species sighted. No unusual species noted.

PHR-24 09/27/04

Lagoonal slope patch reef with sand and rubble. Most abundant fish species present included juvenile scarids, *Chlorurus perspicillatus*, *C. sordidus*, *Scarus dubius*, *Chaetodon miliaris*, and *Caranx melampyus*. The dominant family was Scaridae; most were juvenile and subadult sizes. *Oxycheilinus bimaculatus* was also abundant here. *Pseudojuliodes cerasinus* and *Sargocentron diadema* were present, too. Predatory species included *Caranx ignobilis* and *C. melampyus*.

PHR-R46 09/29/04

Forereef site; great visibility; transect along 15-m isobath. Dominant species include *Chromis vanderbilti*, *Thalassoma duperrey*, *Paracirrhites arcatus*, *Cirrhitops fasciatus*, *Caranx ignobilis*, and *Pseudanthias thompsoni*. NWHI species included *P. thompsoni*, *Xanthichthys mento*, *Genicanthus personatus*, *Desmoholacanthus arcuatus*, and *Heniochus diphreutes*. Predators included *Gymnothorax eurostus* and *G. javanicus*, *Carcharhinus galapagensis*, and *Aprion virescens*.

PHR-31 09/29/04

Shallow back reef site; transect along a 3-m isobath. Most abundant fish species present include *Thalassoma duperrey*, *Stegastes fasciolatus*, *Stethojulis balteata*, *Dascyllus albisella*, *Gomphosus varius*, *Chlorurus perspicillatus* and *C. sordidus*. No jacks were present. One *Triaenodon obesus* was present, as were several *Aprion virescens*. *Epibulus insidiator* and *Acanthurus blochii* were both present. Juvenile abundance was high.

PHR-32 09/29/04

Lagoonal patchreef; transect at the 6-m isobath along the reef slope. The dominant species present were *Thalassoma duperrey*, *Chromis hanui*, *Stegastes fasciolatus*, *Coris venusta*, *Stethojulis balteata*, and *Macropharyngodon geoffroy*. Several *Caranx ignobilis* were present. Three *Synodus* spp. were counted on the transect; *Lutjanus kasmira*, *Cirrhilabrus jordani*, and *Cymolutes lecluse* were present as well.

6. Midway

MID-R15 10/01/04

Shallow lagoon reef; high surge and low visibility. The dominant families were Labridae, Acanthuridae, and Pomacentridae. The most abundant fishes were *Stethojulis balteata*, *Thalassoma duperrey*, *Stegastes fasciolatus*, *Acanthurus triostegus*, and juvenile scarids. High juvenile abundance in general. Few apex predators in the vicinity of the transects.

MID-1 10/01/04

Shallow backreef dominated by coral. The dominant fish families were Labridae and Pomacentridae. The most abundant fishes were *Stethojulis balteata*, *Thalassoma duperrey*, *Stegastes fasciolatus*, *Tylosurus crocodilus*, *Gomphosus varius*, and juvenile scarids. High juvenile abundance in general. Large *Chlorurus perspicillatus* were noted.

MID-H21 10/01/04

Shallow backreef. Large school of *Acanthurus triostegus* recorded. School of large *Chlorurus perspicillatus* and high abundance of juvenile scarids; all species. Most abundant species were *A. triostegus*, juvenile scarids, *Scarus sordidus*, *Chlorurus perspicillatus*, *Thalassoma duperrey*, *Stegastes fasciolatus*, and *Mulloidichthys flavolineatus*. *Caranx ignobilis* and *C. melampygus* were present.

MID-H10 10/02/04

Forereef spur and groove site. Most abundant overall species was *Chromis ovalis*. *Thalassoma duperrey*, *Chromis hanui*, *Chromis vanderbilti*, *Naso unicornis*, and *Kyphosus* spp. were also abundant. Predators include *Carcharhinus galapagensis*, *Caranx melampygus*, *C. ignobilis*, and *Aprion virescens*. Labrid species richness was very high; 12 species recorded, with a relatively high number of terminal phase males. Acanthurid species richness was also high, with no one dominant species. Rare fishes included *Epinephelus quernus*, *Oplegnathus punctatus*, and *Aluterus scriptus*.

MID-R25 10/02/04

Shallow backreef site. Large schools of *Mulloidichthys vanicolensis* and *M. flavolineatus* present. Other most abundant species were *Stethojulis balteata*, *Thalassoma duperrey*, *Stegastes fasciolatus*, *Acanthurus triostegus*, and *Thalassoma ballieui*. *Oplegnathus punctatus* and *O. fasciatus* were both present.

MID-R20 10/03/04

Shallow back reef site; transect at 1-m depth. Most abundant species were *Stethojulis balteata*, *Thalassoma duperrey*, *Stegastes fasciolatus*, *Acanthurus triostegus*, and *Thalassoma ballieui*. Additionally, *Naso unicornis*, *Thalassoma trilobatum*, *Chlorurus perspicillatus*, and *Zebrasoma veliferum* were relatively abundant. Species richness of Labrids was high, with 12 species present.

MID-R3 10/04/04

Forereef spur and groove site. *Chromis hanui*, *Chromis ovalis*, *Chromis verater*, *Abudefduf abdominalis*, *Acanthurus nigroris*, *Thalassoma duperrey*, and *Kyphosus* spp. were the most abundant fish species present. *Centropyge potteri* was abundant. Rare

fishes were *Genicanthus personatus*, *Oplegnathus punctatus*, *Lutjanus kasmira*, *Anampses chrysocephalus*, and *Epinephelus quernus*. A single *Naso caesius* was noted, also. *Carcharhinus galapagensis*, *Caranx melampygus*, and *Aprion virescens* were present.

MID-R7 10/04/04

Forereef spur and groove site. The dominant fishes were *Chromis hanui*, *C. ovalis*, *Chaetodon miliaris*, *Kyphosus* spp., *Abudefduf abdominalis*, *Naso unicornis*, and *Thalassoma duperrey*. *Halichoeres ornatissimus* was abundant as well. *Carcharhinus galapagensis*, *Caranx melampygus*, and *C. ignobilis* were the apex predators present. Uncommon fish present were *Myripristis chryseres* and *Anampses chrysocephalus*.

MID-2 10/04/04

Forereef scoured pavement. Low abundance and diversity of fishes. Dominant fishes were *Thalassoma duperrey*, *Coris venusta*, *Chaetodon fremblii*, *C. miliaris*, and *Chromis ovalis*. Only one acanthurid and no scarid species were present. One *Aprion virescens* was noted.

7. Kure

KURE-R33 10/05/04

Forereef spur and groove site; transect at the 15-m isobath. Dominant fishes present included *Acanthurus triostegus*, *Acanthurus leucopareius*, *Thalassoma duperrey*, *Kyphosus* spp., *Acanthurus nigroris*, and *Stegastes fasciolatus*. *Cirripectes vanderbilti* were abundant. A small group of *Pseudocaranx dentex* (18) were present. Rare fishes included *Desmoholacanthus arcuatus* and *Oplegnathus punctatus*.

KURE-2 10/05/04

Forereef spur and groove site; transect at approximately 12 m depth. Most abundant fish species included *Stegastes fasciolatus*, *Thalassoma duperrey*, and all four species of hawkfishes, *Stethojulis balteata*. Three *Seriola dumerili* were recorded on the transect. *Oplegnathus punctatus* was present.

KURE-R36 10/05/04

Shallow backreef site; transects at 2- to 3-m depth. Labridae, Acanthuridae, and Pomacentridae were the dominant families present. The most abundant fish species were *Stegastes fasciolatus*, *Thalassoma duperrey*, *Stethojulis balteata*, and *Acanthurus triostegus*. *Halichoeres ornatissimus* and *Coryphopterus* spp. were abundant, also. *Seriola dumerili* was present.

KURE-12 10/06/04

Spur and groove forereef site; transects at 10- to 12-m depth. Species rich area. Most abundant fish species were *Chromis ovalis*, *Thalassoma duperrey*, *Acanthurus nigroris*, *Chromis hanui*, and *Centropyge potteri*. Many NWHI fishes present included *Genicanthus personatus*, *Oplegnathus punctatus* and *O. fasciatus*, *Desmoholacanthus arcuatus*, *Epinephelus quernus*, and *Xanthichthys mento*. *Aprion virescens* was the only large predator noted.

KURE-9 10/06/04

Shallow lagoon patch reef; transects at 4-m depth. Dominant fish abundance included juvenile scarids, *Stethojulis balteata*, *Stegastes fasciolatus*, *Thalassoma duperrey*, *Dascyllus albisella*, and *Thalassoma ballieui*. Unusual fishes included *Oxycheilinus bimaculatus*, *Cymolutes lecluse*, and *Dendrochirus barberi*. *Aprion virescens* were present.

KURE-R35 10/06/04

Shallow lagoon patch reef; transect along a four meter isobath. Site was dominated by *Naso unicornis* and *Mulloidichthys* spp. Other most abundant species included *Macropharyngodon geoffroy*, *Thalassoma duperrey*, *Stethojulis balteata*, *Stegastes fasciolatus*, and *Ctenochaetus strigosus*. Unusual fishes include *Taenianotus triacanthus*, *Cymolutes lecluse*, and *Oplegnathus punctatus*. In general, the area was species rich, with Labridae, Mullidae, and Acanthuridae comprising the dominant families.

KURE-18 10/07/04

Lagoon patch reef with a *Porites compressa* slope with sand bottom; transects at approximately 7-m depth. Large schools of *Kyphosus* spp. and *Mulloidichthys flavolineatus*. Other most abundant fish species included juvenile scarids, *Stegastes fasciolatus*, *Thalassoma duperrey*, *Myripristis berndti*, and *Thalassoma ballieui*. Apex predators included *Seriola dumerili*, *Carcharhinus galapagensis*, *Triaenodon obesus*, and *Caranx melampygyus*.

KURE-17 10/07/04

Shallow patch reef; transects at 2- to 3-m depth. Labridae was the dominant family present. Most abundant fish species included *Acanthurus nigroris*, *Thalassoma ballieui*, *Thalassoma duperrey*, *Kyphosus* spp., *Stegastes fasciolatus*, and *Stethojulis balteata*. *Thalassoma trilobatum* was also abundant. *Cheilio inermis* and *Gymnothorax eurostus* were present.

KURE-14 10/07/04

Shallow backreef site; transect at approximately 1-m depth. Most abundant and dominant fishes were *Thalassoma duperrey*, *Thalassoma ballieui*, *Stethojulis balteata*, and *Stegastes fasciolatus*. *Gomphosus varius* was also abundant. *Caranx melampygyus* was present.

8. Lisianski

LIS-R14 10/09/04

Reef area; 15-m depth. Most abundant species were *Chlorurus perspicillatus*, *C. sordidus*, *Scarus dubius*, juvenile scarids, *Thalassoma duperrey*, *Acanthurus nigroris*, and *Stegastes fasciolatus*. Uncommon fishes included *Pervagor spilosoma*. Predators included *Aprion virescens*, *Caranx ignobilis*, and *Monotaxis grandoculis*.

LIS-12 10/09/04

Transect lines laid on a reef in 6- to 7-m depth. Most abundant fish species were *Acanthurus nigroris*, juvenile scarids, *Chlorurus perspicillatus*, *C. sordidus*, *Thalassoma duperrey*, *Stegastes fasciolatus*, *Ctenochaetus strigosus*, and *Chaetodon miliaris*.

Triaenodon obesus was present; other predators included *Aprion virescens*, *Caranx ignobilis*, and *Monotaxis grandoculis*. Uncommon fishes for the region included *Scarus rubroviolaceus* and *Canthigaster coronata*.

LIS-R9 10/09/04

Large reef area sloping down to expansive sand flat; transect at 6- to 7-m depth. Most abundant fish species included *Acanthurus triostegus*, *Naso brevirostris*, *Chlorurus sordidus*, *Stegastes fasciolatus*, and *Thalassoma duperrey*. *Canthigaster jactator* was also abundant. Uncommon presence of *Scomberoides lysan* noted. Other predators included *Caranx ignobilis* and *C. melampygus*.

LIS-10 10/10/04

Reef area; transect depth at 10- to 14-m. Most abundant fishes included *Caranx ignobilis*, juvenile scarids, *Ctenochaetus strigosus*, *Chlorurus sordidus*, *Stegastes fasciolatus*, and *Thalassoma duperrey*. *Chromis ovalis* was also abundant. An unidentified juvenile wrasse collected at this site (may be undescribed color morph of *Bodianus bilunulatus*); two individuals were present at the site. Species richness was low overall.

LIS-R10 10/10/04

Reef area; transects at the 12-m isobath. Abundant fish species were *Ctenochaetus strigosus*, *Acanthurus triostegus*, *Thalassoma duperrey*, juvenile scarids, *Chlorurus sordidus*, *C. perspicillatus*, and *Scarus dubius*. Scarids were primarily represented by subadults and juveniles. Uncommon fish sightings included *Diodon hystrix*, *Pervagor spilosoma*, and *Triaenodon obesus*. Other predators included *Caranx ignobilis*, *C. melampygus*, and *Aprion virescens*. *Selar crumenophthalmus* were abundant also.

LIS-R7 10/10/04

Reef area; transects along a 13-m isobath. Abundant fish species included *Thalassoma duperrey*, *Stegastes fasciolatus*, *Pseudocheilinus octotaenia*, *Abudefduf abdominalis*, and *Chromis hanui*. Overall species richness and diversity were low. Predators present included *Caranx melampygus* and *C. ignobilis*. Most speciose families included Labridae, Acanthuridae, and Pomacentridae.

LIS-18 10/11/04

Note: LIS-18 is the new replacement site for LIS-R16 due to the lack of reef at that site. Reef area: 7-11-m depth. Dominant families include Acanthuridae, Scaridae, and Labridae. Most abundant species were *Thalassoma duperrey*, *Stegastes fasciolatus*, *Stethojulis balteata*, *Acanthurus nigroris*, and *Chlorurus perspicillatus*. *Caranx ignobilis* and *Monotaxis grandoculis* were the large predators present. The unidentified *Bodianus* sp. wrasse (collected at LIS-10) was noted here.

LIS-16 10/11/04

Reef area; 15-m depth. Most abundant fish species present were *Chromis ovalis*, *Ctenochaetus strigosus*, *Stegastes fasciolatus*, *Thalassoma duperrey*, *Abudefduf abdominalis*, and *Acanthurus triostegus*. *Acanthurus dussumieri* was also present on the transect. *Aprion virescens* was present and *Caranx ignobilis* were abundant. Four

species of Chaetodonidae, seven species of Acanthuridae, and nine species of Labridae were noted at the site.

LIS-17 10/11/04

Very poor visibility exacerbated by westerly wind chop. Transect at 11-12-m at the edge of the reef; sand channel below. Most abundant fish species were *Abudefduf abdominalis*, *Chlorurus perspicillatus*, *Ctenochaetus strigosus*, *Mulloidichthys flavolineatus*, juvenile scarids, and *Thalassoma duperrey*. *Chaetodon miliars* were also abundant. *Caranx ignobilis* and *C. melampygus* were present, also.

9. Mokumanamana (Necker Is.)

NEC-2, NEC-R6 , and NEC-4 could not be sampled due to high winds and large seas.

10. Nihoa

NIH-R8, NIH-R10, and NIH-R5 could not be sampled due to high winds and large seas.

Appendix B: Coral REA Team Activity Summary (*Kenyon section*)

A. Methods

Aeby deployed a separate transect tape, marked in centimeter increments, parallel to the second of three, 25-m transect lines previously laid out by the fish team. Aeby used the line-intersect method at 50-cm intervals along this tape to calculate substrate composition. Additionally, the first two 25-m transect lines were videotaped by Kenyon, to be used at a later time to calculate percent coral cover and as a permanent record of the condition of the benthos. The second 25-m transect line was surveyed by Kenyon for coral colonies by species, maximum diameter, and presence/absence of bleaching. All corals whose colony center fell within 1 m on either side of this transect line were enumerated and assigned to one of seven size classes: <5 cm, 6-10, 10-20, 20-40, 40-80, 80-160, and >160 cm. These transect tallies are used to determine size class distributions and incidence of bleaching. Aeby surveyed a 6-m-wide belt along the second transect line for prevalence of coral disease. Following quantitative surveys, qualitative surveys were conducted in a larger area around the first two transect lines to document additional species of corals not occurring within the transect belt, as well as occurrence of coral bleaching and disease. The relative abundance of all coral species and the overall percent coral cover were visually estimated over this broader area.

Aeby collected samples of diseased and healthy corals for microscopic and histological examination. Kenyon collected samples of healthy corals for piggyback studies with two collaborators: (1) a study of zooxanthellae clades headed by Dr. Andrew Baker, World Wildlife Fund and Columbia University, and (2) a study of genetic connectivity of *Pocillopora meandrina* and *Montipora capitata* throughout the Hawaiian Archipelago headed by Dr. Evelyn Cox, Hawaii Institute of Marine Biology, University of Hawaii.

Additionally, Kenyon worked with the mooring team to oversee the collection of six arrays of coral recruitment plates (16 plates per array) from French Frigate Shoals, Maro, Lisianski, Pearl & Hermes, Midway, and Kure, as well as the redeployment of fresh plates. All arrays are fastened to the anchor of either a CREWS buoy or SST instrument. The collected plates represent the third cohort of plates deployed at roughly annual intervals, while the fresh plates represent the fourth such cohort in a time series.

B. Results

REA surveys were conducted at 67 sites between French Frigate Shoals and Kure Atoll. Site numbers, locations, and other site descriptive parameters including percent live coral cover are presented in Table B-1.

Collections of *Pocillopora meandrina* and *Montipora capitata* for genetic studies of reef connectivity, as well as collections of corals for genetic studies of zooxanthellae clades, are summarized in Table B-2.

Table B-1. Sites surveyed by REA team, NOWRAMP 2004. Live coral cover was estimated using a 25m line-intercept method at 50 cm intervals. Maximum depths are from Kenyon dive log.

<u>Site #</u>	<u>Date</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Transect depth (ft)</u>	<u>% coral cover</u>	<u>Max. depth (ft)</u>	<u>Temp. °F</u>
French Frigate Shoals							
H6	9/16	23	52.828 166	16.419	37	15.7	52 81
21	9/16	23	50.875 166	19.581	35	43.1	39 82
23 ^a	9/16	23	52.014 166	14.507	5	1	11 83
R46	9/17	23	46.162 166	15.672	20	45.1	29 82
32	9/17	23	48.377 166	13.852	25-30	19.6	33 82
33	9/17	23	50.148 166	15.962	25	23.5	35 82
"R30" ^{bc}	9/18	23	51.994 166	12.870	5	2	8 82
30 ^c	9/18	23	50.973 166	17.836	19	39.2	23 83
34	9/19	23	37.670 166	8.149	35	9.8	35 81
12	9/19	23	38.270 166	10.802	35	53	41 81
R29	9/19	23	40.711 166	8.784	20-25	11.8	35 82

^a Different patch reef (250m distant) from site surveyed in 2003

^b 1.24 km from R30; backreef too shallow for Hi'ialakai launch to navigate closer

^c Surveyed by benthic team (algae, corals, other invertebrates) only

Gardner Pinnacles

R6	9/20	25	0.036 168	0.088	57	21.6	59 80
R3	9/20	24	59.813 167	59.920	54	9.8	57 81
R5	9/20	24	59.901 168	0.000	50	5.9	55 81

Maro Reef

R8	9/21	25	20.051 170	31.512	45	49	66 82
R6	9/21	25	20.433 170	30.028	38	19.6	43 83
R5	9/21	25	22.101 170	30.127	24	27.5	34 83
R9	9/22	25	28.280 170	38.601	55	56.9	60 81
R12	9/22	25	27.689 170	41.018	35	27.5	61 82
R3	9/22	25	25.149 170	40.165	60	66.7	63 82
22	9/23	25	22.692 170	34.052	38-57	33.3	62 82
6	9/23	25	23.890 170	34.479	20	62.7	27 82
8	9/23	25	25.026 170	35.044	42	23.5	26 82

Laysan

R12	9/24	25	46.650 171	44.827	33-47	5.9	48 81
R9	9/24	25	45.227 171	44.481	26-37	19.6	45 81
R11 ^d	9/24	25	45.932 171	44.653	18-46	23.6	48 82

^d Substitute for site 5, which was too rough to dive

Lisianski

R14	10/9	26	4.684 173	59.825	48	55	53 80
12	10/9	26	3.947 174	0.101	24-28	15.7	40 80
R9	10/9	26	2.373 174	0.755	26	4	42 80
10	10/10	25	56.451 173	55.334	28-31	62.7	43 80

R10	10/10	25	56.670	173	57.209	37-46	60.7	50	80
R7	10/10	25	57.225	173	58.246	34-38	72.5	38	80
18 ^e	10/11	26	0.253	173	59.659	21-28	11.8	39	80
16	10/11	25	59.215	173	59.667	40	37.2	49	80
17	10/11	25	58.244	173	57.851	33-38	25.2	42	80

^e Replacement for site R16, which was only sand and rubble

Pearl and Hermes Atoll

R26	9/26	27	47.150	175	46.817	40	5.9	45	81
R32	9/26	27	50.346	175	45.170	5-8	1	10	82
R31	9/26	27	49.599	175	47.533	34	82.4	42	82
R39	9/27	27	56.428	175	51.693	41-48	3.9	55	81
26	9/27	27	57.470	175	48.144	8	23.5	9	83
24	9/27	27	55.186	175	51.704	24-34	5.9	34	82
33	9/28	27	47.139	175	49.427	40	3.9	41	81
22	9/28	27	47.721	175	51.993	6	2	8	83
30	9/28	27	46.765	175	53.720	9	2	9	83
R42	9/29	27	45.202	175	56.927	45	1	51	80
31	9/29	27	46.551	175	58.398	8	2	26	82
32	9/29	27	46.376	175	56.353	18	5.9	37	82
R44	9/30	27	54.655	175	54.284	44	21.6	44	82
R22	9/30	27	53.958	175	54.885	11-16	5.9	16	80

Midway Atoll

R15	10/1	28	14.243	177	23.703	5-9	3.9	10	78
1	10/1	28	16.158	177	23.170	2-4	35.3	9	77
H21	10/1	28	16.641	177	21.967	3-4	25.5	7	78
H10	10/2	28	12.839	177	25.553	40-45	1	53	79
R25	10/2	28	11.629	177	24.125	6-8	1	8	80
R20	10/3	28	13.914	177	19.101	3-4	5.9	5	no gauge
R3	10/4	28	11.435	177	23.994	36-51	3.9	61	79
R7	10/4	28	11.790	177	22.509	46-49	2	53	80
2	10/4	28	11.854	177	20.772	38-43	3.9	46	79

Kure Atoll

R33	10/5	28	25.002	178	22.715	46-48	19.6	52	78
2	10/5	28	27.211	178	20.658	31-50	27.5	54	79
R36	10/5	28	25.226	178	22.263	8	2	15	79
12	10/6	28	22.957	178	19.485	31-35	5.9	45	79
9	10/6	28	24.345	178	20.561	14-18	2	28	79
R35	10/6	28	23.588	178	20.970	11-16	7.8	19	80
18	10/7	28	25.123	178	20.701	18-24	29.4	37	78
17	10/7	28	25.923	178	21.970	10	1	14	78
14	10/7	28	27.219	178	19.697	3-4	19.6	5	No gauge

Table B-2. Summary of coral samples collected by Kenyon for DNA studies of coral or their zooxanthellae.				
Island/Atoll	Genetic connectivity of corals		Zooxanthellae clades	
	# <i>Pocillopora meandrina</i>	# <i>Montipora capitata</i>	# of samples	# of species represented
French Frigate Shoals	26	26	53	12
Gardner Pinnacles	26	6	5	3
Maro Reef	25	25	26	9
Laysan	0	0	22	3
Lisianski	22	25	11	8
Pearl and Hermes	27	25	33	11
Midway	25	5	23	8
Kure	27	23	26	10
Total # of samples	178	135	199	

Population Parameters

For each reef system, the area surveyed by Kenyon, number of colonies enumerated, and percentage of coral colonies represented by each taxon are shown in Table B-3. Of the 57 scleractinian species documented from the NWHI, 25 species were enumerated within belt transects. In terms of number of colonies represented, *Porites lobata* is a dominant coral at all eight reef locations visited, with *Pocillopora meandrina* and/or *Montipora capitata* each co-dominating at four of the eight reef locations. Second to *Porites lobata*, corals in the genus *Acropora* were the next most abundant taxon at the sites surveyed at French Frigate Shoals. Percent cover of live coral, as determined by the line-intercept method, varied from 1% at five sites distributed among atoll forereef, backreef, and patch reef habitats, to 82.4% on a patch reef site at Pearl & Hermes Atoll. Figure B-1 shows the average percent coral cover from the REA sites surveyed throughout the NWHI.

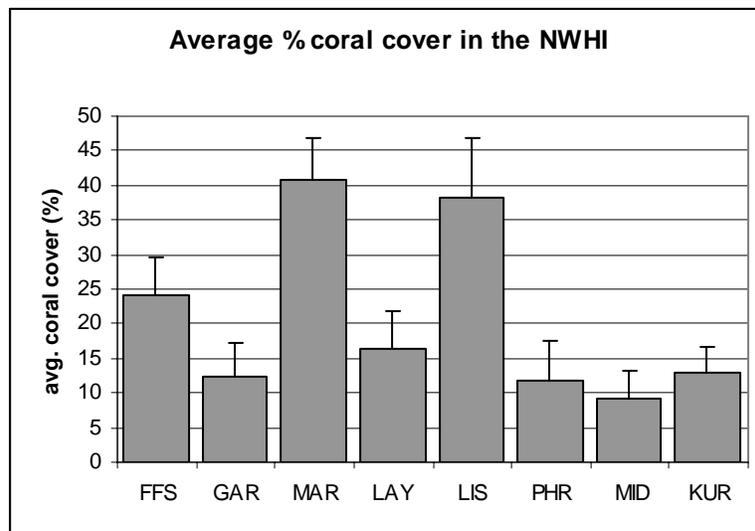


Figure B-1. Average percent live coral cover, from 2004 REA surveys

Size-class distributions of all corals enumerated within belt transects by Kenyon are shown in Figure B-2. Though the area surveyed, number of colonies enumerated, and habitats sampled varied among reef system, these size-class distributions demonstrate differences among reef systems in community structure. Corals at Gardner Pinnacles, for example, rarely attain sizes greater than 20-cm maximum diameter, most likely due to high energy wave exposure. Throughout the NWHI, the majority (76.2%) of coral colonies have a maximum diameter smaller than 20 cm. These size-class distributions serve as a baseline to which distributions from future surveys at the same suite of sites can be compared.

Taxon	FFS		GARDNER		MARO REEF		LAYSAN	
	# of colonies	Percent of total						
<i>Acropora</i>	247	16.8	3	0.3	6	0.6	1	0.4
<i>Montipora capitata</i>	38	2.6	14	1.2	193	19.6	38	14.0
<i>Montipora patula</i>	48	3.3	0	0.0	93	9.4	20	7.4
<i>Montipora verilli</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora flabellata</i>	6	0.4	0	0.0	0	0.0	0	0.0
<i>Montipora turgescens</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora incrassata</i>	7	0.5	0	0.0	0	0.0	0	0.0
<i>Pavona duerdeni</i>	71	4.8	3	0.3	45	4.6	1	0.4
<i>Pavona varians</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Pavona maldivensis</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Cyphastrea ocellina</i>	72	4.9	12	1.0	50	5.1	20	7.4
<i>Leptastrea purpurea</i>	23	1.6	15	1.3	9	0.9	0	0.0
<i>Fungia scutaria</i>	0	0.0	0	0.0	94	9.5	0	0.0
<i>Cycloseris</i> sp.	0	0.0	0	0.0	0	0.0	0	0.0
<i>Pocillopora damicornis</i>	121	8.2	1	0.1	40	4.1	2	0.7
<i>Pocillopora eydouxi</i>	8	0.5	0	0.0	2	0.2	0	0.0
<i>Pocillopora ligulata</i>	46	3.1	0	0.0	2	0.2	1	0.4
<i>Pocillopora meandrina</i>	119	8.1	222	18.6	87	8.8	14	5.1
<i>Pocillopora capitata</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Porites brighami</i>	8	0.5	1	0.1	7	0.7	8	2.9
<i>Porites compressa</i>	103	7.0	0	0.0	92	9.3	11	4.0
<i>Porites evermanni</i>	50	3.4	0	0.0	32	3.2	10	3.7
<i>Porites lobata</i>	483	32.8	906	75.8	227	23.0	146	53.7
<i>Porites rus</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Porites duerdeni</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Psammacora stellata</i>	4	0.3	0	0.0	3	0.3	0	0.0
<i>Palythoa</i> sp.	15	1.0	9	0.8	5	0.5	0	0.0
<i>Zoanthus pacifica</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Sinularia</i> sp.	0	0.0	9	0.8	0	0.0	0	0.0
Total # colonies	1469	100	1195	100	987	100	272	100
Area surveyed (m ²)	650		150		400		200	

Table B-3 cont. Number of anthozoans surveyed at NWHI REA sites by Kenyon during September 2004 surveys. Taxa contributing more than 10% of the total number of coral colonies are in bold.								
Taxon	LISIANSKI		PEARL & HERMES		MIDWAY		KURE	
	# of colonies	Percent of total	# of colonies	Percent of total	# of colonies	Percent of total	# of colonies	Percent of total
Acropora	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora capitata</i>	205	15.6	240	11.7	20	2.3	91	6.3
<i>Montipora patula</i>	190	14.4	2	0.1	0	0.0	0	0.0
<i>Montipora verilli</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Montipora flabellata</i>	0	0.0	82	4.0	68	7.9	75	5.2
<i>Montipora turgescens</i>	5	0.4	31	1.5	15	1.7	7	0.5
<i>Montipora incrassata</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Pavona duerdeni</i>	27	2.1	7	0.3	0	0.0	6	0.4
<i>Pavona varians</i>	3	0.2	1	0.0	0	0.0	10	0.7
<i>Pavona maldivensis</i>	6	0.5	0	0.0	0	0.0	0	0.0
<i>Cyphastrea ocellina</i>	253	19.2	26	1.3	1	0.1	14	1.0
<i>Leptastrea purpurea</i>	1	0.1	107	5.2	9	1.0	65	4.5
<i>Fungia scutaria</i>	18	1.4	11	0.5	1	0.1	6	0.4
<i>Cycloseris</i> sp.	0	0.0	3	0.1	0	0.0	0	0.0
<i>Pocillopora damicornis</i>	172	13.1	109	5.3	49	5.7	157	10.9
<i>Pocillopora eydouxi</i>	1	0.1	3	0.1	2	0.2	2	0.1
<i>Pocillopora ligulata</i>	3	0.2	0	0.0	0	0.0	7	0.5
<i>Pocillopora meandrina</i>	15	1.1	536	26.1	151	17.6	723	50.2
<i>Pocillopora capitata</i>	3	0.2	0	0.0	0	0.0	0	0.0
<i>Porites brighami</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Porites compressa</i>	77	5.9	100	4.9	0	0.0	24	1.7
<i>Porites evermanni</i>	154	11.7	3	0.1	3	0.3	0	0.0
<i>Porites lobata</i>	153	11.6	638	31.1	533	62.1	221	15.3
<i>Porites rus</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Porites duerdeni</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Psammacora stellata</i>	29	2.2	123	6.0	0	0.0	17	1.2
<i>Palythoa</i> sp.	0	0.0	29	1.4	6	0.7	15	1.0
<i>Zoanthus pacifica</i>	0	0.0	0	0.0	0	0.0	0	0.0
<i>Sinularia</i> sp.	0	0.0	0	0.0	0	0.0	0	0.0
Total # colonies	1315	100	2051	100	858	100	1440	100
Area surveyed (m ²)	450		1100		500		550	

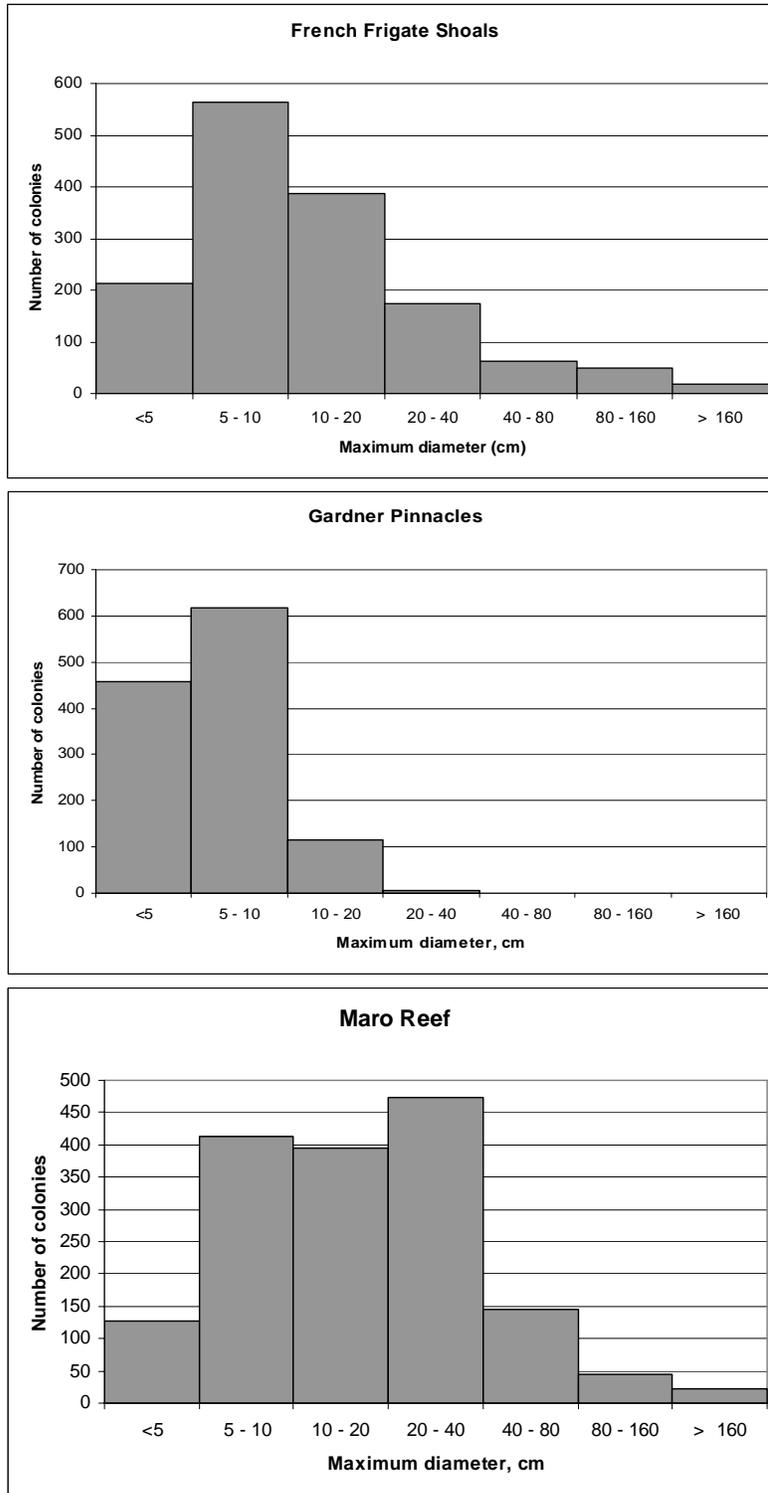


Figure B-2. Size-class distributions of anthozoans within belt transects at FFS, Gardner, Maro Reef, Laysan, Lisianski, Midway, Pearl and Hermes, and Kure.

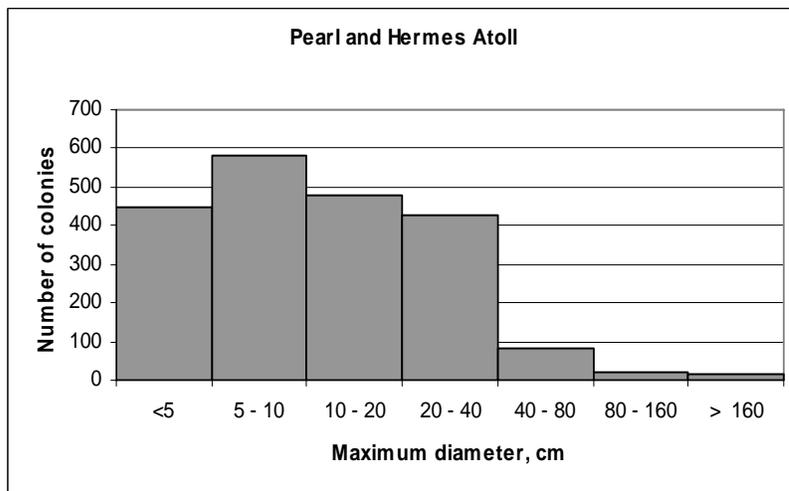
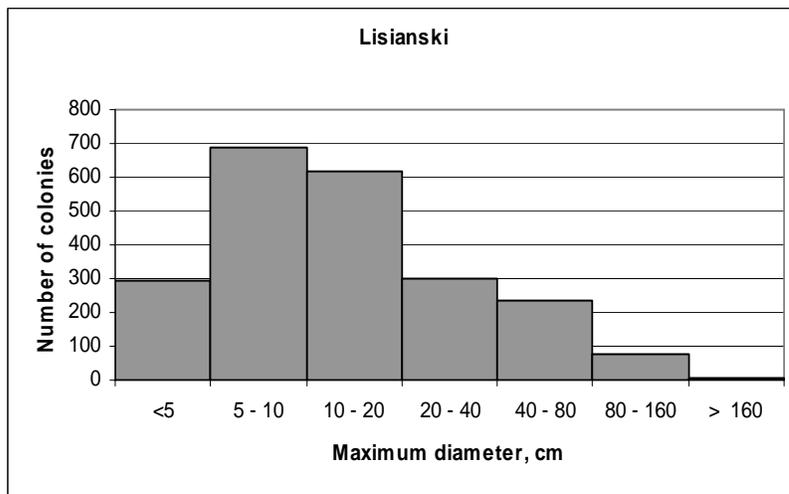
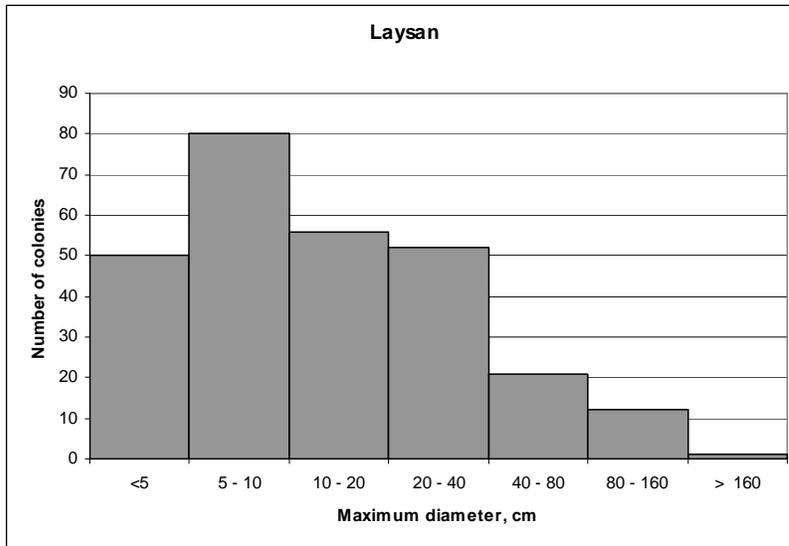


Figure B-2. Size-class distributions of anthozoans within belt transects at FFS, Gardner, Maro Reef, Laysan, Lisianski, Midway, Pearl and Hermes, and Kure.

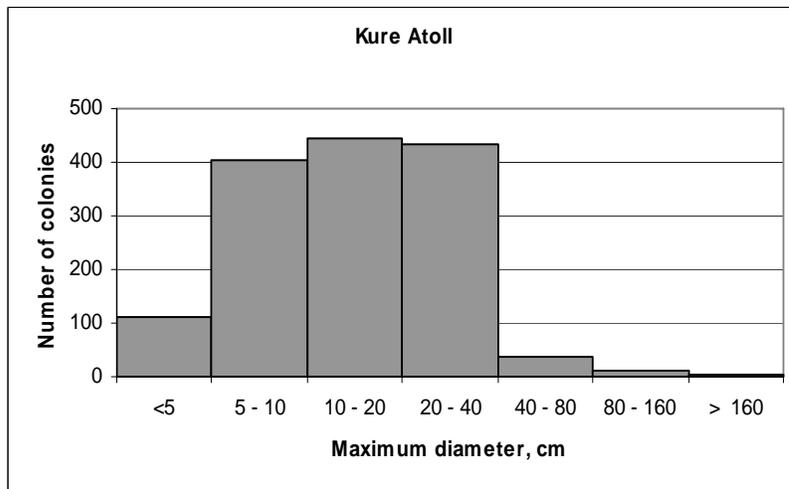
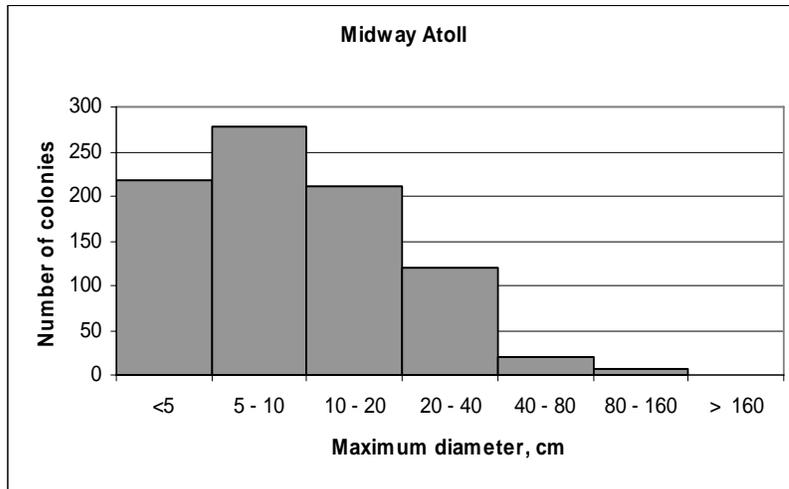


Figure B-2. Size class distributions of anthozoans within belt transects at FFS, Gardner, Maro Reef, Laysan, Lisianski, Midway, Pearl & Hermes, and Kure.

Coral Bleaching

Many reefs throughout the NWHI experienced a mass coral bleaching event in the late summer and fall of 2002, the first such event recorded from the NWHI. Shallow backreef habitats at the three northern atolls (Pearl & Hermes, Midway, and Kure) were most severely affected, in part because their dominant coral fauna, *Montipora capitata* and *Pocillopora meandrina*, are highly susceptible to bleaching. Although data regarding coral and macroalgal abundance at impacted sites surveyed during 2002, 2003, and 2004 await detailed analysis, visual inspection of a number of shallow backreef sites at Pearl & Hermes, Midway, and Kure revealed that the tops of large *M. capitata* colonies were dead and had become overgrown with thick algal turf. Additionally, the shallow (3-4 ft depth) surface of a central patch reef at Kure Atoll that was previously known as “coral gardens” due to its luxuriant coral growth, and on which most corals were bleached when surveyed in 2002, was now completely overgrown with turf and macroalgae except for some surviving fragments of *Porites compressa*.

A milder bleaching event was in progress at numerous sites visited during 2004 REA coral surveys. For all species in which bleaching was recorded, Table B-4 presents the proportion of colonies at each location that had bleached tissue. At French Frigate Shoals, paling of several colonies of pocilloporids and bleaching of small (<10 cm) *Montipora capitata* colonies was observed. However, *Acropora* corals, which in other regions are typically among the taxa most susceptible to bleaching, appeared normally pigmented. Bleached corals were not observed at Gardner Pinnacles. At Maro Reef, bleached coral colonies were observed at eight of the nine sites surveyed. *Montipora patula* was the taxon most frequently affected, with 68.6% of the colonies affected overall at the five sites where it occurred within belt transects. Bleached or substantially paled tissue (estimated 50% pigment loss or greater) was also observed in *Porites evermanni*, *Pocillopora damicornis*, *Pocillopora meandrina*, *Porites compressa*, *Montipora capitata*, and *Porites lobata*, although at lower frequencies that varied among species (35.2%, 27.5%, 8.0%, 6.5%, and 6.2%, respectively; frequency in *P. lobata* was not quantified). At Laysan, *Montipora patula* and *M. capitata* also evidenced bleaching, (35.5% and 13.2%, respectively); pale patches of *Porites lobata* were also observed at Laysan though their frequency was not quantified.

Table B-4. Frequency of bleaching in affected species throughout the NWHI, September/October 2004. # = number of colonies tallied within belt transects; % = proportion of colonies with bleached tissue; NT = not tallied

Species	FFS										Gardner	
	Forereef		Backreef		Acropora reefs		Patch reef		La Perouse		#	%
	#	%	#	%	#	%	#	%	#	%		
<i>Montipora patula</i>	14	0.0	0		7	0.0	6	0.0	19	0.0	0	
<i>Montipora capitata</i>	9	0.0	0		9	NT	19	NT	0		14	0.0
<i>Porites evermanni</i>	3	0.0	9	0.0	8	0.0	30	0.0	0		0	
<i>Porites compressa</i>	5	0.0	7	0.0	6	0.0	85	0.0	0		0	
<i>Porites lobata</i>	176	0.0	23	0.0	82	0.0	160	0.0	40	0.0	906	
<i>Pocillopora damicornis</i>	0		0		1	NT	67	37.3	2	0.0	1	0.0
<i>Pocillopora meandrina</i>	49	0.0	1	0.0	7	NT	17	11.8	45	0.0	222	0.0

Table B-4 cont. Frequency of bleaching in affected species throughout the NWHI, September/October 2004. # = number of colonies tallied within belt transects; % = proportion of colonies with bleached tissue; NT = not tallied

Species	Maro		Laysan		Lisianski	
	#	%	#	%	#	%
<i>Montipora patula</i>	93	68.8	20	35.5	190	56.3
<i>Montipora capitata</i>	193	6.2	38	13.2	205	2.4
<i>Porites evermanni</i>	32	35.2	10	0.0	154	52.6
<i>Porites compressa</i>	92	6.5	11	0.0	77	9.1
<i>Porites lobata</i>	227	NT	146	NT	91	23.1
<i>Pocillopora damicornis</i>	40	27.5	2	0.0	172	27.3
<i>Pocillopora meandrina</i>	87	8.0	13	0.0	15	20.0

Table B-4 cont. Frequency of bleaching in affected species throughout the NWHI, September/October 2004. # = number of colonies tallied within belt transects; % = proportion of colonies with bleached tissue; NT = not tallied

Species	Pearl and Hermes Atoll						Midway Atoll					
	Forereef		Backreef		Patch reef		Forereef		Backreef		Patch reef	
	#	%	#	%	#	%	#	%	#	%	#	%
<i>Montipora patula</i>	1	0.0	1	100.0	0				0		0	
<i>Montipora capitata</i>	2	0.0	237	75.5	1	100.0	2	50.0	18	100.0	0	
<i>Porites evermanni</i>	2	0.0	1	0.0	0				3	33.3	0	
<i>Porites compressa</i>	3	0.0	1	0.0	96	9.4			0		0	
<i>Porites lobata</i>	540	0.0	91	1.1	0		456	0.0	52	1.9	25	0.0
<i>Pocillopora damicornis</i>	5	0.0	98	43.9	6	66.7			16	18.8	33	9.1
<i>Pocillopora meandrina</i>	145	4.1	279	60.2	123	74.8	73	0.0	9	11.1	16	31.3

Table B-4 cont. Frequency of bleaching in affected species throughout the NWHI, September/October 2004. # = number of colonies tallied within belt transects; % = proportion of colonies with bleached tissue; NT = not tallied

Species	Kure Atoll					
	Forereef		Backreef		Patch reef	
	#	%	#	%	#	%
<i>Montipora patula</i>	0		0		0	
<i>Montipora capitata</i>	0		91	61.5	0	
<i>Porites evermanni</i>	0		0		0	
<i>Porites compressa</i>	0		0		24	0.0
<i>Porites lobata</i>	169	0.0	18	0.0	0	
<i>Pocillopora damicornis</i>	2	0.0	80	3.7	7	6.7
<i>Pocillopora meandrina</i>	253	4.1	258	6.2	35	42.9

Bleaching patterns at Lisianski differed substantially from those at Laysan, although the depths surveyed at the two locations (24–48 ft) were essentially similar. The taxonomic extent of bleaching was greater at Lisianski than at Laysan and, with the exception of *Montipora capitata*, which showed relatively little bleaching at Lisianski, the incidence of bleaching was greater. Both *Montipora patula* and *Porites evermanni* experienced moderately high bleaching frequencies (56.3% and 52.6%, respectively), with lesser bleaching incidences in *Pocillopora damicornis*, *Porites lobata*, *Pocillopora meandrina*, *Porites compressa*, and *Montipora capitata* (27.3%, 23.1%, 20.0%, 9.1%, and 2.4%, respectively). It should be noted that moderately high rates of bleaching were noted even at sites with high turbidity/low visibility on the survey day, as turbidity is generally thought to protect corals from bleaching by scattering damaging UV radiation. In both *Porites evermanni* and *P. lobata*, bleaching within individual colonies was “patchy” in that rarely was the entire colony affected, but rather numerous large patches of tissue were bleached, giving the colonies a mottled appearance. At sites where affected colonies of these two species occurred, it was estimated that typically 5%-10% of their tissue across the entire site was bleached.

During the 2002 mass bleaching event at the three northern atolls, incidences of bleaching were highest on the shallow backreef, lowest on the deeper forereef, and moderate on lagoonal patch reefs. Because sampling effort using both REA and towed-diver survey methods in these three atoll habitats had been unequal, no conclusions had been drawn concerning which, if any, of the three northern atolls had been most severely affected by bleaching. The preliminary results of 2004 REA surveys indicate several patterns of bleaching in the three northern atolls that are congruent with those seen in

2002: (1) incidences of bleaching are lowest on the deeper (31-51 ft) forereefs; (2) *Pocillopora meandrina* and *P. damicornis* are highly susceptible to bleaching, with peak values of 74.8% and 66.7%, respectively, across the Pearl & Hermes patch reefs surveyed, and (3) *Montipora capitata* is highly susceptible to bleaching, with incidences ranging from 61.5% on the Kure backreef to 100% on the Midway backreef. It should be noted, however, that these latter values pertain to colonies or portions of colonies with surface exposure, while those colonies or sides of colonies with reduced solar exposure typically have more extensive areas of unbleached tissue. Contrary to the 2002 pattern, inspection of the data suggests that patch reef habitats at Pearl & Hermes may be experiencing higher incidences of bleaching than backreef habitats; this suggestion awaits more detailed statistical analysis, however. Additionally, it was qualitatively noted during field surveys that pocilloporids at Kure backreef sites manifested less bleaching than their backreef congeners at Pearl & Hermes and at Midway, an impression that is born out by the quantitative data.

In the wake of the 2002 mass coral bleaching event, during NOWRAMP 2003 (July/August 2003) CRED oceanographers deployed 22 surface temperature recorders (STRs) in water depths ranging from 2 to 34 ft at French Frigate Shoals (4), Gardner (1), Maro (2), Laysan (2), Lisianski (1), Pearl & Hermes (5), Midway (4), and Kure (3). Retrieved during the present cruise (see Oceanography section for details), each recorder provides a water temperature profile over a period of roughly 14 months. While these temperature profiles require more detailed analysis by experienced oceanographers, the records from many locations show that (1) temperatures peak in early-mid September, and (2) water temperatures were warmer ($\geq 1^{\circ}\text{C}$) in 2004 at locations where substantial bleaching was observed than during 2003, when only minor bleaching was observed. It should be noted, however, that benthic surveys in 2003 were conducted during July/August, before the period of prolonged peak temperatures. From the viewpoint of future monitoring of coral populations for bleaching events in the NWHI, it is best that surveys be conducted in September/October, as was done in both 2002 and 2004.

Analysis of the more spatially extensive surveys conducted by towed divers remains to be done in order to better describe 2004 coral bleaching patterns throughout the NWHI. A number of additionally interesting topics arise from this year's REA surveys, however, including (1) the widespread patchy bleaching observed in *Porites lobata* in deeper (21-48 ft), turbid water at Lisianski and, to a lesser degree at Maro and Laysan, while conspecifics on the clear, shallow backreefs of the three northern atolls were rarely bleached, and (2) the relative resistance of *Acropora* to bleaching in the NWHI, as they are frequently among the first taxon to manifest bleaching in other areas of the Pacific.

Quantitative surveys of coral disease were initiated in 2003 to assess the frequency and abundance of disease on the reefs of the NWHI. Surveys of these same sites are planned on an annual basis to monitor the health of corals through time. In 2004, 71 sites were resurveyed for coral disease. Methodology between 2003 and 2004 was identical with the exception of an increase in the amount of time allocated for disease assessment in 2004. Evidence of coral disease in the NWHI is widespread but is found at low levels indicative of a healthy population. A total of 11 different coral diseases affecting the four major genera of coral (*Porites*, *Montipora*, *Pocillopora*, and *Acropora*) have now been described from the NWHI (Table B-5). Distribution of each disease varies across the NWHI as does frequency of occurrence. *Porites* trematodiasis, a disease caused by the larval stage of a digenetic trematode is the most widespread (all

islands) and common disease (frequency of occurrence=70.0 %). Diseases appeared to be more widespread in 2004 as compared to 2003 but search time was also increased. However, one disease, Acroporid white syndrome, was considered to be more prevalent as few sites ($n=8$) have *Acropora* so search time was not considered to be a factor. Acroporid white syndrome was first discovered at one site in 2003 and was found at three sites in 2004. Acroporid white syndrome causes complete tissue loss on large areas of table corals. Acroporid table corals are found only at certain regions within the NWHI (French Frigate Shoals, Maro, Lisianski, and Gardner) and encompass < 5% of the overall coral community. As such, these populations of coral should be monitored closely for this disease and will be a prime target for further disease investigation in a research cruise scheduled for spring 2005. In collaboration with scientists at USGS, histopathological analysis is also being conducted to characterize the tissue level changes associated with each disease, and scientists at the Hawaii Institute of Marine Biology are using molecular techniques to determine the possible etiologies of the different diseases.

Table B-5. Description of 11 coral diseases found on the reefs of the NWHI

Genera	Disease	Characteristics	Distribution in 03	Freq of occurrence 03 (%)	Distribution in 04	Freq of occurrence 04 (%)
<i>Porites</i>	Poritid Trematodiasis (zits)	3-5mm pink, swollen nodules on coral colony	all islands	57.5	all islands	70.0
	Poritid Tissue Loss Syndrome (TLS)	irregularly shaped areas of complete tissue loss on coral colony; border bet/ healthy and diseased tissue can be bleached, pink or have mucous layer	FFS,MAR,PHR.MID ,KUR	11.0	FFS,MAR,LAY,PHR. MID,KUR,LIS	30.3
	Poritid Dark Tissue Thinning Syndrome (DTTS)	darkened areas on coral colony w/ obvious lack of polyp extension and thinned tissue layer	FFS,MAR,LAY,PHR. MID,LIS.KUR	20.5	FFS,MAR,LAY,PHR. MID,LIS	18.2
	Poritid Brown Necrotising Disease (BND)	coral tissue appears as dark brown gelatinous layer w/ loss of recognizable polyp structure	PHR	2.7	PHR,LIS	3.0
	Poritid Growth Anomaly (GA)	abnormal appearance of coral skeleton; is usually protrusive		0	MAR,KUR	4.5

Montipora	Montiporid White Syndrome (WS)	irregularly shaped white areas of complete tissue loss on coral colony; border bet/ healthy and diseased tissue can be bleached, have mucous layer or have thin (1 polyp deep) layer of white necrotic tissue	MAR, MID,LAY	MAR,PHR,MID,KUR, LIS	6.8	18.2
	Montiporid White Spot	small white circular areas of complete tissue loss; can have residual necrotic tissue in center; usually ~ 5mm in size but can coalesce to form larger areas of tissue loss	MAR	MAR,MID,KUR	1.4	7.6
	Montiporid Growth Anomaly (GA)	abnormal appearance of coral skeleton; is usually protrusive	PHR	MAR,LAY	1.4	3.0
Acropora	Acroporid White Syndrome	white areas of complete tissue loss; can be irregularly shaped or can appear as a linear pie wedged area of tissue loss from the center of the plate to the outer edge. progresses in a circular manner across the table coral	FFS	FFS	1.4	4.5

Acropora	Acroporid Growth Anomaly	abnormal appearance of coral skeleton; is usually protrusive; can range from < 1cm to >35cm; 2 types have been described: type 1 is compact w/ reduced calyx structure. Type 2 has elongated but distorted calyx structure	FFS	FFS	2.7	3.0
Pocillopora	Pocilloporid White Band Disease	appears as a narrow, linear band of tissue loss usually at the base of branches	PHR		1.4	0
	Pocilloporid Growth Anomaly	abnormal appearance of coral skeleton; is usually protrusive	*found in 2002			

Appendix C: **Algal REA Team Activity Summary** (*Peter Vroom and Erin Looney*)

A. Methods

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

B. Results

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

1. French Frigate Shoals (Table C-1)

Site Descriptions

FFS-H6, 9/16/04

This site is a forereef with a depth range of 40-57 ft. The dominant species of coral was *Porites lobata*. There did not seem to be much coral or macroalgal cover. In the photoquads turf algae, crustose coralline algae (CCA), *Halimeda discoidea*, and *Halimeda velasquezii* were most common.

FFS-21, 9/16/04

This lagoonal reef is located near Shark Island. Depths ranged from 20 to 45 ft. This site was primarily composed of the table coral, *Acropora cytheria*. The photoquads were again dominated by CCA, turf algae, and *Halimeda velasquezii*.

FFS-23, 9/16/04

This lagoonal reef had a depth range of 0-11 ft. *Porites lobata* was the dominant coral species. There seemed to be a lot of rubble and sediment with low coral and macroalgal cover. *Microdictyon setchelliannum* and turf algae were most common in the photoquads.

FFS-R46, 9/17/04

This site is right next to La Pérouse Pinnacle and the depth range was 10-31 ft. There were extremely evident spur and groove formations at this site with *Porites lobata* being the primary coral species. This site appeared to have more coral and algal cover than the others. Past the spur and grooves, big table corals were found. This site had a high diversity of algal species, found in the random swim. In the photoquads, the dominant species were CCA and turf algae.

FFS-32, 9/17/04

This site was in the lagoon and had a depth range of 10-30 ft. The reef went down in a fairly steep slope. This site also had many algae species found in the random swim, but turf algae and CCA were dominant in the photoquads.

FFS-33, 9/17/04

This reef was also deeply sloping with a depth range of 10-35 ft. Next to the reef was a large sand patch. Again, turf algae and CCA were most common in the photoquads, but many other species were found in the random swim.

FFS-R30, 9/18/04

This site was a backreef and was extremely shallow with a depth range of 0-8 ft. The most common algae were *Microdictyon setchellianum* and a species of *Liagora*. In some areas, *M. setchelliannum* covered the entire floor. The majority of the substrate was covered by rubble. The dominant coral species was again *Porites lobata*. During the random swim, there were only a few other species of algae collected.

FFS-30, 9/18/04

This site is a lagoonal reef with a depth range of 15-26 ft. Most of the quadrats showed *Halimeda velasquezii* to be the most common macroalga. The dominant coral of this site was *Acropora cytheria*. Many other species of algae were found in the random swim.

FFS-34, 9/19/04

This site was a forereef that had low coral and algal cover. The depth range was 30-35 ft. The floor consisted of mostly rubble and a few colonies of coral, primarily *P. lobata*. In the photoquads, turf and CCA were most prevalent.

FFS-12, 9/19/04

This lagoonal (?) reef has very obvious spur and groove formations, and the spurs were almost entirely made up of *Acropora cytheria*. The depth range of this site was 30-40 ft. There was very little algae seen in the photoquads, but during the random swim we found and collected several species.

FFS-R29, 9/19/04

The patch reef in this site was deeply sloping with a depth range of 15-20 ft. The visibility was low and the current was quite strong. The dominant coral species was *P. lobata* and the most common algae seen was *Halimeda velasquezii*.

	FFS H6	FFS 21	FFS 23	FFS r46	FFS 32	FFS 33	FFS r30	FFS 30	FFS 34	FFS 12	FFS R29	Island Average
<i>Asparagopsis taxiformis</i>	*			*								
branched coralline		8.33 4.0	66.67 2.5	16.67 3.5	16.67 4.5	*	50.00 2.7	16.67 4.0			58.33 3.4	21.21 (25.1) 3.5 (0.7)
<i>Chrysmenia</i> spp.				16.67 3.0								1.52 (5.0) 3.0
<i>Coelothrix irregularis</i>					*							
crustose coralline	83.33 1.8	91.67 1.2		91.67 2.0	25.00 2.0	75.00 2.0	100.00 2.4	83.33 2.2	66.67 2.8	33.33 1.8	91.67 2.3	67.42 (33.0) 2.0 (0.4)
<i>Dasya iridescens</i>					*	*			*			
<i>Gibsmithia hawaiiensis</i>				*				*		*		
<i>Halichrysis coalescens</i>				*								
<i>Haloplegma duperreyi</i>	*	*				*		8.33 4.0			*	0.76 (2.5) 4.0
<i>Jania</i> spp.								*				
<i>Laurencia galtsoffii</i>			8.33 4.0									0.76 (2.5) 4.0
<i>Laurencia parvipapillata</i>				*		*						
<i>Laurencia</i> sp.			*					*				
<i>Liagora</i> spp.	*	*			*		66.67 3.5		8.33 2.0			6.82 (20.0) 2.8 (1.1)
<i>Peyssonnelia</i> spp.	*	*	16.67 3.5	*		*						1.52 (5.0) 3.5
<i>Predaea weldii</i>	*										*	
<i>Spyridea filamentosa</i>					*							
Brown Algae												
<i>Dictyota friabilis</i>				*				8.33 4.0				0.76 (2.5) 4.0
<i>Dictyota</i> spp.								*		*		
<i>Lobophora variegata</i>				8.33 3.0	*	*	*		58.33 3.3		*	7.41 (19.3)

	FFS H6	FFS 21	FFS 23	FFS r46	FFS 32	FFS 33	FFS r30	FFS 30	FFS 34	FFS 12	FFS R29	Island Average
												3.1 (0.2)
<i>Styopodium hawaiiensis</i>				*								
Blue-green Algae				16.67 3.5		8.33 4.0	8.33 4.0	16.67 4.0	8.33 4.0		8.33 4.0	6.06 (6.6) 3.9 (0.2)
Algal Turf	100.00 1.2	83.33 2.1	100.00 1.3	100.00 1.0	100.00 1.25	100.00 1.33	91.67 1.1	100.00 1.2	100.00 1.0	100.00 1.1	100.00 1.2	97.73 (5.4) 1.2 (0.3)

2. Gardner Pinnacles (Table C-2)

Site Descriptions

GAR-R6, 9/20/04

This site was on the northwest side of Gardner Pinnacle. The habitat was made up of boulder formations and visibility was extremely clear. There was very little coral or macroalgae. The photoquads showed primarily *Microdictyon setchellianum*, turf algae, CCA, and blue-green algae. During the safety swim, there were about 24 sharks hanging out with us.

GAR-R3, 9/20/04

This site was on the south side of the Pinnacle, and although there were a few small boulders, it was quite different from the previous site. The topography was flatter with little coral and algae. The photquads showed *Halimeda velasquezii*, turf algae, and blue-green algae being the most dominant, but during the swim, several other species were collected.

GAR-R5, 9/20/04

This site was more like the first site, R6, with many large boulders. It was located between the two previous sites, right off the Pinnacle. With the boulders, most substrate was comprised of rocks and turf algae. The photoquads didn't have much macroalgae, mainly turf and blue-green algae. This is the site where we saw two eagle rays, a monk seal, and several sharks.

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

	GAR 6	GAR R3	GAR 5	Island average
Green Algae				
<i>Dictyosphaeria cavernosa</i>		8.33 4.0	*	2.78 (4.8) 4.0
<i>D. versluysii</i>	*			
<i>Halimeda velasquezii</i>	83.33 3.1	83.33 3.1	*	55.56 (48.1) 3.1 (0)
<i>Microdictyon setchellianum</i>	41.67 2.0	58.33 2.1	25.00 2.3	41.67 (16.7) 2.2 (0.2)
Red Algae				
branched coralline	16.67 3.5			5.56 (9.6) 3.5
crustose coralline	16.67 2.5		8.33 2.0	8.33 (8.33) 2.3 (0.4)
<i>Dasya iridescens</i>	*			
<i>Halichrysis coalescens</i>			*	
<i>Laurencia</i> sp.			*	
<i>Liagora</i> spp.		*		
<i>Portieria hornemannii</i>			*	
Brown Algae				
<i>Dictyota friabilis</i>	8.33 6.0		*	2.78 (4.8) 6.0
<i>Dictyota</i> spp.	8.33 5.0	*		2.78 (4.8) 5.0
<i>Padina</i> sp.	*			
Blue-green Algae	33.33 2.8	83.33 2.8	58.33 2.0	58.33 (25.0) 2.5 (0.4)
Algal Turf	100.00 1.1	100.00 1.0	100.00 1.0	100.00 (0) 1.0 (0)

3. Maro Reef (Table C-3)

Site Descriptions

MAR-R8, 9/21/04

This reef was mostly rock with a large abundance of *Sporochnus dotyi*. The depth range was 40-67 feet. In the photoquads, *Halimeda opuntia*, *H. velasquezii*, *Laurencia* sp., branched coralline algae, turf, and *S. dotyi* were most prevalent, but in the random swim, several other species were found.

MAR-R6, 9/21/04

This reef was very similar to the previous. The visibility in both was extremely poor. The reef did not have any *S. dotyii*. The depth range was 40-60 ft. The most abundant, again, in the photoquads were turf and coralline algae. *Halimeda velasquezii* was also fairly common in the quads.

MAR-R5, 9/21/04

This reef was also similar to the previous two, but this one seemed to have more topography. The depth range was 40-50 ft and the visibility was low. The most common coral species was *Porites lobata*, and there were several species of algae found during the random swim.

MAR-R12, 9/22/04

This site had large boulders with little macroalgae and moderate coral cover. The most abundant species of algae in the photoquads was CCA with *Halimeda opuntia* being the second most abundant. The most common coral species was *Porites lobata*.

MAR-R9, 9/22/04

This dive was cut short due to an extremely strong current. We weren't able to take photos, but we were able to collect algae. The reef was characterized by large "hills" of reef and deep overhangs. There was a large abundance of coral and a moderate amount of algae. The species found are listed.

MAR-R3, 9/22/04

This site was done only by Erin, Peter's fin broke at the last site. Because of this, only photos were taken and collection, no visual survey. This site also had an extremely sloping reef, deep overhangs, and deep valleys. The reef was dominated by coral, mainly *Montipora patula*, and little macroalgae.

MAR-22, 9/23/04

This patch reef had a depth range of 40-60 ft. It was characterized by deep overhangs and steep slopes. The most abundant coral species were *P. lobata*, *P. compressa* and *Montipora capitata*. Blue-green algae was widespread. In the photoquads, turf, blue-green, and CCA were most common. *H. opuntia* and *H. velasquezii* were the most common throughout the reef.

MAR-6, 9/23/04

This patch reef had moderate relief and was deeply sloping. The depth range was 15-25 ft. The substrate was primarily comprised of rubble. CCA, turf, and *H. velasquezii* were the dominant algae in the photoquadrats.

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

	MAR R8	MAR R6	MAR R5	MAR R12	MAR R9	MAR R22	MAR R6	MAR R8	Island Average
Green Algae									
<i>Bryopsis pennata</i>							*	*	
<i>Caulerpa nummularia</i>			*				*		
<i>C. taxifolia</i>			*						
<i>C. webbiana</i>			*						
<i>Caulerpella ambigua</i>			*						
<i>Dictyosphaeria cavernosa</i>			8.33 2.0						1.19 (3.1) 2.0
<i>D. versluysii</i>	8.33 5.0	16.67 5.5	8.33 5.0				16.67 5.0	*	7.14 (7.5) 5.1
<i>Halimeda opuntia</i>	75.00 3.7	25.00 4.3	41.67 2.0	91.67 1.8	*	41.67 2.2	16.67 5.0	25.00 1.0	45.24 (28.0) 2.9 (1.5)
<i>H. velasquezii</i>	75.00 3.0	83.33 3.2	91.67 2.2	25.00 2.7	*	58.33 2.9	100.00 3.1	58.33 2.9	70.24 (25.4) 2.8 (0.3)
<i>Neomeris</i> spp.	8.33 6.0	8.33 5.0			*	*			2.38 (4.1) 5.5 (0.7)
<i>Palmophyllum crassum</i>			*						

	MAR R8	MAR R6	MAR R5	MAR R12	MAR R9	MAR 22	MAR 6	MAR 8	Island Average
Red Algae									
branched coralline	33.33 4.8	50.00 3.2	8.33 3.0	50.00 3.3			33.33 3.8	16.67 3.5	27.38 (19.7) 3.6 (0.6)
<i>Chrysymenia</i> spp.								8.33 3.0	1.19 (3.1) 3.0
crustose coralline	58.33 1.6	91.67 1.5	66.67 3.1	100.00 1.7		33.33 3.5	83.33 2.2	75.00 6.0	72.62 (22.4) 2.2 (0.8)
filamentous red	8.33 3.0								1.19 (3.1) 3.0
<i>Gibsmithia dotyi</i>								8.33 3.0	1.19 (3.1) 3.0
<i>G. hawaiiensis</i>	*					*			
<i>Haloplegma duperreyi</i>					*				
<i>Kallymenia thompsonii</i>				*		*		*	
<i>Laurencia galtsoffii</i>							83.33 3.8	8.33 4.0	13.10 (31.1) 3.9 (0.1)
<i>Laurencia</i> sp.	75.00 3.8	50.00 3.8	75.00 3.6	*	*	75.00 2.9			39.29 (37.8) 3.5 (0.4)
<i>Liagora</i> spp.						8.33 5.0	*		1.19 (3.1) 5.0
<i>Neomartensia</i> sp.							*		
<i>Peyssonnelia</i> spp.	8.33 4.0			*					1.19 (3.1) 4.0
<i>Portieria hornemannii</i>	*			*	*				
<i>Predaea weldii</i>	8.33 7.0	*	*						1.19 (3.1) 7.0
Brown Algae									
<i>Lobophora variegata</i>		8.33 4.0		*			8.33 4.0		2.38 (4.1) 4.0 (0)
<i>Sporochnus dotyi</i>	41.67 5.2								5.95 (15.7) 5.2

	MAR R8	MAR R6	MAR R5	MAR R12	MAR R9	MAR 22	MAR 6	MAR 8	Island average
Blue-green Algae	8.33 3.0	25.00 5.3		8.33 4.0		58.33 3.0	16.67 5.5	16.67 3.0	19.05 (19.1) 4.0 (1.2)
Algal Turf	83.33 1.4	100.00 1.7	91.67 1.5	66.67 2.6		100.00 1.1	100.00 1.2	75.00 1.7	88.10 (13.5) 1.6 (0.5)

R**MAR-8, 9/23/04**

Patch reef with high algae cover and *P. lobata*, *P. compressa*, and *M. capitata* being the dominant coral species. This was a shallow reef with a depth range of 6-35 ft. This reef had extremely high relief. This site had massive amounts of netting around some of the stands of coral. Turf, coralline, and *H. velasquezii* were again the dominant algal species.

4. Laysan Island (Table C-4)

Site Descriptions

LAY-R12, 9/24/04

This forereef is characterized by scoured pavement and boulders with moderate coral cover. The depth range was 40-50 ft. The abundance of algae was moderate but there were more species found at this site than any other. Turf algae was most common in the photoquadrats, and 17 species were found during the random swim.

LAY-R9, 9/24/04

This forereef was similar to the first with scoured pavement and low coral cover. There were a few overhangs. The depth range was 40-48 ft. *H. velasquezii* and *Dictyota* sp. were common macroalgal species, and in the photoquads, turf, blue-green algae, *Laurencia* sp., and CCA were dominant.

LAY-R11, 9/24/04

This reef had higher relief than the previous two with moderate coral and algal cover. The depth range was 40-50 ft. Turf and coralline algae were the most common algal species. *H. velasquezii* was again the most common in the photoquads.

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

	LAY R12	LAY R9	LAY R11	Island Average
Green Algae				
<i>Bryopsis pennata</i>			8.33 3.0	2.78 (4.8) 3.0
<i>Caulerpa webbiana</i>	*	*	8.33 5.0	2.78 (4.8) 5.0
<i>Dictyosphaeria versluisii</i>			8.33 4.0	2.78 (4.8) 4.0
<i>Halimeda discoidea</i>	8.33 2.0	*	*	2.78 (4.8) 2.0
<i>H. opuntia</i>			8.33 6.0	2.78 (4.8) 6.0
<i>H. velasquezii</i>	50.00 2.8	100.00 2.3	91.67 2.6	80.56 (26.8) 2.6 (0.3)
<i>Microdictyon setchellianum</i>	16.67 2.5	33.33 3.5		16.67 (16.7) 3.0 (0.7)
<i>Neomeris</i> spp.		*		
Red Algae				
<i>Amansia glomerata</i>	*			
<i>Botryocladia skottsbergii</i>		*		
<i>Chrysomenia</i> spp.	*	*		
crustose coralline	25.00 2.3	66.67 3.1	66.67 1.9	52.78 (24.1) 2.4 (0.6)
<i>Galaxaura</i> sp.	8.33 3.0	*	*	2.78 (4.8) 3.0
<i>Gelidiopsis</i> sp.	8.33			2.78

	LAY R12	LAY R9	LAY R11	Island Average
	2.0			(4.8) 2.0
<i>Gibsmithia dotyi</i>	*			
<i>G. hawaiiensis</i>	*	*	*	
<i>Haloplegma duperreyi</i>	8.33 4.0	*	*	2.78 (4.8) 4.0
<i>Laurencia galtsoffii</i>		66.67 4.4		22.22 (38.5) 4.4
<i>Neomartensia</i> sp.	*		25.00 3.0	8.33 (14.4) 3.0
<i>Peyssonnelia</i> spp.	*	*	8.33 3.0	2.78 (4.8) 3.0
<i>Portieria hornemannii</i>			16.67 3.5	5.56 (9.6) 3.5
Brown Algae				
<i>Dictyota friabilis</i>	*	50.00 4.5	8.33 3.0	19.44 (26.8) 3.8 (1.1)
<i>Dictyota</i> spp.	8.33 5.0		33.33 3.3	13.89 (17.3) 4.1 (1.2)
<i>Padina</i> sp.		*		
Blue-green Algae	8.33 3.0	83.33 4.3	8.33 4.0	33.33 (43.3) 3.8 (0.7)
Algal Turf	91.67 1.1	100.00 1.2	91.67 1.4	94.44 (4.8) 1.2 (0.1)

5. Pearl and Hermes Atoll (Table C-5)

Site Descriptions

PHR-R26, 9/26/04

This site was characterized by spur and groove formations. The coral cover was low and the dominant algal species were *Microdictyon*, *Laurencia* sp. and *H.*

velasquezii. The depth range was 36-46 ft. In the photoquads, turf algae and *Microdictyon* were most common.

PHR-R32, 9/26/04

This site was extremely shallow with a depth range of 7-10 ft. The site was divided into two habitats, a shallow reef with a deeper sand channel running down the middle. The algae that occurred most frequently in the photoquads were *Microdictyon*, turf, and coralline algae. We found a few other species in the random swim, including *Turbinaria*, which hasn't been found at any other site.

PHR-R31, 9/26/04

This site was primarily dominated by *Porites compressa*. The reef was sloping with a depth range of 10-60 ft. There were hardly any other coral species, and no macroalgae were seen in the photoquads besides turf algae. Closer to the boat, we collected *H. discoidea*, *H. velasquezii*, and *Laurencia galtsoffii* for Kim Page's Master's work.

PHR-R39, 9/27/04

Forereef with a depth range of 36-46 ft. This reef had large boulders with swim-through channels. There was very little coral and algae cover. The dominant algal species all over the reef was *H. velasquezii*. In the photoquads, coralline and turf algae were most frequent. We collected only *H. velasquezii* for Kim at this site, the other two were not present.

PHR-26, 9/27/04

This backreef was extremely shallow, depth range of 1-5 ft. The reef consisted of patches of *Montipora* sp. that were bleached two years ago and still not doing well. The most common algae were *H. velasquezii*, *M. setchelliannum*, and *L. galtsoffii*. Turf, branched, and coralline algae were most common in the photoquads.

PHR-24, 9/27/04

This site was a lagoonal reef with a depth range of 15-35 ft. The visibility was very poor. Half of the site was a sand patch, the other half was heavily overgrown by *H. velasquezii*. This alga appeared different from normal; there were curtains of abnormally long strands of it. Again, only *H. velasquezii* and *H. discoidea* were collected for Kim, as *Laurencia* wasn't seen.

PHR-33, 9/28/04

This site was completely flat with *Microdictyon* covering most of the floor. The depth was 35 ft. There was hardly any coral or other algal species. In the photoquads, *Microdictyon* was prominent with a few sprigs of *H. velasquezii* and *H. discoidea*.

PHR-22, 9/28/04

This reef was shallow with a depth range of 3-5 ft. Most of the *Pocillopora* was covered by branched coralline algae. The dominant algae was again *M.*

setchelliannum. We were able to photograph only the first 6 quads because of surge.

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

	PHR R26	PHR R32	PHR R31	PHR R39	PHR 26	PHR 24	PHR 33	PHR 22	PHR 24	PHR R42	PHR 31	PHR 32	PHR R44	PHR R22	Island Average
Green Algae															
<i>Bryopsis pennata</i>						*									
<i>C. serrulata</i>	*	*										8.33 5.0		*	0.69 (2.4) 5.0
<i>C. webbiana</i>								*							
<i>Codium arabicum</i>		*		*	*								*		
<i>Dictyosphaeria cavernosa</i>		*		*	*							8.33 2.0			0.69 (2.4) 2.0
<i>D. versluysii</i>	8.33 7.0	8.33 4.0		*	8.33 6.0	*	*							*	2.08 (3.8) 5.7 (1.5)
<i>Halimeda discoidea</i>	16.67 4.0	*			25.00 4.0	16.67 2.0	41.67 2.0	*	*	16.67 3.5			16.67 3.5		11.11 (13.5) 3.2 (0.9)
<i>H. opuntia</i>				*	*	25.00 1.3							8.33 5.0	16.67 2.5	4.17 (8.3) 2.9 (1.9)
<i>H. velasquezii</i>	83.33 3.4	25.00 3.0		91.67 2.6	58.33 3.9	41.67 1.8	16.67 2.0	*	*	8.33 3.0	8.33 4.0		91.67 3.3	58.33 2.9	40.28 (35.5) 3.0

	PHR R26	PHR R32	PHR R31	PHR R39	PHR 26	PHR 24	PHR 33	PHR 22	PHR 24	PHR R42	PHR 31	PHR 32	PHR R44	PHR R22	Island Average
															(0.7)
<i>Microdictyon setchellianum</i>	91.67 1.5	50.00 2.3		16.67 3.0	75.00 3.0		100.00 1.0	*	*	100.00 1.1	8.33 3.0	100.00 1.7		16.67 2.5	48.61 (42.5) 2.1 (0.9)
<i>Neomeris spp.</i>	16.67 5.0				*		*			8.33 3.0	8.33 4.0	25.00 3.3	16.67 5.5		6.25 (8.8) 4.2 (1.1)
Red Algae															
Branched coralline	50.00 3.8	25.00 3.7			91.67 3.6		25.00 3.3	*	*		75.00 2.3		66.67 3.4	25.00 4.0	29.86 (33.2) 3.5 (0.5)
Crustose coralline	33.33 4.5	50.00 2.2	25.00 2.0	100.00 1.5	41.67 2.6	16.67 2.5	8.33 3.0	*	*	16.67 3.0	33.33 2.8		100.00 1.5	58.33 2.1	40.28 (32.5) 2.5 (0.8)
<i>Dasya iridescens</i>						*									
<i>Galaxaura sp.</i>						8.33 3.0									0.69 (2.4) 3.0
<i>Ganonema farinosum</i>		33.33 2.3						*	*						2.78 (9.6) 2.3
<i>Halichrysis coalescens</i>							*								
<i>Haloplegma duperreyi</i>				8.33 5.0											0.69 (2.4) 5.0

	PHR R26	PHR R32	PHR R31	PHR R39	PHR 26	PHR 24	PHR 33	PHR 22	PHR 24	PHR R42	PHR 31	PHR 32	PHR R44	PHR R22	Island Average
<i>Laurencia galtsoffii</i>					58.33 3.9			*	*						4.86 (16.8) 3.9
<i>Laurencia parvipapillata</i>					*										
<i>Laurencia</i> sp.	33.33 3.8						16.67 2.5			16.67 4.0		8.33 4.0			6.25 (10.7) 3.6 (0.7)
<i>Liagora</i> spp.										16.67 3.0		16.67 3.0			2.78 (6.5) 3.0 (0)
<i>Peyssonnelia</i> spp.				16.67 4.0											1.39 (4.8) 4.0
Brown Algae															
<i>Dictyota</i> spp.				8.33 4.0				*							0.69 (2.4) 4.0
<i>Lobophora variegata</i>	16.67 4.0	*										8.33 3.0			2.08 (5.2) 3.5 (0.7)
<i>Padina</i> sp.		8.33 2.0										91.67 1.8			8.33 (26.4) 1.9 (0.1)
<i>Turbinaria ornata</i>		*			*									8.33 3.0	0.69 (2.4) 3.0

	PHR R26	PHR R32	PHR R31	PHR R39	PHR 26	PHR 24	PHR 33	PHR 22	PHR 24	PHR R42	PHR 31	PHR 32	PHR R44	PHR R22	Island Average
Blue-green Algae			8.33 <i>2.0</i>	8.33 <i>4.0</i>	8.33 <i>4.0</i>										2.08 (3.8) <i>3.3</i> <i>(1.2)</i>
Algal Turf	100.00 <i>1.4</i>	91.67 <i>1.1</i>	100.00 <i>1.0</i>	100.00 <i>2.1</i>	100.00 <i>1.0</i>	75.00 <i>1.1</i>	8.33 <i>2.0</i>	*	*	75.00 <i>1.9</i>	100.00 <i>1.0</i>		100.00 <i>1.8</i>	100.00 <i>1.0</i>	79.17 (36.3) <i>1.4</i> <i>(0.4)</i>

PHR-30, 9/28/04

This reef was also very shallow with a depth range of 3-5 ft. We only collected algae and didn't take photos. The main species was again *Microdictyon*, but we also found a few other species. *H. discoidea* and *Laurencia* were the only two we were able to collect for Kim.

PHR-R42, 9/29/04

This site had a depth range of 35-40 ft. There were slight spur and groove formations, not very obvious. Most of the floor was covered by *M. setchelliannum*. There weren't many other species of algae. The most common coral species was *Pocillopora*.

PHR-31, 9/29/04**PHR-32, 9/29/04****PHR-R44, 9/30/04**

This site had a depth range of 40-60 ft. The spur and groove formations were very obvious and deep. The main coral species was *Porites compressa* and the most obvious macroalga was *H. velasquezii*. In the photoquads, turf and crustose coralline algae were dominant. Only a few other species were collected during the random swim.

PHR-R22, 9/30/04

This was a shallow site with a depth range of 5-20 ft. This was the second and last dive of the day due to bad weather. There was very high relief, and most common algae seen overall were *H. velasquezii* and *H. opuntia*. In the photoquads, turf and crustose algae were dominant.

6. Midway Atoll (Table C-6)

Site Descriptions

MID-R15, 10/1/04

This patchreef was a shallow site that had a depth range of 5-10 ft. There wasn't much live coral and the substrate consisted of mostly sand and rubble. We only collected algae from this site because of the depth and surge; no pictures were taken.

MID-1, 10/1/04

This was an extremely shallow site, depth range of 1-5 ft. *Montipora* was the dominant coral species. Again, we weren't able to use the photoquad, so we only collected species qualitatively.

MID-H21, 10/1/04

This shallow backreef had a depth range of 1-5 ft. In the photoquads, turf and crustose coralline algae were most common.

MID-H10, 10/2/04

This site was characterized by spur and groove formations. The coral and algae cover were both very low. The substrate was mostly scoured rock with deep sand channels. The depth range was 35-50 ft. In the photoquads, the most common algae were turf, *Lobophora variegata*, CCA, and *Laurencia* sp.

MID-R25, 10/2/04

This site was shallow with a depth of 5 ft but we were able to take photos and collect. The dominant algae in the photoquads were turf, CCA, and *L. variegata*.

MID-R20, 10/3/04

This backreef was very shallow, depth was 3 ft. The reef was low-relief with patches of hollowed-out coral mounds. We weren't able to take photos so we just snorkeled.

MID-R3, 10/4/04

This forereef had a depth range of 50-60 ft. The reef was high-relief with large overhangs and caves. The coral cover was low, with only small patches (colonies) of *P. lobata*. The macroalgae cover was also low. In the photoquads, turf, CCA, and *L. variegata* were most common.

MID-R7, 10/4/04

This forereef had a depth range of 45-55 ft. This was a complex habitat with many overhangs. Again, the coral and macroalgae cover was low. There were many large sand patches. Turf, *L. variegata*, and CCA were the dominant algae in the photoquads.

MID-2, 10/4/04

This site is located in the south channel and had a depth range of 40-50 ft. There were large patches of rock and sand. Coral and macroalgae were scarce, although many species of algae were found during the swim. *Dictyota* sp., *Padina* sp. and *L. variegata* were the most common species of algae seen in the photoquads and on the reef in general.

	MID R15	MID 1	MID H21	MID H10	MID R25	MID R20	MID R3	MID R7	MID 2	Island average
branched coralline				8.33 5.0	8.33 3.0		16.67 3.5			5.56 (6.8) 3.8 (1.0)
crutose coralline			16.67 2.5	50.00 2.8	91.67 2.7	*	75.00 3.0	50.00 3.2		47.22 (34.4) 2.8 (0.3)
<i>Dasya iridescens</i>	*									
filamentous red	*									
<i>Galaxaura</i> sp.		*	*							
<i>Gibsmithia hawaiiensis</i>	*									
<i>Haloplegma duperreyi</i>				*						
<i>Hypnea</i> sp.				*						
<i>Laurencia galtsoffii</i>	*	*			*	*			8.33 3.0	1.39 (3.4) 3.0
<i>L. parvipapillata</i>			*			*				
<i>Laurencia</i> sp.				58.33 3.0	*		*			9.72 (23.8) 3.0
<i>Liagora</i> spp.						*				
<i>Peyssonnelia</i> spp.			*							
<i>Platoma</i> sp.					*	*				
<i>Plocamium</i> sp.					*		*			
<i>Portieria hornemannii</i>				*						
<i>Trichogloeopsis</i> sp.						*				
<i>Tricleocarpa fragilis</i>	*			*					33.33 3.0	5.56 (13.6) 3.0
Brown Algae										
<i>Dictyota friabilis</i>				*		*	16.67 4.5	8.33 3.0		4.17 (7.0) 3.8 (1.1)
<i>Dictyota</i> sp.	*		*				*	33.33 3.0	58.33 2.9	15.28 (25.0) 2.9 (0.1)

	MID R15	MID 1	MID H21	MID H10	MID R25	MID R20	MID R3	MID R7	MID 2	Island Average
<i>Lobophora variegata</i>		*	*	75.00 2.0	58.33 2.6	*	100.00 2.0	83.33 2.0	33.33 2.3	58.33 (36.5) 2.2 (0.3)
<i>Padina</i> sp.	*			16.67 3.5	*		25.00 3.7	16.67 4.0	50.00 4.7	18.06 (18.6) 4.0 (0.5)
<i>Sargassum</i> sp.					*		*		25.00 4.3	4.17 (10.2) 4.3
<i>Sphacelaria</i> sp.					*					
<i>Styopodium</i> sp.						*				
<i>Turbinaria ornate</i>				*	*					
Blue-green Algae	*	*	25.00 2.3		25.00 2.7					8.33 (12.9) 2.5 (0.2)
Algal Turf			100.00 1.0	100.00 1.0	100.00 1.0		100.00 1.0	100.00 1.0	91.67 1.0	98.61 (3.4) 1.0 (0)

7. Kure Atoll (Table C-7)

Site Descriptions

KUR-R33, 10/5/04

Forereef with a depth range of 40-60 ft. The reef had complex structure, deep sand channels and many overhangs. The dominant coral was *Pocillopora*. The most common algal species were *Styopodium hawaiiensis*, *L. variegata*, and *Dictyota* sp. In the photoquads, these plus turf and coralline algae were seen the most frequently.

KUR-2, 10/5/04

This site is a forereef with spur and groove formations. The depth range was 45-55 ft. *Pocillopora* was abundant. The most common algal species were *L. galtsoffii*, *S. hawaiiensis*, and *L. variegata*. These were the most frequent macroalgae in the photquads along with turf and coralline algae.

KUR-R36, 10/5/04

This was a shallow backreef with a depth range of 5-15 ft. The substrate was abundant with *Montipora* and *P. lobata* colonies. *M. setchellianum* was the macroalga that was most abundant in the photoquads and on the reef in general.

KUR-12, 10/6/04

This forereef had a depth range of 30-60 ft. There were wide ridges of reef with sand channels in between. The visibility was 100+ ft. The dominant algal species were *M. setchellianum*, *L. variegata*, and *S. hawaiiensis*. In the photoquads, these species were most common along with turf and CCA.

KUR-9, 10/6/04

The patch reef had a depth range of 5-20 ft. The substrate consisted mostly of sand and rubble. The coral cover was low and the dominant alga was *M. setchellianum*. Much of the *M. setchellianum* was covered with *Dictyota* and other epiphytes. These were the most common algae in the photoquads along with turf, *L. variegata*, and CCA. Thirteen other species were found during the swim.

KUR-R35, 10/6/04

This was a back reef that had a depth range of 5-15 ft. The coral cover at this site was also low. *M. setchellianum* and *Styopodium hawaiiensis* were the most common macroalgae both in general and in the photoquads.

KUR-18, 10/7/04

This was a patch reef with a deep slope; the depth range was 20-40 ft. The coral cover was very high, with *Porites compressa* being the dominant species. There are now patches of the reef that are covered with *M. setchellianum*, the most common algal species on this reef. In the photoquads, turf, crustose, and *M. setchellianum* were seen the most.

KUR-17, 10/7/04

Backreef site with a depth range of 5-15 ft. The dominant coral species were *Montipora* and *P. lobata*. *M. setchellianum* was the most common macroalgal species both in the photoquads and in general. In the photoquads, turf and CCA were most frequent.

KUR-14, 10/7/04

Back reef, very shallow with a depth range of 3-5 ft. The coral cover was high, most common species were again *Montipora* and *P. lobata*. Macroalgal cover was low. *M. setchellianum*, *L. galtsoffii*, and *L. variegata* were dominant all over the reef. These plus turf were seen most often in the photoquads.

	KUR R33	KUR 2	KUR R36	KUR 12	KUR 9	KUR R35	KUR 18	KUR 17	KUR 14	Island average
branched coralline	16.67 3.5	16.67 6.0	8.33 3.0	33.33 5.8	50.00 4.7	33.33 4.5		33.33 3.0	*	21.30 (17.2) 4.3 (1.2)
<i>Chrysomenia</i> sp.	*	*		*						
crustose coralline	91.67 2.2	83.33 2.6	83.33 2.8	75.00 4.9	58.33 3.9	33.33 4.5	66.67 4.0	91.67 3.1	8.33 6.0	65.74 (28.4) 3.8 (1.2)
<i>Daysa iridescens</i>		*			*					
<i>Galaxaura</i> sp.							*			
<i>Halichrysis coalescens</i>				*						
<i>Haloplegma duperreyi</i>	*	*		*		*				
<i>Hypnea</i> sp.					*		*		*	
<i>Laurencia galtsoffii</i>		91.67 4.3				33.33 3.0		33.33 3.3	75.00 3.2	25.93 (35.7) 3.4 0.6
<i>L. parvipapillata</i>		8.33 5.0	8.33 4.0		8.33 4.0				*	2.78 (4.2) 4.3 (0.6)
<i>Laurencia</i> sp.				66.67 5.3						7.41 (22.2) 5.3
<i>Liagora</i> spp.									*	
<i>Peyssonnelia</i> spp.							41.67 2.6			4.63 (13.9) 2.6
<i>Platoma</i> sp.					*					
<i>Plocamium</i> sp.			*							
<i>Portieria hornemannii</i>	*	*			*					
Brown Algae										
<i>Dictyota friabilis</i>	16.67 4.5	8.33 5.0								2.78 (5.9) 4.8 (0.4)
<i>Dictyota</i> sp.	41.67 3.6	*	*		66.67 2.6					12.04 (24.7) 3.1 (0.7)
<i>Lobophora variegata</i>	50.00 3.33	58.33 3.0	8.33 4.0	100.00 3.3	58.33 3.4	50.00 4.0		25.00 3.7	41.67 3.0	43.52 (30.0) 3.5 (0.4)

	KUR R33	KUR 2	KUR R36	KUR 12	KUR 9	KUR R35	KUR 18	KUR 17	KUR 14	Island average
<i>Lobophora variegata</i>	50.00 3.33	58.33 3.0	8.33 4.0	100.00 3.3	58.33 3.4	50.00 4.0		25.00 3.7	41.67 3.0	43.52 (30.0) 3.5 (0.4)
<i>Sargassum</i> sp.	*	25.00 4.3		*		*			8.33 4.0	3.70 (8.4) 4.2 (0.2)
<i>Styopodium</i> sp.	58.33 4.3	83.33 4.0	8.33 4.0	100.00 3.3	33.33 4.5	75.00 2.6		16.67 3.5	8.33 5.0	42.59 (37.4) 3.9 (0.8)
<i>Turbinaria ornate</i>	*	*	8.33 5.0	*				*	8.33 3.0	1.85 (3.7) 4.0 (1.4)
Blue-green Algae	*		*		*	8.33 6.0	16.67 4.5			6.25 (8.0) 5.3 (1.1)
Algal Turf	100.00 1.0	100.00 1.0	100.00 1.1	100.00 1.0	75.00 1.8	91.67 1.1	100.00 1.5	100.00 1.0	100.00 1.0	96.30 (8.4) 1.2 (0.3)

8. Lisianski Island (Table C-8)

Site Descriptions

LIS-R14, 10/9/04

This forereef had a depth range of 40-55 ft. There were classic spur and groove formations with deep sand channels. The coral cover was high with the dominant species being *P. compressa* and *P. lobata*. Macroalgal cover was moderate, *H. velasquezii*, *H. opuntia*, and *M. setchellianum* were most common. CCA was also extremely abundant. All of these were seen frequently in the photoquads.

LIS-12, 10/9/04

This forereef was very similar to the last, the depth range was 35-50 ft. Instead of spur and groove formations though, there were random mounds of reef. *P. compressa* seemed to be the dominant coral species. The algal cover was almost identical to R14. Branched coralline algae was more abundant.

LIS-R9, 10/9/04

Forereef with a depth range of 25-50 ft. This site was the same in coral and algae cover as the previous two sites. There were spur and groove formations with overhangs and sand channels. Algal diversity was again low.

LIS-10, 10/10/04

This is a forereef with a depth range of 40-50 ft. The reef is characterized by huge mounds of coral, *Porites*, *Montipora*, and *Pocillopora*. There wasn't much macroalgae on the reef or in the photoquads, CCA and turf were extremely abundant. *H. opuntia* was the most common macroalga.

LIS-R10, 10/10/04

This forereef was similar to the last, with a depth range of 40-60 ft. There was extremely high relief and high coral cover. Macroalgae again seemed to be infrequent; in the photoquads, CCA were dominant along with encrusting *L. variegata*. *H. opuntia* was the alga most seen.

LIS-R7, 10/10/04

This is a patch reef with a depth range of 40-50 ft. There were slight spur and groove formations. This site had lower relief than the previous two. Coral cover was again high, *P. compressa* was the dominant species. *H. velasquezii*, turf and crustose were most abundant in the photoquads. Thirteen species were found during the random swim.

LIS-18, 10/11/04

This patch reef had a depth range of 20-40 ft. This site replaced R16. There was extremely high relief with huge mounds of coral, *P. compressa* and *P. evermanni*. The reef had a deep slope which bordered a vast sand channel. The camera flooded so no pictures were taken, we only collected algae.

LIS-16, 10/11/04

This patch reef had a depth range of 40-50 ft. We used Darla's camera to take pictures. The coral cover was again high with the dominant species being *P. compressa* and *P. evermanni*. CCA was very abundant. In the photoquads, the most common macroalgae were *H. velasquezii* and *H. opuntia*.

LIS-17, 10/11/04

This was also a patch reef with a depth range of 35-45 ft. Visibility was only 5-10 feet. This site was very similar to the previous two; coral cover was the same. CCA was most common in the photoquads and on the reef in general. *H. velasquezii* and *H. opuntia* were again the most abundant macroalgae.

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

	LIS R14	LIS 12	LIS R9	LIS 10	LIS R10	LIS R7	LIS 18	LIS 16	LIS 17	Island Average
Green Algae										
<i>Bryopsis pennata</i>				*			*			
<i>C. serrulata</i>					*					
<i>C. taxifolia</i>							*		*	
<i>C. webbiana</i>	*	*		*		*				
<i>Dictyosphaeria cavernosa</i>	*	*	8.33 5.0	*	8.33 5.0	16.67 4.0	*			4.17 (6.3) 4.7 (0.6)
<i>D. versluysii</i>	*	8.33 6.0	16.67 5.5	8.33 3.0	8.33 5.0		*			4.9 (1.3)
<i>Halimeda discoidea</i>	*	8.33 6.0		8.33 3.0	8.33 3.0	*			8.33 5.0	4.17 (4.5) 4.3 (1.5)
<i>H. opuntia</i>	50.00 3.3	41.67 4.4	41.67 3.0	41.67 2.4	58.33 2.6	16.67 3.5	*	50.00 3.7	41.67 2.6	42.71 (12.1) 3.2 (0.7)
<i>H. velasquezii</i>	83.33 3.5	91.67 3.9	83.33 3.4	*	33.33 4.0	83.33 2.3	*	83.33 3.2	75.00 2.9	66.67 (32.4) 3.3 (0.6)
<i>Microdictyon setchellianum</i>	50.00 4.0	75.00 2.0	58.33 3.1			16.67 2.5	*	8.33 4.0		26.04 (30.4) 3.1 (0.9)
<i>Neomeris</i> spp.	*			8.33 3.0		16.67 5.0		8.33 6.0		4.17 (6.3) 4.7 (1.5)
Red Algae										
<i>Amphiroa</i> sp.	*	*	25.00 5.7							3.13 (8.8) 5.6
branched coralline	8.33 5.0	66.67 3.9	58.33 4.0	25.00 2.3	25.00 4.0	8.33 4.0	*	25.00 3.0	16.67 3.5	29.17 (21.8) 3.7 (0.8)

	LIS R14	LIS 12	LIS R9	LIS 10	LIS R10	LIS R7	LIS 18	LIS 16	LIS 17	Island average
<i>Chrysymenia</i> spp.						*			*	
<i>Coelarthrum</i> sp.		8.33 7.0	*				*			1.04 (2.9) 7.0
crutose coralline	100.00 2.2	100.00 2.6	100.00 1.8	91.67 1.6	91.67 1.6	83.33 3.1		100.00 1.8	91.67 1.7	94.79 (6.2) 2.0 (0.5)
<i>Dasya iridescens</i>				*	*	*				
<i>Gibsmithia</i>									*	
<i>G. hawaiiensis</i>									*	
<i>Haloplegma duperreyi</i>	*	*	8.33 5.0		*		*			1.04 (2.9) 5.0
<i>Hypnea</i> sp.							*			
<i>L. parvipapillata</i>						*	*			
<i>Laurencia</i> sp.							*			
<i>Liagora</i> spp.						8.33 4.0				1.04 (2.9) 4.0
<i>Neomartensia</i> sp.							*			
<i>Peyssonnelia</i> spp.	8.33 2.0	*	*	8.33 4.0			*	8.33 6.0		3.13 (4.3) 4.0 (2.0)
<i>Platoma</i> sp.									*	
<i>Portieria hornemannii</i>							*			
<i>Predaea weldii</i>	*			*	*	8.33 6.0		16.67 4.5	*	3.13 (6.2) 5.3 (1.1)
Brown Algae										
<i>Lobophora variegata</i>	8.33 2.0	75.00 5.7	41.67 5.2			41.67 3.6	*	16.67 3.5		28.13 (26.3) 3.9 (1.3)
Blue-green Algae	25.00 4.3	16.67 4.5	8.33 3.0	*	16.67 4.0	8.33 2.0	*	91.67 4.2	66.67 4.3	29.17 (32.4) 4.0 (1.4)
Algal Turf	100.00 1.5	100.00 2.4	83.33 2.2	100.00 1.8	100.00 1.6	100.00 1.0		91.67 2.3	83.33 1.7	94.79 (7.6) 1.8 (0.5)

C. Summary

- Many reefs in the NWHI are dominated by algae rather than coral.
- The green alga *Microdictyon setchellianum* is one of the most common algae in forereef regions at many islands and atolls. At certain sites, all firm substrate was colonized by almost 100% *M. setchellianum* cover.
- Patch reefs in lagoonal areas often exhibited an extremely high abundance of the green alga *Halimeda opuntia*. This alga formed dense 3-dimensional mats that stabilized silty sand patches.
- The green alga *Halimeda velasquezii* was one of the most ubiquitous algae along the NWHI chain and occurred in moderate to high abundances at almost every site and island.
- Brown algae such as *Lobophora variegata*, *Styopodium flabelliforme*, and species of *Dictyota* became much more abundant in the northwesternmost islands than they were in southeastern locales. This may be because of slightly cooler temperatures in more northerly areas.
- Lisianski Island exhibits a uniformly higher cover of crustose coralline algae (CCA) than any other island. The reefs take on a pink appearance at many sites.
- Although the diversity of red algae is greater in the NWHI than any other evolutionary algal group (particularly because of the high number of red algal epiphytes found in the NWHI), green algae are the most abundant in terms of biomass.

Appendix D: **Macroinvertebrate REA Team Activity Summary** (*Ranya Hensen*)

Introduction

The purpose of the activities for HI-04-01 was to visit previously selected sites for long term monitoring. Selection of sites was based on their year-round accessibility and their representation of the habitats present at each site. Surveys focusing on marine invertebrates other than corals were performed in conjunction with surveys of coral and macroalgae, collectively termed the benthic survey. This benthic survey was conducted collaboratively with fish surveys. This report will cover the non-coral invertebrates encountered and from this point forward any mention of marine invertebrates will mean this particular group.

Methods

Quantitative counts for specific target marine invertebrates are done along two separate 2-by-25-m belt transects. This is followed by two 10-by-25-m quadrat surveys accomplished by swimming a zigzag search pattern. The 10-by-25-m quadrat survey is conducted in conjunction with both 2 by 25 transects, which are used as the reference line for the long axis. Additionally, five 0.5 m quadrats will be conducted along each of the 2-by-25-m belt transects in order to count percent coverage of smaller organisms.

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

These target species are:

PORIFERA - Sponges

CNIDARIA

Zoanthids – rubber corals

Hydroidea – hydroids etc.

ANNELIDA- tube-dwelling worms

ECHINODERMS

Echinoids – sea urchins

Holothuroids – sea cucumbers

Asteroids – sea stars

MOLLUSCA

Bivalves – ark shells, spondylid oysters, pearl oysters

Nudibranchs – sea slugs

Gastropods – snails

Cephalopods - octopus

CRUSTACEA

hermit crabs, lobsters, and large crabs

The marine invertebrate species recorded and identified represent the noncryptic fauna of the reef habitat and should not be considered the only species present at each site. There is an abundance of other organisms, both cryptic and noncryptic, that dwell in these habitats that are not included in the monitoring scheme. Previous efforts between 2000 and 2003 focused on the collection of non-coral macroinvertebrates from a variety of habitats to create a species inventory that will identify the full spectrum of organisms associated with the reef habitats of the Northwestern Hawaiian Islands. There was no

collecting of cryptic organisms during invertebrate surveys for HI-04-01 since previous years have yielded a high number of organisms.

The following is a set of descriptions for all sites surveyed for non-coral invertebrates. A tally of all sites surveyed for non-coral invertebrates is as follows:

Necker Island – 3
 French Frigate Shoals – 11
 Gardner Pinnacles - 3
 Maro Reef – 5
 Laysan Island – 3
 Lisianski Island/Neva Shoals – 9
 Pearl and Hermes Reef – 14
 Kure Atoll – 10
 Midway Atoll - 7

Site Descriptions

1. French Frigate Shoals

Site Descriptions

H6, Forereef, Maximum depth: 57 ft, Location: north of Tern Island, and GPS: 23° 52.828, 166° 16.419

Forereef habitat north of Tern Island. The dominant coral was *Porites lobata* with a moderate representation of *Acropora*. The habitat was made up of low relief coral structure with sand channels. The macro-invertebrates were dominated by echinoid and holothuroid echinoderms. The echinoids were *Echinostrephus* and *Echinometra*, while the holothuroid present was *Holothuria whitmaei*. The molluscan species were primarily the coralliphilids. Small colonies of the zoanthid *Palythoa caesia* were also present.

21, Backreef, Maximum depth: 40 ft, Location: near Shark Island, and GPS: 23° 50.875, 166° 19.581

Backreef area in the vicinity of Shark Island that was dominated by *Acropora* and *Pocillopora* corals. The habitat had moderate relief and was bisected by sand areas. *Palythoa caesia* was common throughout the habitat, as were the gastropod mollusks *Turbo sandwichensis*, coralliphilids, and cowries. Sponges were present but not common. Echinoid and holothuroid echinoderms were present, with the most numerous echinoid being *Echinostrephus*.

23, Patch reef, Maximum depth: 11 ft, Location: north side of the lagoon, and GPS: 23° 52.014, 166° 14.507

This was a *Porites compressa* patch reef that also contained *Porites lobata* and *Pavona duerdeni*. There was a high amount of rubble and sediment. The site was dominated by gastropod mollusks, mostly coralliphilids. The echinoderms present were *Mithroidia fisheri* and *Echinometra*. *Actinopyga obesa* and *Loimia medusa* were occasional.

R-46, La Perouse reef, Maximum depth: 33 ft, Location: south side of La Perouse Pinnacle, and GPS: 23° 46.162, 166° 15.672

Complex carbonate reef habitat with high coral cover. There were abundant vermetids, bivalve mollusks, and echinoderms. The bivalves were *Spondylus* and *Arca*. *Echinostrephus* was abundant and *Echinometra* was occasional. *Heterocentrotus* and *Mithroidia fisheri* were present.

32, Patch reef, Maximum depth: 33 ft, Location: northeast of La Perouse pinnacle, and GPS: 23° 48.277, 166° 13.852

Lagoon reef area primarily composed of ark shells. This unique habitat had abundant invertebrate macrofauna that was both cryptic and noncryptic. The ark shell *Arca ventricosa* was dominant in this habitat, which was complex. Many caves, holes, and overhangs existed at the site, which provided abundant habitat for a variety of motile and sessile organisms. Hermit crabs were common, as was *Holothuria whitmaei*. *Echinostrephus* and *Echinometra* were occasional.

33, Patch reef, Maximum depth: 33 ft, Location: inside the northern edge of the lagoon, and GPS: 23° 50.148, 166° 15.962

A lagoon patch reef with rare occurrence of the boring urchins *Echinostrephus* and *Echinometra* and the holothuroid *Actinopyga obesa*. Molluscs were abundant; the most numerous invertebrate was the ark shell *Arca ventricosa*, which was in association with fewer *Spondylus*. Coralliphilids were also abundant. *Holothuria atra* and hermit crabs were recorded as rare.

“R-30”, Backreef, Maximum depth: 8 ft, Location: northeast side of lagoon, and GPS: 23° 51.994, 166° 12.870

Backreef habitat that was composed of coralline covered rubble with a high abundance of *Microdictyon*. Echinoderms were the dominant group of marine invertebrates. Three species of holothuroids were documented: *Holothuria atra*, *Holothuria whitmaei*, and *Actinopyga obesa*. The echinoids *Echinometra* and *Tripneustes* were common in the habitat. Also common were species of hermit crabs and cone shells.

30, Patch reef, Maximum depth: 26 ft, Location: east of Shark Island, and GPS: 23° 50.973, 166° 17.836

A complex lagoon reef habitat made up of *Acropora* and *Porites lobata*. The habitat was high-relief reef structure with sand channels. Most common were echinoderms; *Echinostrephus*, *Echinometra*, and *Linkia multifora aciculatus*. The annelid *Spirobranchus* was present but rare, as were hermit crabs.

34, Forereef, Maximum depth: 35 ft, Location: outside the southern edge of the lagoon, and GPS: 23; 37.670, 166° 08.149

Flat forereef site with a high diversity of invertebrates. Echinoids were dominant including *Echinostrephus*, *Echinometra*, *Diadema*, *Echinothrix*, and *Tripneustes*. Colonies of *Palythoa caesia* were occasional, as were *Holothuria whitmaei*,

Actinopyga mauritiana, *Actinopyga obesa*, and *Linkia multifora*. Crustaceans included hermit crabs and an occasional trapezid crab.

R-29, Patch reef, Maximum depth: 38 ft, Location: inside the southern side of the lagoon and GPS: 23' 40.711, 166' 10.802

Coralline algal patch reef habitat dominated by coral cover. This was a complex habitat of coral associated with a broad sand expanse. Few macroinvertebrates were recorded. *Echinostrephus* and *Echinometra* were occasional. Annelids included *Loimia medusa* and an occasional *Spirobranchus*. *Holothuria atra* and *Actinopyga obesa* were present.

12, Forereef, Maximum depth: 40 ft, Location: south end of lagoon, and GPS: 23' 38.270, 166' 10.802

Forereef site at the southeastern end of the atoll. Dominated by table *Acropora* with roughly 90% cover. Broad sand patches occurred occasionally. There were very few other invertebrates in the habitat with the exception of the echinoid *Echinostrephus*, which was common. *Diadema*, *Acanthaster planci* and a single *Actinopyga mauritiana* were recorded as rare.

2. Gardner Pinnacles

Site Descriptions

R-6, Boulders, Maximum depth: 64 ft, Location: northwest side of Pinnacles, and GPS: 25' 00.036, 168' 00.088

Flat scoured basalt pavement boulders with thin sand veneer. Low-growing algae and corals made up the majority of the community. The common invertebrates were the zoanthid *Palythoa caesia*, *Echinostrephus*, and hydroids. Trapezid crabs, *Echinometra*, and *Acanthaster planci* were occasional.

R-3, Boulders, Maximum depth: 55 ft, Location: south of the Pinnacles, and GPS: 24' 59.813, 167' 59.920

Scattered boulders on a reef flat with a high percentage of Porifera coverage. Other common invertebrates were *Echinostrephus*, hermit crabs, and trapezoid crabs. There were infrequent *Linkia guildingi*, *Acanthaster planci* and *Echinometra*.

R-5, Boulders, Maximum depth: 58 ft, Location: west side of the Pinnacles, and GPS: 24' 59.901, 168' 00.00

Boulder field at the base of the west side cliffs. Sparse cover by *Pocillopora meandrina* and *Palythoa caesia*. Species of hydroid and the terebellid worm *Loimia medusa* were common. Hermit crabs and the holothuroids *Holothuria atra* and *Actinopyga obesa* were occasional. *Echinometra* was rare at the site.

3. Maro Reef

Site Descriptions

R-8, Patch reef, Maximum depth: 68 ft, Location: southern end of reef, and GPS: 25° 20.051, 170° 31.512

Patch reef with moderate relief and high algae abundance. Macroinvertebrates were not numerous and made up of crustaceans and the terebellid polychaete worm *Loimia medusa*. The crustaceans were primarily hermit crabs and *Panulirus*. *Echinostrephus* and *Diadema* were rare at the site.

R-6, Patch reef, Maximum depth: 46 ft, Location: southern end of reef, and GPS: 25° 20.422, 170° 30.028

Patch reef with moderate relief and high algae abundance. Very few macroinvertebrates present and the ones that were present were not abundant. Hermit crabs and *Echinometra* were the dominant invertebrates. Also present, but in small numbers, were *Echinostrephus* and *Spribranchus*. *Panulirus* were occasional.

R-5, Patch reef, Maximum depth: 35 ft, Location: southeast side of reef, and GPS: 25° 22.181, 170° 30.127

Patch reef with moderate relief and high algae abundance. Very few macroinvertebrates present and the ones that were present were not abundant. The only common invertebrate were *Arca* shells. The echinoid *Echinostrephus* was very rare and a single holothuroid, *Holothuria whitmaei*, was noted within the vicinity of the transect. A few crustaceans were found, hermit crabs, *Panulirus*, and trapezoid crabs.

R-12, Patch reef, Maximum depth: 62 ft, Location: northwest side of reef, and GPS: 25° 28.280 170° 38.601

Small pinnacles covered with mostly *Porites compressa* rubble on a sandy bottom. Very few macroinvertebrates, the most common being ark shells. Also found were *Spondylus* and hydroids.

R-3, Patch reef, Maximum depth: 62 ft, Location: west side of reef, and GPS: 25° 29.149, 170° 40.165

Complex habitat with many overhangs, scrubbed pavement canyons, and reef flats with a wide variety of corals. *Echinostrephus* was widespread while *Echinometra* and ark shells were occasional. In the *Pocillopora* heads trapezoid crabs and hermit crabs were common. There was a small percent coverage of Porifera and small colonies of *Palythoa* present throughout the site.

4. Laysan

Site Descriptions

R-12, Fringing reef, Maximum depth: 47 ft, Location: west of the island, and GPS: 25° 46.650, 171° 44.870

Scoured pavement, outcrops and boulders with moderate algae cover and low growing *Porites lobata* and *Pocillopora meandrina* corals. Echinoderms were the only common invertebrate at the site with the echinoids *Echinostrephus* and *Echinometra*; the holothuroid *Actinopyga obesa* was rare. Trapezid crabs were found in *P. meandrina* heads.

R-9, Fringing reef, Maximum depth: 47 ft, Location: south of the island, and GPS: 25° 45.227, 171° 44.481

Scoured pavement with outcroppings, overhangs, and boulders with patches of *Porites lobata*. *Echinostrephus* was abundant while hermit crabs, trapezid crabs and *Echinometra* were common. *Loimia medusa*, *Achtinopyga mauritiana*, and *Holothuria whitmaei* were present but rare.

R-11, Fringing reef, Maximum depth: 47 ft, Location: west of the island, and GPS: 25° 45.932, 171° 44.653

Complex habitat of coral pinnacles surrounded by scrubbed pavement. *Echinostrephus* and *Echinometra* were the most abundant echinoids; *Heterocentrotus* and *Diadema* were rare. *Loimia medusa*, *Achtinopyga obesa*, and hermit crabs were also recorded as rare.

5. Pearl and Hermes Reef

Site Descriptions

R-26, Fore reef, Maximum depth: 46 ft, Location: southeast side of the atoll, and GPS: 27° 47.150, 175° 46.817

Low-relief spur and groove with high *Microdictyon* cover. Low diversity and abundance of visible macroinvertebrates. The boring urchin *Echinostrephus* was the only numerous macroinvertebrate. *Echinometra* was occasional. *Holothuria whitmaei* and *Holothuria atra* were rare. Scattered small colonies of the zoanthid *Palythoa* were present.

R-32, Backreef, Maximum depth: 10 ft, Location: southeast side of the atoll, and GPS: 27° 50.346, 175° 45.170

Backreef site with numerous holothuroids and boring urchins. The site had two different habitats, a shallow, flat reef and a sandy, rubble bottom. The holothuroids present were *Actinopyga obesa*, *Holothuria atra*, and *Holothuria whitmaei*. The boring urchins were *Echinometra*. Colonies of the zoanthid *Palythoa* were common. Hermit crabs were rare and a single lobster was recorded at the site.

R-31, Patchreef, Maximum depth: 52 ft, Location: southeast side of the atoll, and GPS: 27° 49.599, 175° 47.533

Porites compressa patch reef with low abundance and diversity of macroinvertebrates. There was a small percent coverage of Porifera. The sacoglossan nudibranch *Plakobranthus ocellatus* was rare and single starfish *Linckia multifora* was present.

R-39, Forereef, Maximum depth: 62 ft, Location: northwest end of the atoll, and GPS: 27° 56.428, 175° 51.693

Complex carbonate reef structure dominated by crustose coralline algae and *Halimeda*. Very little in the way of abundance or diversity in visible macroinvertebrates. The zoanthid *Palythoa* and echinoid *Echinostrephus* were the only common macroinvertebrates apparent at the site. There were rare sightings of the urchin *Echinometra*.

26, Backreef, Maximum depth: 10 ft, Location: north end of the lagoon, and GPS: 27° 57.470, 175° 48.144

Shallow backreef area originally dominated by *Montipora capitata* but experienced a bleaching event in 2002. There were very few macroinvertebrate species present at the site. There was low abundance of the urchins *Echinostrephus* but *Echinometra* was common. Also common was the holothuroids *Actinopyga obesa* and *Holothuria whitmaei*.

24, Patchreef, Maximum depth: 44 ft, Location: northwest end of the atoll, and GPS: 27° 55.186, 175° 51.704

Patch reef dominated by the macro-algae *Halimeda* and sessile bivalve communities. The slope of this patch reef was composed mainly of *Arca* and *Spondylus*. The urchins *Echinometra* and *Echinostrephus* were not found at the site. There were only a small number of holothuroids, which were *Actinopyga obesa*, *Holothuria atra*, and *Holothuria whitmaei*.

33, Forereef, Maximum depth: 44 ft, Location: south end of the atoll, and GPS: 27° 47.139, 175° 49.427

Forereef site that was flat with sand patches, no spur, and groove. The site had extremely low numbers of macroinvertebrates. The boring urchin *Echinostrephus* was very abundant, while *Echinometra* was common. A small number of holothuroids, *Actinopyga obesa*, and *Holothuria whitmaei* were present.

22, Backreef, Maximum depth: 7 ft, Location: northwest end of the atoll, and GPS: 27° 47.721, 175° 51.993

Backreef site with a scoured and pitted surface and having numerous dead and living *Pocillopora* coral heads; the dead ones were covered with coralline algae. The boring urchin *Echinometra* was abundant. *Mithrodia fisheri* was present as were a small number of cone shells.

30, Backreef, Maximum depth: 9 ft, Location: southern end of the atoll, and GPS: 27° 46.765, 175° 53.720

Shallow backreef with many dead *Pocillopora* heads. The only abundant macroinvertebrates found were *Echinometra*. *Echinostrephus* was rare, as were hermit crabs. Only one transect was used at this location due to weather.

R-42, Forereef, Maximum depth: 49 ft, Location: western tip of the atoll, and GPS: 27° 45.202, 175° 56.927

Forereef site near Seal/Kittery Island. Flat expanse with shallow channels and small sand patches. Dominated by the macroalgae *Microdictyon* and sparsely occupied by *Pocillopora* heads, both live and dead. The most numerous macroinvertebrate was the boring urchin *Echinostrephus*, while *Echinometra* was only common. Numerous coralliphillids, hermit crabs, and trapezid crabs were exploiting the live *Pocillopora* heads. Zoanthid colonies were scattered sparsely. One octopus was recorded, and a single *Stigopus* sea cucumber was found.

31, Patchreef, Maximum depth: 31, Location: southwest end of the atoll, and GPS: 27° 46.551, 175° 58.398

Reticulated reef area with steep walls and large sand channels. The holothuroids *Actinopyga obesa* and *Holothuria whitmaei* were common. *Echinostrephus* and *Echinometra* were both abundant. Gastropods present were cone shells found in the sand channels and coralliophids in *Pocillopora* heads.

32, Patchreef, Maximum depth: 32 ft, Location: southwest end of the atoll, and GPS: 27° 46.376, 175° 56.353

Patchreef area with broad sand expanse associated with the habitat. There was a low abundance of macroinvertebrate fauna overall. Echinoids were the most common with *Echinometra*, *Echinostrephus*, *Heterocentrotus*, and *Pseudoboletia* urchins present at the site. *Holothuria atra* and *Holothuria whitmaei* were present in the sand expanses in the area. Coralliophilids were rare in *Pocillopora* heads. Also, there was a *Halophila* sea grass species present on the sand expanse.

R-44, Forereef, Maximum depth: 56 ft, Location: northwest end of the atoll, and GPS: 27° 54.655, 175° 54.284

High-relief spur and groove with scoured surface. Low diversity and abundance of visible macroinvertebrates. The zoanthid *Palythoa caesia* and the boring urchin *Echinostrephus* were the only numerous macroinvertebrates, while *Echinometra* was only occasional. Colonies of *Acabaria* were rare. A single species each of *Charonia* and *Pinctada* were recorded at the site.

R-22, Backreef, Maximum depth: 17 ft, Location: northwest end of the atoll, and GPS: 27° 53.958, 175° 54.885

Shallow backreef area with complex reef structure and broad rubble/sand expanses. The most numerous visible macroinvertebrate was the boring urchin *Echinometra*. Cone and *Arca* shells were common at the site. The holothuroids *Holothuria whitmaei* and *Actinopyga obesa* were common throughout the site. One lobster was recorded.

6. Midway

Site Descriptions

R-15, Patchreef, Maximum depth: 12 ft, Location: central lagoon, and GPS: 28° 14.243, 177° 23.703

Shallow patch reef with mostly rubble/sand areas. The reef was covered in *Microdictyon* and most coral species were dead. *Echinometra* was the most abundant macroinvertebrate. There were occasionally coralliphilids found in the living *Pocillopora* heads. *Actinopyga mauritiana* and *Linkia guildingi* were rare.

1, Backreef, Maximum depth: 7 ft, Location: on the eastern side of the north channel, and GPS: 28° 16.158, 177° 23.170

Extremely shallow site dominated by mounds of *Montipora*. There was low diversity and numbers of macroinvertebrates. Occasional *Echinostrephus* and *Echinometra* urchins were recorded. The only other visible macroinvertebrates were *Actinopyga mauritiana*, *Actinopyga obesa*, and cone shells.

H-21, Backreef, Maximum depth: 7 ft, Location: northern end of the atoll, and GPS: 28° 16.641, 177° 21.967

Shallow backreef with not many macroinvertebrates. The echinoids *Echinometra* and *Heterocentrotus* were the dominant invertebrates at the site. *Actinopyga mauritiana* were also abundant. *Echinostrephus* was rare.

R-20, Backreef, Maximum depth: 5 ft, Location: eastern end of the atoll, and GPS: 28° 13.914, 177° 19.101

Shallow backreef site with low relief patches of coral. *Heterocentrotus* was the dominant invertebrate. *Echinometra* was common while *Echinostrephus* was not present. Occasional *Actinopyga mauritiana* were found. Trapezid and hermit crabs were rare.

R-3, Maximum depth: 64 ft, Location: southern end of the atoll, and GPS: 28° 11.435, 177° 23.994

High-relief forereef site with many overhangs and caves. Most of the surface was covered with turf algae. Few sand channels and patches. The boring urchin was the dominant macroinvertebrate at the site; *Echinometra* was occasional. Porifera coverage was moderate on the underside of overhangs. *Holothuria atra* was found in the sand channels. One *Acanthaster planci* was observed.

R-7, Forereef, Maximum depth: 55 ft, Location: south side of the island, in front of Bulky Dump, and GPS: 28° 11.790, 177° 22.509

South-facing reef area with complex carbonate structure with many overhangs. The site was dominated by the boring urchins *Echinostrephus* and *Echinometra*. An unknown elysidae nudibranch was abundant at the site. *Actinopyga mauritiana* and *Holothuria atra* were present but not abundant.

2, Forereef, Maximum depth: 47 ft, Location: on the east side of the south channel and, GPS: 28° 11.854, 177° 20.772

Located in the south channel, flat expanse with sand patches and low relief of scrubbed pavement. *Echinostrephus* was the only abundant invertebrate. Holothuroids *Actinopyga mauritiana*, *Holothuria atra*, and *Holothuria whitmaei* were occasional. There was a small number of the bivalve *Spondylus*, and cone shells were rare.

7. Kure

Site Descriptions

R-33, Forereef, Maximum depth: 60 ft, Location: west side of atoll and, GPS: 28°25.002, 178° 22.715

Complex reef structure dominated by dead and living *Pocillopora* and deep sand channels and many overhangs. Coralliophilids were present in most of the *Pocillopora* heads, some having up to 10 individuals. The dominant echinoid was the boring urchin *Echinometra* with a small number of the holothuroids *Actinopyga mauritiana*, *Holothuria atra*, and *Holothuria whitmaei*. There was a rare occurrence of the annelids *Spirobranchus* and *Chaetopterus*.

2, Forereef, Maximum depth: 55 ft, Location: north side of atoll and, GPS: 28° 27.211, 178° 20.658

Classic spur and groove habitat with abundant *Pocillopora* coral heads and macroalgae. The dominant macroinvertebrates were the boring urchins *Echinostrephus*, while *Echinometra* were less common. There were small colonies of the zoanthid *Palythoa caesia*. The serpulid worm *Spirobranchus gigantea* was very abundant within *Porites lobata* coral and within the carbonate substrate. *Holothuria atra* were rare, and the asteroid *Linckia multifora* was occasional. Murexs were common. Not many trapezids or coralliophilids compared to the similar site R-33.

R-36, Back reef, Maximum depth: 10 ft, Location: north side of atoll and, GPS: 28° 25.226, 178° 22.213

Backreef site with *Montipora* and *Porites lobata*. Echinoderms were the most abundant taxa present and were represented by holothuroids and echinoids. *Actinopyga mauritiana* was the dominant species, followed by *Echinostrephus*, *Heterocentrotus* and *Echinometra*. Very little else was present for macroinvertebrates except for a trapezid and hermit crabs found in *Pocillopora* heads.

12, Forereef, Maximum depth: 56 ft, Location: south side of atoll and, GPS: 28° 22.957, 178° 19.485

Forereef site with spur and groove habitat. The polychaete *Spirobranchus* was very common at the site within *Porites* colonies and within the carbonate substrate. Echinoderms were by far the dominant taxa present, which included *Echinostrephus*, *Echinometra*, *Holothuria atra*, *Holothuria whitmaei*, and *Actinopyga obesa*. The anemone *Heteractis malu* and hydroids were recorded at the site but were rare.

9, Patchreef Maximum depth: 28 ft, Location: central lagoon and, GPS: 28' 24.345, 178' 20.970

Patchreef composed of rubble with few *Pocillopora* and *Microdictyon*. The holothuroid *Actinopyga mauritiana* was quite abundant, as was the boring urchin *Echinometra*. With the exception of the coralliophilid snails, gastropods were rare at the site, with the species *Pinctada* and *Spondylus* being recorded. *Holothuria whitmaei* and *Actinopyga obesa* were rare. Trapezid and hermit crabs were recorded but not common.

R-35, Patchreef, Maximum depth: 19 ft, Location: southwest side of atoll and, GPS: 28' 23.588, 178' 20.970

Patchreef near the main channel with the boring urchin *Echinostrephus* being abundant. Coralliophilid gastropods and hermit crabs were common in *Pocillopora* heads. The holothuroid *Actinopyga obesa* was common while *Holothuria atra*, *Holothuria whitmaei*, and *Actinopyga mauritiana* were occasional. The bivalve *Spondylus* was rare.

18, Patchreef, Maximum depth: 35 ft, Location: central lagoon and, GPS: 28' 25.123, 178' 20.701

This site was an isolated patchreef with a deep slope comprised of *Porites compressa* and an expansive sand flat. The reef crest has experienced a bleaching event and has been taken over by low growing algae. The dominant macroinvertebrate was *Holothuria mauritiana*. Gastropods included *Charonia* and *Pinctada*. Large patches of *Chaetopterus* were found throughout the site. *Linkia multifora* and *Actinopyga obesa* were rare. A single chocolate chip sea cucumber was found.

17, Backreef, Maximum depth: 9 ft, Location: west side of atoll and, GPS: 28' 25.923, 178' 21.970

Backreef site with *Montipora* and *Porites lobata*. This site was dominated by echinoid echinoderms; it was numerous *Heterocentrotus mammilatus*, *Echinostrephus* and *Echinometra*. *Actinopyga mauritiana* and *Holothuria atra* were common. Very little else for macroinvertebrates except for *Linkia guildingi* and rare coralliophilids.

14, Backreef, Maximum depth: 15 ft, Location: north side of atoll and, GPS: 28' 27.219, 178' 19.697

Shallow site very close to the surrounding reef made of low-relief carbonate structure and rubble. *Echinostrephus* and *Echinometra* were very abundant at this site. Other echinoids present were *Heterocentrotus mammilatus*, *Holothuria atra*, *Actinopyga mauritiana*, and *Actinopyga obesa* were also present, though not common. Hermit crabs were rare.

8. Lisianski/ Neva Shoals

Site Descriptions

R-14, Maximum depth: 56 ft, Location: northwest of Lisianski Island and, GPS: 26° 04.684, 173° 59.825

Extensive *Porites compressa* and *Porites lobata* patchreef with abundant *Microdictyon* macroalgae and small sand channels. Low abundance of macroinvertebrates with the exception of the boring urchins *Echinostrephus* and *Echinometra*. *Arca* shells were occasional. *Pinctada* shells and *Chaetopterus* were rare. A single *Holothuria atra* was recorded.

12, Maximum depth: 50 ft, Location: northwest side of Lisianski Island and, GPS: 26° 03.947, 174° 00.101

High-relief *Porites compressa* and *Porites evermanni* patch reef with complex topography and broad sand expanses. The abundance of macroinvertebrates was low, and the only organism that was common was the boring urchin *Echinostrephus*. The other echinoderms present were the urchins *Echinometra* and *Echinothrix*. Gastropods *Pinctada* and turban shells were present but rare.

R-9, Maximum depth: 51 ft, Location: west of Lisianski Island and, GPS: 26° 02.373, 174° 00.755

Site was similar to site 12. The boring urchin *Echinostrephus* was occasional, while the remainder of the macroinvertebrate species were rare. Cone shells and *Pinctada* were present but rare. A *Stichopus* (chocolate chip) cucumber was found on the first transect.

10, Maximum depth: 43 ft, Location: south end, Neva Shoals area and, GPS: 25° 56.451, 173° 55.334

High coral cover, mostly *Porites compressa* sand patches between coral stands. Not a great many of macroinvertebrates at this site. Ark shells were common at the base of all the coral stands. Hermit crabs and hydroids were the only other invertebrate species recorded.

R-10, Maximum depth: 41 ft, Location: Neva Shoals area and, GPS: 25° 56.670, 173° 57.209

Very similar to site 10. Extensive *Porites compressa* reef with moderate algae cover and low abundance and diversity of marine invertebrates. Few echinoderms were recorded except for a two *Echinostrephus* urchins and one *Echinometra* urchin. Zoanthid anemones were recorded, but extremely rare.

R-7, Maximum depth: 40 ft, Location: Neva Shoals area and, GPS: 25° 57.252, 173° 58.245

Similar to sites 10 and R-10. Very few macroinvertebrates, *Echinostrephus* being the most numerous but still only occasional. Hermit and trapezid crabs were rare. Gastropods included *Arca* shells and coralliophilids, which were both rare as well.

18, Maximum depth: 46 ft, Location: west side of Neva Shoals and, GPS: 26' 00.253, 173' 59.659

Extensive *Porites compressa* patch reef that was mostly overgrown with macroalgae. Echinoderms were rare and were only presented by two species of sea urchin: *Echinometra* and *Echinostrephus*. *Arca*, *Pinctada*, and hermit crabs were rare.

16, Maximum depth: 45 ft, Location: west of Neva Shoals area and, GPS: 25' 59.215, 173' 59.667

Coralline algal patch reef with sandy bottom. The abundance of macroinvertebrates was low. Only a few urchins were recorded, *Echinostrephus* and *Echinometra*. Gastropods included ark shells, *Pinctada*, and coralliophilids. Hydroids and *Chaetopterus* were present under overhangs.

17, Maximum depth: 46 ft, Location: west of Neva Shoals area and, GPS: 25' 58.244, 173' 57.851

Extensive *Porites compressa* patchreef with steep-sloping topography that had a diverse community of macroalgae species. This was quite a healthy reef with all components appearing to be in balance. There were very little in the way of macroinvertebrates, and most of this component was cryptic sessile fauna such as tunicates, sponges, and bryozoans. The dominant macroinvertebrate was *Arca*, other bivalves included *Spondylus* and *Pinctada*. *Echinostrephus* and *Echinometra* were rare.

Appendix E: **Towed Diver Habitat/Fish Survey Team Activity Summary** (*Brian Zgliczynski, Molly Timmers, Joe Laughlin, and Casey Wilkinson*)

A. Methods

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

B. Results

Location	Days Surveyed	# of Tows	Towed km
French Frigate Shoals (FFS)	4	17	34
Gardner Pinnacles (GAR)	1	2	3.7
Maro Reef (MAR)	3	12	21.4
Laysan Island (LAY)	1	5	8.4
Lisianski Island (LIS)	3	12	22.1
Midway Atoll (MID)	3	15	30.7
Pearl and Hermes Reef (PHR)	5	21	44.7
Kure Atoll (KUR)	3	13	28.7
Total		97	193.7

1. French Frigate Shoals

Seventeen towed-diver habitat and fish surveys were conducted at French Frigate Shoals during 4 days of field operations covering a total of 34 km of benthic habitat. Atoll-wide monitoring was completed by conducting seven surveys along the forereef, four along the backreef, four in the lagoon, and one around La Perouse Pinnacle.

Fish observations

The blacktongue unicornfish (*Naso hexacanthus*) was the most commonly observed fish larger than 50-cm TL with 109 individuals encountered. The second most commonly encountered fish was the green jobfish (*Aprion virescens*) with 38 individuals observed during the surveys. The giant trevally (*Caranx ignobilis*) was the most common species of jack encountered during the survey

period. Relatively few sharks were observed during the surveys with only 3 gray reef sharks (*Carcharhinus amblyrhynchos*) and 11 reef whitetip sharks (*Trianodon obesus*) observed.

2. Gardner Pinnacle

The tow team conducted 2 towed-diver habitat and fish surveys around Gardner Pinnacle. A total of 3.72 km of habitat was surveyed during the single day of operations

Fish Observations

The giant trevally (*Caranx ignobilis*) was the most commonly observed fish larger than 50-cm TL with 32 quantitative observations made. Two galapagos sharks (*Carcharhinus galapagensis*) were also observed during the quantitative surveys. Other notable observations included sightings of the Spotted Knifejaw (*Oplegnathus punctatus*) and the African Pompano (*Alectis ciliaris*) both over 50-cm TL.

3. Maro Reef

A total of 12 tows 21.35 kms 6 backreef and 6 forereef.

Fish Observations

High-rugosity and low-visibility conditions at Maro Reef were not conducive for towed-diver surveys. Low visibility impacted the selection of survey sites because surveys could not be conducted where visibility was less than 5 m. In most areas at Maro Reef visibility was under 10 m making fish surveys difficult. The most commonly observed fish was the giant trevally (*Caranx ignobilis*) with 28 observations made during the quantitative surveys. Galapagos sharks (*Carcharhinus galapagensis*) were the second most common observed fish larger than 50-cm total length with 55 sightings. The majority of these sightings were made during one survey on the NW reef. These fish were most often observed approaching divers from the sides or behind.

4. Laysan Island

A total of 5 towed-diver surveys were conducted at Laysan Island covering 8.4 km.

Fish Observations

The most commonly observed fish was the green jobfish (*Aprion virescens*) with 14 quantitative observations made. The giant trevally (*Caranx ignobilis*) followed close behind with 11 observations made. One sighting was made of the African Pompano (*Alectis ciliaris*) It was noted that no sharks were observed on any of the tows conducted at Laysan island.

5. Pearl and Hermes Reef

Twenty-one towed-diver habitat and fish surveys were conducted at Pearl and Hermes Reef during 5 days of field operations covering a total of 44.7 km of benthic habitat. Atoll-wide monitoring was completed by conducting 10 surveys along the forereef and 11 along the backreef.

Fish Observations

The most commonly observed fish during the quantitative surveys was the giant trevally (*Caranx ignobilis*) with 111 sightings. The green jobfish (*Aprion virescens*) was the second most commonly observed fish larger than 50-cm TL with 56 fish observed. Shark sightings were dominated by the Galapagos shark (*Carcharhinus galapagensis*). Another notable sighting was a single observation of a tiger shark (*Galeocerdo cuvier*).

6. Midway Atoll

Fifteen towed-diver habitat and fish surveys were conducted at Midway Atoll during 4 days of field operations covering a total of 30.7 km of benthic habitat. Atoll-wide monitoring was completed by conducting seven surveys along the forereef, six along the backreef and one in the lagoon.

Fish Observations

The spectacled parrotfish (*Chlorurus perspicillatus*) was the most commonly observed fish larger than 50-cm TL with 67 observations. The Hawaiian Grouper (*Epinephelus quernus*) was also observed during the quantitative surveys with 17 observations made. Surprisingly, no sharks were observed during the quantitative surveys.

7. Kure Atoll

Thirteen towed-diver habitat and fish surveys were conducted at Kure Atoll during 3 days of field operations covering a total of 28.7 km of benthic habitat. Atoll-wide monitoring was completed by conducting seven surveys along the forereef, four along the backreef and two in the lagoon.

Fish Observations

The spectacled parrotfish (*Chlorurus perspicillatus*) was the most commonly observed fish during the quantitative surveys. 67 individuals were sighted during the surveys. The Hawaiian Grouper (*Epinephelus quernus*) was also observed during the quantitative surveys along the forereef with 7 observations made. Like Midway no sharks were observed during the quantitative surveys.

8. Lisianski Islands and Neva Shoals

Fifteen towed-diver habitat and fish surveys were conducted at Lisianski and Neva Shoals during 3 days of field operations covering a total of 22.1 km of

benthic habitat. Atoll-wide monitoring was completed by conducting 11 surveys along the forereef and 1 along the backreef.

Fish Observations

The giant trevally (*Caranx ignobilis*) was the most abundant fish larger than 50-cm TL observed during the surveys. A total of 119 individuals were recorded. The green jobfish (*Aprion virescens*) followed distantly behind with only 13 sightings made. It was noted that very few sharks were observed during 3-days of surveys with only one quantitative observation made.

Benthic Observations:

Sightings of coral appearing white and pale occurred throughout the chain. *Pocillopora*, *Montipora*, and to a lesser extent *Porites* were genera that appeared both pale and white. *Pocillopora* was the dominant genus appearing white along the chain with the exception at Kure Atoll where the *Pocillopora* appeared healthy. A high presence of coral appeared white along backreefs of PHR and Midway. This is a notable observation considering that low amounts of coral are present at these habitats. *Porites* in addition to *Montipora* and *Pocillopora* appeared white and pale at Maro Reef, Laysan, and Lisianski Island. Crown-of-thorns (COTS) were observed at Kure, Midway, Pearl and Hermes, Gardner Pinnacles, and French Frigate Shoals. Seventy-six percent of all observed COTS were seen at Pearl and Hermes Reef. Seventy-six percent of observed COTS at Pearl and Hermes were located along the southwestern forereef near Seal Kittery. Divers observed the presence of cyanobacteria in the maze at Kure that was not present during the 2003 survey.

Appendix F: **Mooring Deployments and Oceanographic Data Collection** (Kyle Hogrefe, Stephani Holzworth, Elizabeth Keenan, and Daniel Merritt)

Monitoring and assessment methodology

The Coral Reef Ecosystem Division has been conducting multidisciplinary research cruises in the Northwest Hawaiian Islands (NWHI) since the NOWRAMP 2000. Considering that the oceanographic component of these cruises has been well established, the deployment of instrument platforms and oceanographic measurements represent an ongoing effort of monitoring and assessment. On HI0401, the oceanography team utilized both well-established and new methods to monitor long-term trends and assess oceanographic conditions.

Long-term oceanographic monitoring and assessment are accomplished by deployment and retrieval of a variety of internally recording and near-real time telemetered instrument platforms. These instruments include the following:

1. Coral Reef Early Warning System (CREWS) buoys: Surface buoys which measure solar radiation, air temperature, wind speed and direction, sea surface temperature, salinity, turbidity, and (on enhanced models) photosynthetically active chlorophyll. CREWS buoys telemeter a portion of their collected data in near real time.
2. Sea Surface Temperature (SST) buoys: Surface buoys which measure high resolution water temperature and telemeter their data in near-real time.
3. Wave and Tide Recorders (WTR): Moored instruments that measure spectral wave energy, precision tidal elevation, and subsurface water temperature.
4. Ocean Data Platforms (ODP): Moored instruments that measure subsurface temperature, salinity, directional spectral wave energy, precision tidal elevation, and current profiles.
5. Subsurface Temperature Recorders (STR): Moored instruments that measure high resolution subsurface temperatures.
6. Satellite Drifters: Free floating, drogued (Lagrangian) devices that provide surface layer circulation and water temperature data. Satellite drifters telemeter their data in near real time.

NOTE: Satellite Drifters were not deployed because they were not delivered from the manufacturer in time for the cruise. (They were delayed in Florida due to the hurricanes.)

7. Recruitment Plate Arrays: An arrangement of ceramic tiles embedded in a PVC framework and affixed to both CREWS buoy and ODP anchors. These arrays are deployed to support studies by Jean Kenyon and are intended to monitor the recruitment patterns of coral species. Refer to Activity Summary of Coral REA Team for additional information.

Oceanographic assessments in the NWHI are accomplished by:

1. Shallowwater CTD casts (max 100 ft), including turbidity measurements, are performed using a SBE 19+ at regularly spaced intervals around each island/atoll/shoal. These casts sample vertical water profiles of water properties providing indications for water mass movement and local sea water chemistry changes.
2. Shallowwater radiometer casts are performed as a subset of the shallowwater CTD casts using a Biospherical PRR2600 profiling unit and PRR2610 deck unit. The PRR 2600 measures both downwelling irradiance and upwelling radiance that infers the concentration of photosynthetically active chlorophyll in the water column. The PRR 2610 measures the ambient solar radiation, which can vary depending on cloud cover, at the time of the cast.
3. Water sample collection casts are conducted as a subset of the shallowwater CTD/Radiometer casts. Water samples are collected using a hand-deployed Niskin bottle at depths of 90, 60, 30, and 5 ft as allowed by the depth at each cast site. Water is collected for color decomposed organic matter (CDOM) or chlorophyll concentration sampling at each depth depending on the samples type(s) desired from each site.
4. Deepwater CTD casts (max 500 m) including fluorometry measurements are performed at evenly spaced intervals around each island/atoll/shoal and along an established transect running the length of the NWHI archipelago. Water samples are collected at 150 m, 125 m, 100 m, 80 m and at the surface during each cast. These casts sample vertical water profiles of water properties providing indications for water mass movement, local sea water chemistry changes, and chlorophyll concentration. Refer to the Night Operations Activities Summary for more information on deepwater CTD casts.

NOTE: Acoustic Doppler current profiler (ADCP) transects, which provide information on overall oceanographic structure, were not conducted on this cruise. The *Hi'ialakai* did not have the instrument available.

5. Continuous recording of surface and subsurface water temperatures as a function of depth is kept during all towed-diver operations, providing a broad and diverse spatial and thermal sampling method. Refer to the Towed-Diver Habitat/Fish Survey Team Activity Summary for site and isobath information. These data are part of the tow team Arcview project.

Oceanographic data collection and instrumentation activities

French Frigate Shoals:

One CREWS buoy was deployed at the established site, the old CREWS having been recovered by the Marine Debris Mooring Team approximately 1 month previous. A recruitment plate array was affixed to the CREWS anchor. Four STRs were recovered and replaced, and one additional STR was deployed on the CREWS anchor. Fifteen shallowwater CTDs were conducted around the periphery and in central locations of the

shoal in 50 to 120 ft of water following the distribution pattern established on the OES0306 cruise. Radiometer and water sampling casts were conducted at four of these sites with a total of 10 chlorophyll and 6 CDOM samples being collected. Two deepwater CTDs were conducted during night operations.

In addition to these standard operations, a Semipermeable Membrane Device (SPMD) was installed in coordination with the USF&W staff on Tern Island. The SPMD is used to study the settlement of airborne pollutants into the marine environment. This deployment serves as a control as it is being performed in conjunction with others in the Caribbean to monitor the effects of pollutants from the African dust cloud that periodically reaches the South Atlantic. USF&W staff will recover the SPMD a month from its deployment date so we have no future responsibilities concerning the device.

Gardner Pinnacles:

One STR was recovered and replaced. Nine shallowwater CTDs were conducted around the periphery of the pinnacle in 50 to 120 ft of water following the distribution pattern established on the OES0306 cruise. Water-sampling casts were conducted at two of these sites with a total of eight chlorophyll samples being collected. The radiometer malfunctioned and no casts were possible. One deepwater CTD was conducted during night operations.

Maro Reef:

One CREWS buoy, its anchor and its associated recruitment plate array were recovered and replaced. Two STRs were recovered and replaced and one additional STR was deployed on the CREWS anchor. Nineteen shallowwater CTDs were conducted around the periphery of the reef in 50 to 120 ft of water following the distribution pattern established on the OES0306 cruise. Water sampling casts were conducted at three of these sites with a total of 10 chlorophyll samples being collected. The radiometer malfunctioned and no casts were possible. Five deepwater CTDs were conducted during night operations.

Laysan Island:

One SST buoy was recovered and replaced at the established site. Two STRs were recovered and replaced at established sites. Eight shallowwater CTDs were conducted around the periphery of the island in 50 to 120 ft of water following the distribution pattern established on the OES0306 cruise. Water sampling casts were conducted at two of these sites with a total of six chlorophyll samples being collected. The radiometer malfunctioned and no casts were possible. Two deepwater CTDs were conducted during night operations.

Pearl and Hermes Atoll:

One CREWS buoy, its anchor and its associated recruitment plate array were recovered and replaced. Five STRs were recovered and replaced. One additional STR was deployed on the CREWS anchor and another was deployed at a deep site to study a

thermocline that has been observed off the south side of the atoll. Forty-four shallowwater CTDs were conducted around the periphery and in central locations of the atoll in 50 to 120 ft of water following the distribution pattern established on the OES0306 cruise. Five of these CTD sites were redundant with those covered the previous day off the southern side of the atoll to further study the aforementioned thermocline. Radiometer casts were conducted at nine of these sites and water samples were collected at six of the radiometer sites with a total of 18 chlorophyll samples being collected. Eight deepwater CTDs were conducted during night operations.

Midway Atoll:

One SST buoy was recovered from its mooring on an old CREWS 1,200-pound anchor and replaced at a site about 100 feet to the south with a new 250-pound anchor. This move was a precaution taken to avoid potential chaffing on nearby coral heads and binding of the line affixed to a nonswivel anchor. The recruitment plate array was collected and a new one was deployed on the 1,200-pound anchor, which was left in place for this purpose. The ODP was found 4 feet from its deployment site upside down and wedged between the walls of the channel in which it was placed. It is probable that a high energy wave event caused the adjustment to the platform's position. The ODP was extracted over the course of six dives. The new ODP was deployed at a site about a quarter of a mile away in 96 ft of water. Four STRs were recovered and replaced. The complicated effort to remove the ODP reduced the time available to conduct oceanographic sampling; however, 12 shallowwater CTDs were conducted around the periphery and in central locations of the atoll in 30 to 120 ft of water following the distribution pattern established on the OES0306 cruise. Radiometer casts were conducted at six of these sites and water samples were collected at three of the radiometer sites with a total of seven chlorophyll and six CDOM samples being collected. Three deepwater CTDs were conducted during night operations.

Kure Atoll:

One CREWS buoy, its anchor, and its associated recruitment plate array were recovered and replaced. Two WTRs were recovered and replaced. Two STRs were recovered and replaced. Last June, in response to the cessation of data transmission from the CREWS buoy, the Marine Debris Mooring Team deployed a SST buoy close to the CREWS buoy and a STR on its subsurface mast. The STR was retrieved while the SST was observed to be in fine condition, with the expected amount of marine growth present and left in place. An additional STR was deployed on the CREWS anchor. Twenty-seven shallowwater CTDs were conducted around the periphery and in central locations of the atoll in 12 to 120 feet of water following the distribution pattern established on the OES0306 cruise. Radiometer casts were conducted at five of these sites and water samples were collected at three of the radiometer sites with a total of eight chlorophyll samples being collected. Four deepwater CTDs were conducted during night operations.

Lisianski Island / Neva Shoals:

Two WTRs were recovered and replaced. One STR was recovered and replaced. The SST, which was affixed to an old CREWS anchor, was in less than optimal condition.

The line was severely twisted so that there were several ~ 2 foot “tails” off the main line and a 1-by-2-ft bundle of line just above the anchor. A new 250-lb anchor was deployed about 50 ft to the S-SW (210°) of the old CREWS anchor and a new SST was moored to it. An additional STR was deployed on the old CREWS anchor along with a new recruitment plate array that replaced the old one. Twenty-eight shallowwater CTDs were conducted around the periphery and in central locations of the atoll in 20 to 120 ft of water following and adding to the distribution pattern established on the OES0306 cruise. Radiometer casts were conducted at five of these sites and water samples were collected at three of the radiometer sites with a total of eight chlorophyll samples being collected. Four deepwater CTDs were conducted during night operations.

Mokumanamana (Necker) Island:

Operations were canceled at Mokumanana Island due to severe weather. Therefore, no instrumentation was recovered or replaced and no oceanographic sampling occurred. One ODP and one SST were left as deployed on the OES0306 Cruise. The status of these instruments was not checked.

Nihoa Island:

Operations were canceled at Nihoa Island due to severe weather. Therefore, no oceanographic sampling occurred. There were no instrument sites to maintain.

Table 1: Instrumentation Summary

Site	CREWS	SST	ODP	WTR	STR	RPA	SPDM	Comments
French Frigate Shoals	1				5*	1	1**	* One STR was a new deployment on the CREWS anchor. The STR by Disappearing Island was moved out of the surf zone. ** The SPDM was a an installation action to assist USF&W staff at Tern Island. CRED has no further responsibility concerning this device.
Gardner Pinnacles					1			
Maro Reef	1				3*	1		* One STR was a new deployment on the CREWS anchor.
Laysan Island		1			2			
Pearl and Hermes Atoll	1				7*	1		*One STR was a new deployment on the CREWS anchor and another was a new deployment at 74 feet off of the S edge of the atoll to study an observed thermocline.
Midway Atoll		1*	1***		4	1**		* The SST was deployed on a new 250 pound anchor w/ swivel about 50 feet South of the site on the old CREWS anchor. ** The array was affixed to the old CREWS anchor near the new SST site. ***The new ODP was deployed at a new site about 1/4 mile to the North of the old site to remove it from the drastic wave power that presumably flipped the old ODP.
Kure Atoll	1	1*		2	3**	1		* The SST was deployed by the Marine Debris Mooring Team in June 2004, it was observed to be in excellent condition and left in place. ** The STR that was affixed to the CREWS subsurface mast (deployed by the Marine Debris Mooring Team) was removed and a new one was deployed on the CREWS anchor.
Lisianski Island/Neva Shoal		1*		2	2***	1**		* The SST was deployed on a new 250 pound anchor w/ swivel about 50 feet South-southwest of the site on the old CREWS anchor. ** The array was affixed to the old CREWS anchor near the new SST site. *** One STR was a new deployment on the old CREWS anchor.
Mokumanamana Island		1	1			1		Field operations canceled due to severe weather. Instruments are those deployed on the OES0306 Cruise.
Nihoa Island								No instrumentation has been deployed around Nihoa.

Note: All instrumentation numbers represent replacement deployments unless otherwise indicated in the comments column.

Acronyms: CREWS = Coral Reef Early Warning System (buoy), SST = Sea Surface Temperature (buoy), ODP = Ocean Data Platform, WTR = Wave and Tide Recorder, STR = Subsurface Temperature Recorder, RPA = Recruitment Plate Array, SPDM = Semipermeable Membrane Device

Table 2: Oceanographic Sampling Summary

Site	CTD sites	Radiometer sites	Water sample sites	Chlorophyll samples collected	CDOM samples collected	Comments
French Frigate Shoals	15	4	4	10	6	First water sample site: chlorophyll samples collected at 60, 30 and 5 feet. Second site: chlorophyll samples collected at 5 and 25 feet, CDOM samples collected at 5 and 20 feet. Third and fourth site: both chlorophyll and CDOM samples collected at 5 and 30 feet, additional chlorophyll sample at 60 feet.
Gardner Pinnacles	9	0	2	8		Both water sample sites: chlorophyll samples collected at 5, 30, 60 and 90 feet. The radiometer was malfunctioning so no casts were possible.
Maro Reef	19	0	3	10		First and second water sample sites: chlorophyll samples collected at 5, 30, 60 and 90 feet. Third site: samples were collected at 5, 30 and 60 feet. The radiometer was malfunctioning so no casts were possible.
Laysan Island	8	0	2	6		Both water sample sites: chlorophyll samples collected at 5, 30 and 60 feet. The radiometer was malfunctioning so no casts were possible.
Pearl and Hermes Atoll	44	9	6	18		All water sample sites: chlorophyll samples collected at 5, 30 and 60 feet.
Midway Atoll	12	4	3	7	6	First water sample site: chlorophyll samples collected at 60, 30 and 5 feet, CDOM samples collected at 30 and 5 feet. Second and third site: chlorophyll and CDOM samples collected at 5 and 20 feet.
Kure Atoll	27	5	3	8		First and second water sample sites: chlorophyll samples collected at 5, 30 and 60 feet. Third site: samples were collected at 5 and 20 feet.
Lisianski Island/Neva Shoal	28	5	3	8		First and second water sample sites: chlorophyll samples collected at 5, 30 and 60 feet. Third site: samples were collected at 5 and 30 feet.
Mokumanamana Island	0	0	0	0		Field operations canceled due to severe weather.
Nihoa Island	0	0	0	0		Field operations canceled due to severe weather.
FFS (Deepwater CTD)	1	1	1	4		Casts / samples run concurrently with deepwater CTD cast at permanent deepwater CTD station. Chlorophyll samples collected at 5, 30, 60 and 90 feet.

Note: All radiometer casts are performed concurrently with CTD casts and all water sample sites are concurrent with CTD/radiometer sites.

Acronyms: CTD = Conductivity, Temperature and Depth (recorder), CDOM = Color Dissolved Organic Matter

Protocol 1: Water Sampling Methods

Prepared By: Daniel Merritt

Chlorophyll Sampling

*Based on the University of Hawaii's HOTS Program

Note: Filter is collected.

Prior to departure, 5 mL of 100% acetone was added to glass chlorophyll screw-top tubes and placed in a freezer at -20° C. Further, brown rectangular 125 mL HPDE bottles were precisely measured for volume and uniquely labeled.

1. Seawater samples are collected at various predetermined sites using a handheld niskin bottle and messenger. Samples are collected at 5 ft, 30 ft, 60 ft, and 90 ft (keeping a minimum of 10 ft to 15 ft between the bottom and the deepest sample).
2. A data sheet is kept that references the concurrent CTD cast ID, the PRR file(s), latitude and longitude, date, time, water depth and water sample ID, sample bottle ID, and sample depth.
3. The HPDE bottle and cap are rinsed 2 times with the sample water prior to filling the bottle all the way to the top of the neck before capping. It is important for the bottle to be as full as possible.
4. The samples are kept in dry/ambient temperature cooler until filtration.
5. Prior to filtration, the vacuum filtration funnels are rinsed with DI water. Filtration takes place the evening of sampling.
6. Samples are filtered using an oil-free vacuum pump system and 25 mm GFF filters. It is important that none of the sample is spilled during the filtering process.
7. After the entire sample has been filtered, the filter is folded and placed into the pre-prepared glass screw-top tubes with 5 mL of acetone. The entire filter is submerged in the acetone.
8. The tube is labeled with tape referencing the water sample ID (i.e., KUR1), the sample bottle ID (i.e., C01), and the sample depth (i.e., 30 ft). The labeled tube is then wrapped in aluminum foil, placed in a rack, and stored at -20 degrees C.
9. The vacuum filtration funnel and HPDE bottle are then rinsed with DI water.

Color Dissolved Organic Matter (CDOM) Sampling

*Based on input from Erik Stabenau

Note: Water is collected.

1. Seawater samples are collected at various predetermined sites using a handheld niskin bottle and messenger. Two samples are collected at 5 ft and 30 ft or 5 ft and 20 ft if water depth is less than 30 ft.
2. A data sheet is kept that references the concurrent CTD cast ID, the PRR file(s), latitude and longitude, date, time, water depth and water sample ID, sample bottle ID, and sample depth.
3. One L brown Nalgene bottles are used to store the collected samples. The bottles and caps are rinsed 2 times with the sample water prior to filling the bottle. The samples are kept in dry/ambient temperature cooler until filtration.
4. Prior to filtration, the Erlenmeyer flask and filtration funnel is rinsed with DI water. Filtration takes place the evening of sample collection.
5. Samples are filtered using an oil-free vacuum pump system and 0.2-um pore size polycarbonate filters.
6. Approximately 200 mL is first filtered through the flask and funnel. This sample is then used to rinse the 250 mL Wheaton glass bottles with Teflon-lined lids used to store the samples. This water is then poured out and the remainder of the original sample is filtered, collected, and stored in the Wheaton bottles.
7. The Wheaton bottle is labeled with tape referencing the water sample ID (i.e., KUR1), the sample bottle ID (i.e., CDOM01), and the sample depth (i.e., 30 ft). The labeled bottle is then placed in a dark refrigerator.
8. The filtration funnel, flask, and Nalgene bottle are then rinsed with DI water, and the filter is discarded.

Appendix G: **Night Operations Activities Summary** (*Scott Ferguson*)

A. Preparation

The TOAD and CTD were both deployed from the vessel's J-frame. The TOAD was configured with a single underwater video camera and two 500-W lights mounted on the original sled frame. The MiniBAT pressure sensor and wing controller was also mounted on the frame, but no wings were installed. Cable between the sled and the surface consisted of a underwater electrical cable (cable 1, blue in color) with a separate load-bearing line to support the sled frame. The electrical cable was clipped to the line at regular intervals upon deployment and removed upon recovery. The load-bearing line was led to the starboard capstan on the aft deck. All TOAD interface boxes were located in the Dry Lab in an equipment rack on the after bulkhead. After operations began we learned that the sled's pressure sensor was not working.

The first 4 days of the survey were dedicated to completing the installation and configuration of shipboard scientific equipment. This included wiring the shipboard CTD, configuring the deck unit and testing the winch. The Scientific Computing System (SCS) was configured to output two data streams: one providing position and depth data to the TOAD data acquisition system and the other providing a data feed for Nobeltec software so that the scientific party had access to positioning information in the Dry Lab.

B. Operational Plan

TOAD deployments were conducted between 1800 and midnight and CTD casts were conducted during the remaining available time. TOAD tows were usually limited to 20 minutes at a given location in order to allow for more tows to be conducted and thus increase the spatial distribution of the observations. CTDs casts were conducted to 500 m unless otherwise noted. Water samples were taken on selected casts and analyzed to determine the concentration of chlorophyll-*a*. Five 10-liter Niskin bottles were mounted on the rosette and samples were taken at 150 m, 125 m, 100 m, 80 m, and at the surface.

C. Results

1. French Frigate Shoals

Three TOAD tows were conducted, all of which resulted in usable data. The tows were located on the leeward bank.

Two CTD casts were conducted; one at the permanent "FFS" station and another west of the bank.

2. Gardner Pinnacles

One CTD cast was conducted at the permanent "Gardner" CTD station.

3. Maro Reef

Nine TOAD tows were conducted, of which seven produced useable data. Three were located on the eastern bank and four on the northwestern bank.

Five CTD casts were conducted; one at the permanent "Maro" station and four located north, south, east, and west of the bank.

4. Laysan Island

Five TOAD tows were conducted, of which three resulted in useable data. These were located on the northern bank.

Two CTD casts were conducted: one at the permanent “Laysan” station and one northeast of the bank. A third station was attempted but had to be aborted when the data link to the CTD fish failed and could not be repaired in time to reoccupy the station.

5. Pearl & Hermes Atoll

Twenty-nine TOAD tows were conducted, of which 25 resulted in usable data. These were distributed across all areas of the banks.

Eight CTD casts were conducted. The permanent “PHReef” station was occupied three times and five other casts were distributed around the bank. Two casts were performed to the east of the bank with water samples. On the third station all five Niskin bottles were destroyed when the CTD rosette struck bottom in 459 m of water. Therefore, six casts were performed without taking water samples. A description of the events that led to this error is included at the end of this appendix.

6. Midway Atoll

Ten TOAD tows were conducted, of which nine resulted in usable data. These were located on the western banks because bad weather precluded working in other areas.

Three CTD stations were conducted: one at the permanent “Midway” station and two others at locations northeast and southwest of the bank. Water sampling was resumed beginning with these casts.

7. Kure Atoll

Nineteen TOAD tows were conducted, of which 18 resulted in usable data. These were distributed across all areas of the banks.

Four CTD casts were conducted: two at the “Kure” station, which was occupied twice and two others at locations northeast and southwest of the bank. Water samples were taken during three casts.

8. Lisianski Island

Thirteen TOAD tows were conducted, all of which resulted in usable data. These were distributed across the northwestern and southeastern portion of the banks.

Four CTD casts were conducted: two at the “Lisianski” station, which was occupied twice and two others at locations northeast and southwest of the bank. Water samples were taken during three casts.

9. Mokumanamana (Necker) Island

Six TOAD tows were conducted, all of which resulted in usable data. These were located on the bank west of Necker Island.

One CTD cast was conducted at the permanent “Necker” CTD station.

10. Nihoa

One CTD cast was conducted at the permanent “Nihoa” CTD station.

Table G-1: Night operations conducted around the Northwestern Hawaiian Islands.

Location	No. TOAD deployments	CTD casts
French Frigate Shoals	3	2
Gardner Pinnacles	0	1
Maro Reef	9	5
Laysan Island	5	2
Pearl & Hermes Atoll	29	8
Midway	10	3
Kure	19	4
Lisianski	13	4
Mokumanamana (Necker Island)	6	1
Nihoa	0	1

Table G-2: Summary of TOAD Camera Transects.

Date	Total Tows	Good Tows	Time on Bottom	Min Depth, m	Max Depth, m	Tow distance, km
Cruise Total	88	79	30:09:05	17	143	73.8
French Frigate Shoals	3	3	1:49:47	17	29	4.5
Maro	9	7	3:01:53	26	32	6.3
Laysan	5	3	1:07:00	26	38	1.8
Pearl & Hermes	29	26	9:06:25	24	143	21.3
Midway	10	9	2:45:00	35	102	8.7
Kure	19	18	5:53:15	23	80	15.2
Lisianski	13	13	4:16:45	24	62	9.8
Necker	6	6	2:09:00	24	36	6.3

HI0401 CTD CAST LOCATIONS TO DATE

15-Oct.-2004

Table G-3: Shipboard CTD Cast Locations

Cast No.	Location	Date JD-time (UTC)	Latitude	Longitude	Cast depth	Bottom depth	Water samples
Cast001	FFSCTD 001	19Sep04 263-0420	23 44.860N	166 24.000W	500	335 fm	Y
Cast002	FFS*	19Sep04 263-1125	23 34.240N	166 18.080W	500	1000 fm	Y
Cast003	Gardner*	20Sep04 264-1115	24 07.950N	167 39.990W	500	1800 fm	Y
Cast004	Maro*	21Sep04 265-1237	25 00.098N	169 59.949W	500	2200 fm	Y
Cast005	MaroCTD 002	22Sep04 266-1028	25 19.980N	170 15.870W	500	602 fm	Y
Cast006	MaroCTD 001	22Sep04 266-1318	25 39.624N	170 28.064W	500	1100 fm	N
Cast007	MaroCTD 004	23Sep04 267-1036	25 19.653N	170 54.818W	500	700 fm	Y
Cast008	MaroCTD 003	23Sep04 267-1341	25 12.704N	170 33.526W	500	500 fm	Y
Cast009	Laysan*	24Sep04 268-0821	25 34.098N	171 32.179W	500	2000 fm	Y
Cast010	LayCTD 001	25Sep04 269-1026	25 51.183N	171 33.720W	500	500 fm	Y
Cast011	LayCTD 002	25Sep04 269-1311	25 47.176N	171 54.544W	<i>CTD failed</i>	Unk	N
Cast012	PHReef*	26Sep04 270-1153	27 40.040N	175 49.894W	500	1800 fm	Y
Cast013	PHCTD _001	27Sep04 271-1126	28 00.418N	175 40.320W	500	2000 ft.	Y
Cast014	PHCTD _002	27Sep04 271-1325	27 49.814N	175 40.526W	500	2167 m	Y
Cast015	PHCTD _003	28Sep04 272-1142	27 53.817N	176 01.840W	459	459 m	N
Cast016	PHCTD _004	28Sep04 272-1317	27 46.540N	176 05.350W	500	Unk	N
Cast017	PHCTD _005	29Sep04 273-1144	27 41.140N	176 00.460W	500	Unk	N
Cast018	PHReef* 2 nd cast	29Sep04 273-1352	27 39.990N	175 49.090W	500	1760 fm	N
Cast019	PHCTD _007	30Sep04 274-1126	27 41.130N	176 00.190W	500	1800 m	N
Cast020	PHReef* 3 rd cast	30Sep04 274-1304	27 39.990N	175 49.050W	500	1760 fm	N

Cast No.	Location	Date JD-time (UTC)	Latitude	Longitude	Cast depth	Bottom depth	Water samples
Cast021	MidCTD_001	04Oct04 278-1201	28 18.490N	177 12.490W	500	1585 fm	Y
Cast022	Midway*	04Oct04 278-1422	28 06.090N	177 21.340W	500	1351 fm	Y
Cast023	MidCTD_002	05Oct04 279-1108	28 10.700N	177 31.300W	500	1618 fm	Y
Cast024	KurCTD_001	06Oct04 280-1112	28 28.630N	178 10.530W	500	Unk	Y
Cast025	Kure*	06Oct04 280-1345	28 12.089N	178 20.010W	500	1555 fm	Y
Cast026	KurCTD_002	07Oct04 281-1116	28 24.110N	178 29.385W	500	Unk	Y
Cast027	Kure* 2 nd cast	07Oct04 281-1332	28 12.031N	178 20.070W	500	1555 fm	N
Cast028	LisCTD_001	10Oct04 284-1221	26 11.290N	173 43.990W	500	1100 fm	Y
Cast029	LISIANS KI*	10Oct04 284-1510	25 49.972N	173 40.040W	500	1465 fm	Y
Cast030	LISIANS KI*	11Oct04 285-1157	25 50.048N	173 40.008W	500	1465 fm	N
Cast031	LisCTD_002	11Oct04 285-1528	25 58.255N	174 11.453W	500	1115 fm	Y
Cast032	FFS* 2 nd cast	13Oct04 287-2121	23 35.158N	166 24.476W	500	1223 fm	Y
Cast033	NECKER *	14Oct04 288-0742	23 11.053N	164 42.470W	500	Unk	Y
Cast034	NIHOA*	15Oct04 289-2114	22 32.200N	161 59.800W	500	4105 m	Y

* Permanent stations

Report on damage to Niskin Bottles

Five large Niskin bottles were destroyed on 27 September 2004 when the CTD was inadvertently deployed to the bottom, where it apparently rolled down a steep slope. The CTD unit and the cable appeared to be undamaged and worked on a subsequent cast without bottles; the rosette is scarred but otherwise ok. The cast location was NW of Pearl & Hermes (27°54N, 176°02W) in an area without charted soundings. Once on station the bridge reported a depth of 3,272 m when in fact the depth was 459 m. When the package hit bottom there was evidently enough weight from the deployed cable that the winch tension readout did not indicate a significant change, and it was only when survey tech noticed that the pressure stopped changing that we learned we had a problem.

In retrospect, the station was obviously placed too close to the atoll and did not account for the fact that one sounding to the south indicates that the shoulder of the atoll may extend farther to the west than it does elsewhere. Prior to each cast the bridge officers were monitoring the Abyss 24 kHz navigation echosounder to provide a reliable indication of depth, and it was assumed that this was a sufficient check to the depth of the station. This was obviously an erroneous assumption. Unfortunately the officers were at times unable to obtain reliable soundings but usually when the echosounder is not locked onto the bottom it triggers on noise, which is easy to detect. At the CTD station the sonar evidently locked onto an artifact well below the actual depth. A better echosounder should be made available for bridge navigation.

Appendix H: **Educational Team Summary** (*David Liittschwager, Susan Middleton, Dan Suthers, Stephani Holzwarth*)

Purpose:

The Outreach and Education Team was a new component of the NWHI RAMP (Reef Assessment and Monitoring Program) cruise. The team included two photographers, a science writer/Web master, and a diver to assist with field logistics. David Liittschwager and Susan Middleton, the photographers, were working on a book and 20-page article on the NWHI that will be published by National Geographic. In addition, two exhibitions will be opening concurrently in Hawaii (Honolulu Academy of the Arts) and Washington D.C. (National Geographic), scheduled for fall 2005. Daniel Suthers (associate professor at University of Hawaii) was the science writer and Web master. Stephani Holzwarth (CRED diver) assisted the team with field logistics, diving operations, and care of living specimens. Divers from other teams helped collect fish, algae, coral, and invertebrates on an opportunistic basis, and collaboratively shared specimens from their field collection activities.

Methods:

For the photography mission, specimens were collected from the field by divers (generally in >60 ft of water) and transported alive to the shipboard photo studio that was set up in the wetlab. Specimens were returned to a similar, suitable habitat on the same atoll or back where they were collected, with the exception of some algae and invertebrates, which were collected for identification or documentation by U.S. Fish and Wildlife Service and/or State of Hawaii collecting permits.

Specimens were staged in 5-gallon buckets with free-flowing or often-changed sea water, air stones, and filters. Specimens were photographed one at a time in 2- to 15-gallon aquaria with white, grey, or black backgrounds. The photographers used studio strobe lighting and a medium format camera on a tripod with fine-grained film for final shots and Polaroid film for test shots. A Canon EOS-1Ds (11.0 megapixel digital still camera) was also used for less stationary (i.e., nontripod) shots. A Canon 5060 (5.1 megapixel digital still camera) in a waterproof housing was used for in situ contextual shots of reef habitats and inhabitants, which were taken while diving and/or snorkeling on the reefs.

Sites:

At French Frigate Shoals, the photographers completed portraits of five specimens of algae, one coral, three fish, and eight invertebrates. The photographers and the science writer accompanied the REA team on snorkel at La Parouse pinnacle, which allowed them to take some in situ photographs of the pinnacle and to observe the coral, fish, algae, and invert surveys. They visited Tern Island briefly on the first day and overnight on the second day to photograph green sea turtle hatchlings. Hatchlings that wandered onto the runway or into the claws of crabs were rescued and loaned for a brief amount of time for portraits in an aquarium studio assembled in the field station garage. Two ecologically important land plants were photographed as well during the Tern Island visit.

At Gardner Pinnacle the outreach and education team spent the afternoon free-diving for in situ photography of the pinnacle and underwater as well as above-water scene. One alga and two invertebrates were collected and photographed in the shipboard photo studio.

At Maro Reef, Susan Middleton and David Liittschwager finished portraits of four algae, five corals, two fish, and three invertebrates, including spiny lobsters and a large, pinkish sand anemone. Divers

from all teams brought in specimens and kept the photographers more than busy. Conditions were not conducive to underwater photography (Maro was murky), so no snorkel field trips were undertaken except for a short one on the last day to return specimens to the reef.

At Laysan Island, the outreach and education team and Stefan Kropidowski (USFWS camp leader on Laysan) accompanied Stephani Holzwarth to the north side of the island to recover and replace an STR (subsurface temperature recorder), a process they photo-documented. The tow team captured a group of juvenile domino damselfish (*Dascyllus albisella*) and a Hawaiian cleaner wrasse (*Labroides phthiophagus*) that were transported back to the ship to be photographed by David Liittschwager and were released at the end of the day from the same location where they were captured. Susan Middleton and Dan Suthers accompanied Mark Vekasy (USFWS/USGS field biologist) to the hypersaline lake to photograph native plants and endemic ducks with transmitters. Twenty ducks (marked with transmitters) are slated for translocation to Sand Island of Midway in an effort to create a second population as an “insurance policy” against extinction in the event of a disease or natural disaster at Laysan, where the remaining ~500 individuals of this species of duck (*Anas laysanensis?*) reside. Two algae and one marine invertebrate were later photographed in the shipboard photo studio.

At Pearl & Hermes Reef 15 fish species, 2 algae, and 12 invertebrates were photographed in the shipboard studio, including endemics such as male and female Masked Angelfish (*Genicanthus personatus*), the Bandit Angel (*Holocanthus arcuatus*), the Flame Wrasse (*Cirrhilabrus jordani*), and the Hawaiian Lionfish (*Pterois sphex*). In addition, a new species of sea cucumber (the chocolate chip sea cucumber, *Stichopus* sp.) and a new species of red algae (*Dasya atropurpurea*), both of which are currently being described by scientists in Hawaii, were collected and photographed. Shore visits in quarantine clothes, with a monk seal escort (Stephani Holzwarth) were made to Grass Island, North Island, and Little North in order to photograph plants, sea birds, and the islands themselves. Susan Middleton and Stephani Holzwarth completed a 10-minute training dive in the lagoon and a photographic dive on the northwestern forereef. An additional dive was scheduled for the last day of ops at PHR but was canceled due to thunderstorms and violent rain squalls.

At Midway Atoll, the photographers completed portraits of 11 fish species and 1 invertebrate. Six of the fish species were endemic, including the bluestriped butterflyfish (*Chaetodon fremblii*), potter’s angelfish (*Centropyge potteri*), shortnose wrasse (*Macropharyngodon geoffroy*), and elegant coris (*Coris venusta*). In addition, Susan Middleton went ashore to document the introduction of Laysan ducks to Sand Island on the night the ducks arrived on a tugboat and the team of animal care experts flew in from Honolulu.

At Kure Atoll six fishes and four invertebrates were photographed in the studio, and one dive was made on the southwest forereef near the channel for in situ photography. One day was spent on Green Island taking pictures of plants and birds, followed by snorkeling near the shipwreck on the north backreef for pictures of ulua, butaguchi, and other reef residents.

At Lisianski and Neva Shoals, seven fishes, four invertebrates, three coral, and three algae species were photographed in the shipboard studio. Three dives were conducted (two on the southeast corner of Neva Shoals, one on the northeast corner) in addition to snorkeling near the island on the shallow rice coral reef flats. The two photographers and Stephani Holzwarth (as the monk seal escort) spent half a day on the island, avoiding the bird burrow-riddled interior.

In total, formal studio portraits were completed for 114 species at eight atolls and banks in the Northwestern Hawaiian Islands, using 320 rolls of 120 film, in addition to contextual photographs taken with digital cameras.

Science Writer

The role of science writer was filled by Dan Suthers, associate professor at the University of Hawai`i in the Department of Information and Computer Sciences. Dr. Suthers specializes in technology for educational applications, particularly in science. His responsibility on this expedition was to document the science being conducted on this voyage for dissemination to the general public and secondary school populations. During the voyage, he maintained an expedition Web site (hawaiianatolls.org/research/NWHIRAMP2004) where he posted reports of daily activities, as well as special feature stories. The updates were made on an almost daily basis (when satellite communication was available). The Web site has been advertised via announcements to the Hawaii Networked Learning Communities (hnlc.org) Web site and e-mail list, reaching teachers in 36 member schools as well as others. The site has also been referenced in stories published in local newspapers. At the conclusion of the expedition, the materials will be made available to teachers and others.

The strategy taken to Web site development has been to hook in the audience with stories that convey the excitement of the expedition and the uniqueness of the NWHI and then to transition to more detailed stories about the science itself. During the first two transit days, Dr. Suthers became familiar with the teams onboard and ship operations and documented training operations conducted on the *Hi`ialakai*. He also worked out procedures for onboard image processing and Web site editing, and for uploading these edits to the server at the University of Hawai`i. When field work began, journals were written during field days that included a summary of activity of all the major teams and their observations. Daily journals were submitted for activities at French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan, Pearl and Hermes, Kure, and Lisianski. A combined journal was also submitted for Midway, where Dr. Suthers did not observe any field observations. Each day, he surveyed the diversity of activity, and briefly highlighted significant REA and towboard operations, oceanography operations, and onboard lab activity.

As of October 13, 26 journal entries and 6 feature stories had been posted on the Web site. The feature stories were on the methodologies of the three major expedition teams (oceanography, rapid ecological assessment, and towed diver surveys), on observations of coral bleaching, the discovery of shipwrecks at Pearl and Hermes, and the documentary photography of the onboard photographers. At least two more journal entries and several other feature stories are planned, the latter focusing on specific research topics with reef management implications. About 4,600 digital photographs and over 5 hours of video and audiotape of activities have been gathered to date.

Table 1. Categories of specimens collected from each island.

Count of #	Group							Grand Total
	Algae	Algae + invert	Coral	Fish	Invert	Plant	Vert	
MAR		4		5	2	6		17
FFS		5		1	3	8		17
FFS-Tern Island							2	3
GAR		1				2		3
KUR					6	4		10
LAY		4			2	2		8
LIS		1		4	7	4		16
MID					11	1		12
PHR		1	1		15	11		28
Grand total		16	1	10	46	38		114