

January 10, 2005

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CRUISE REPORT

**VESSEL:
CRUISE:** *Oscar Elton Sette*, Cruise 03-06 (OES-07)

PERIOD: 12 July-17 August 2003

**AREA OF
OPERATION:** Northwestern Hawaiian Islands (NWHI) (Fig. 1)

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

ITINERARY:

- 12 July Start of cruise. Embarked Ed DeMartini (fish), Mark Albins (fish), Steve Cotton (fish), Jean Kenyon (coral), Greta Aeby (coral), Scott Godwin (invertebrates), Kim Page (algae), Jon Winsley (algae), Joe Laughlin (towboard/fish), Brian Greene (towboard/fish), Joe Chojnacki (towboard/habitat), Molly Timmers (towboard/habitat), Stephani Holzwarth (moorings/tow), Jamie Gove (moorings/tow), Ron Hoeke (moorings/tow), Joyce Miller (mapping/CTD), John Rooney (mapping/CTD), Scott Ferguson (mapping), Marc Lammers (bioacoustics), and Sun He Bak (data manager). The R/V AHI (Acoustic Habitat Investigator) is carried on deck. Departed Snug Harbor at 0922 en route to Nihoa to commence cruise.
- 13 July Deployed drifter. Performed conductivity-temperature-depth (CTD) at NIHOA station. Conducted diver emergency orientation and drills.
- 14 July Conducted CTD at NECKER station. Arrived at Necker Island. Conducted three benthic and fish rapid ecological assessment (REA) stations and four towed-diver surveys. Recovered and replaced ocean data platform (ODP) and sea surface temperature (SST) buoy and performed four shallow water CTDs. Departed for French Frigate Shoals (FFS). Deployed drifter.

- 15 July Performed CTD at FFS station. Arrived at FFS. Conducted three benthic and fish REA stations and four towed-diver surveys. Recovered and replaced CREWS buoy and surface temperature recorder (STR). Transferred supplies to NMFS and Fish and Wildlife Service (FWS) field camps at Tern Island. Conducted one bioacoustics transect.
- 16 July Conducted three benthic and fish REA stations and six towed-diver surveys. Recovered and replaced one STR and performed six shallow water CTDs. Conducted five bioacoustics transects and five tethered optical assessment device (TOAD) transects. The ship was notified that the Coral Reef Early Warning System (CREWS) buoy deployed on 15 July was not transmitting data to shore; try to locate problem with system.
- 17 July Conducted three benthic and fish REA stations and six towed-diver surveys. Deployed two STRs and performed four shallow water CTDs. Conducted four bioacoustics transects and two TOAD transects. CREWS buoy debugging continued without success.
- 18 July Conducted three benthic and fish REA stations and four towed-diver surveys in the vicinity of Tern Island. Removed the new CREWS buoy, replaced it with the one recovered on 15 July, deployed one STR and performed six shallow water CTDs. Conducted two bioacoustics transects, one TOAD transects and one bottom grab. Attempted an EK60 calibration but the current was too high to complete the calibration. Departed for Gardner Pinnacles.
- 19 July Performed CTD at GARDNER station. Arrived at Gardner Pinnacles. Conducted three benthic and fish REA stations and two towed-diver surveys. Deployed one STR and performed nine shallow water CTDs. Conducted three TOAD transects. Departed for Maro Reef. Deployed drifter.
- 20 July Performed CTD at MARO station. Arrived at Maro Reef. Conducted three benthic and fish REA stations and six towed-diver surveys. Recovered one STR and deployed two STRs and performed five shallow water CTDs. Conducted two bioacoustics transects and one TOAD transect.
- 21 July Conducted three benthic and fish REA stations and five towed-diver surveys. Deployed one STR and performed seven shallow water CTDs. Conducted three bioacoustics transects and three TOAD transects.
- 22 July Conducted three benthic and fish REA stations and eight towed-diver surveys. Performed two shallow water CTDs. Conducted three bioacoustics transects and four TOAD transects. Rendezvoused with *M/V American Islander*; disembarked Jean Kenyon, and embarked Jake Asher. Departed for Laysan Island.

- 23 July Performed CTD at LAYSAN station. Arrived at Laysan Island. Conducted three benthic and fish REA stations and five towed-diver surveys. Recovered and replaced SST and STR and performed eight shallow water CTDs. Departed for Lisianski Island. Deployed drifter.
- 24 July Performed CTD at LISIANSKI station. Arrived at Lisianski/Neva Shoals. Conducted three benthic and fish REA stations and five towed-diver surveys. Recovered and replaced SST and deployed Wave and Tide Recorder (WTR). Conducted bottom grab, bioacoustics transect, and three TOAD transects.
- 25 July Conducted three benthic and fish REA stations and six towed-diver surveys. Performed nine shallow water CTDs. Conducted four bioacoustics transects and three TOAD transects.
- 26 July Conducted three benthic and fish REA stations and four towed-diver surveys. Recovered and replaced SST, deployed WTR and performed three shallow water CTDs. Conducted four bioacoustics transects and four TOAD transects.
- 27 July Conducted two bioacoustics transects, CTD and two TOAD transects. Departed for Midway Atoll. Deployed drifter.
- 28 July Performed CTD at MIDWAY station. Arrived Midway Atoll. Moor vessel alongside Sand Island tug pier. Conducted three benthic and fish REA stations and four towed-diver surveys. Recovered and replaced SST and four STRs; performed eight shallow water CTDs. Deployed *R/V AHI* along with 300 gallons of diesel fuel. Removed CREWS buoys to the pier for repair while vessel was conducting other operations. Loaded 300 gallons of gasoline. Disembarked Miller and Ferguson to conduct benthic habitat mapping of the banks offshore of the atoll. Holzwarth was chief scientist while Ferguson was on Midway. *R/V AHI* conducted CTD. Departed for Pearl and Hermes Reef.
- 29 July Arrived at Pearl and Hermes Reef. Conducted three benthic and fish REA stations and eight towed-diver surveys. Recovered and replaced STR. Performed shipboard CTD. Conducted two bioacoustics transects and three TOAD transects. *R/V AHI* conducted multibeam survey and CTD at Midway Atoll.
- 30 July Conducted three benthic REA stations and eight towed-diver surveys. Conducted two fish collection stations. Recovered 1 STR, deployed 2 STRs, and performed 15 shallow water CTDs. Conducted two bioacoustics transects and seven TOAD transects. *R/V AHI* conducted multibeam survey at Midway Atoll.

- 31 July Conducted three benthic and fish REA stations and six towed-diver surveys. Deployed STR, refurbished CREWS buoy and performed two shallow water CTDs. Performed shipboard CTD. Conducted three bioacoustics transects and five TOAD transects. *R/V AHI* conducted multibeam survey at Midway Atoll.
- 1 August Conducted three benthic REA stations and six towed-diver surveys. Conducted two fish collection stations. Deployed STR and performed 11 shallow water CTDs. Performed shipboard CTD and bottom grab. Conducted five bioacoustics transects and four TOAD transects. *R/V AHI* conducted multibeam survey and CTD at Midway Atoll.
- 2 August Conducted three benthic and fish REA stations and seven towed-diver surveys. Recovered and replaced STR and performed nine shallow water CTDs. Conducted two bioacoustics transects and five TOAD transects. Performed two shipboard CTDs, including one at Pearl and Hermes station. Departed for Kure Atoll. *R/V AHI* conducted multibeam survey at Midway Atoll.
- 3 August Arrived at Kure Atoll. Conducted three benthic and fish REA stations and five towed-diver surveys. Refurbished CREWS buoy, recovered and replaced two STRs, and deployed WTR. Conducted six TOAD transects. *R/V AHI* conducted multibeam survey and two CTDs at Midway Atoll.
- 4 August Conducted four benthic and fish REA stations and six towed-diver surveys. Recovered ODP and deployed WTR; performed 14 shallow water CTDs. Performed shipboard CTD. Conducted four bioacoustics transects and five TOAD transects. *R/V AHI* conducted multibeam survey and CTD at Midway Atoll.
- 5 August Conducted two benthic and fish REA stations and two towed-diver surveys. Performed eight shallow water CTDs. Conducted four bioacoustics transects. Performed two shipboard CTDs, including one at KURE station. Deployed drifter. Transited to Midway Atoll and moored at tug pier. Disembarked Hoeke to *M/V American Islander* to supervise CREWS buoy replacement at Kure Atoll. *R/V AHI* conducted multibeam survey and three CTDs at Midway Atoll.
- 6 August Conducted three benthic and fish REA stations and six towed-diver surveys. Ship's divers removed line from shaft. Departed from tug pier to work around Midway Atoll. Conducted bioacoustics transect and five TOAD transects. *R/V AHI* conducted multibeam survey and two CTDs.
- 7 August Embarked Hoeke upon small-boat transfer from *M/V American Islander*. Conducted three benthic REA stations and four towed-diver surveys. Conducted three fish collection stations. Deployed ODP and performed 11 shallow water CTDs. Performed shipboard CT. Conducted four

bioacoustics transects and four TOAD transects. *R/V AHI* conducted multibeam survey and two CTDs.

- 8 August Conducted two benthic and three fish REA stations and three towed-diver surveys. Performed shipboard CTD and conducted three bioacoustics transects. Moored at Sand Island tug pier. Loaded *R/V AHI* and one repaired CREWS buoy. Embarked Ferguson, Miller, and Appelgate. Ferguson resumed duties as chief scientist. Disembarked DeMartini, Albins, Cotton, Aeby, Page, Winsley, Greene, Chojnacki, Gove, Lammers, and Asher. Departed Midway en route to Saipan.
- 9-17 August Transited to Saipan.
- 18 August Arrived Saipan.

Table 1: Cruise statistics

CRUISE STATISTICS:

	Nihoa	Necker Island	FFS	Gardner Pinnacles	Maro Reef	Laysan Island	Lisianski Island	Pearl and Hermes Reef	Kure Atoll	Midway Atoll	Totals
Towed Diver Habitat/Fish Surveys	0	4	20	2	19	5	20	35	13	17	135
Fish Rapid Ecological Assessments	0	3	12	3	9	3	12	9	9	9	69
Fish Collection	0	0	0	0	0	0	0	4	0	3	7
Benthic Rapid Ecological Assessments	0	3	12	3	9	3	12	15	9	11	77
SST buoys deployed	0	1	0	0	0	1	2	0	0	1	5
SST buoys recovered	0	1	0	0	0	1	2	0	0	1	5
STR deployed	0	0	5	1	3	1	2	6	2	4	24
STR recovered	0	0	2	0	1	1	2	3	2	4	15
CREWS deployed	0	0	1	0	0	0	0	0	0	0	1
CREWS refurbished	0	0	1	0	1	0	0	1	1	0	4
CREWS recovered	0	0	1	0	0	0	0	0	0	0	1
ODP deployed	0	1	0	0	0	0	0	0	0	1	2
ODP recovered	0	1	0	0	0	0	0	0	1	0	2
WTR deployed	0	0	0	0	0	0	2	0	2	0	4
Shallow water CTDs	0	4	16	9	14	8	20	37	22	19	149
TOAD transects	0	0	8	3	8	0	12	19	11	9	70
Bioacoustics Transects	0	0	12	0	8	0	11	17	8	8	64
Bottom Grabs	0	0	1	0	0	0	1	1	0	0	3
Shipboard CTDs	1	1	1	1	1	1	3	5	3	3	20
Drifters Deployed	1	1	0	1	0	1	2	0	1	0	7
Days of multibeam survey by <i>R/V AHI</i>	0	0	0	0	0	0	0	0	0	10	10
CTDs by <i>R/V AHI</i>	0	0	0	0	0	0	0	2	6	5	13

MISSIONS AND RESULTS:

- A. Begin monitoring the species composition, abundance, percent cover, size distribution, and general health of the fish, corals, other invertebrates, and algae of the shallow water (<35 m) coral reef ecosystems of the NWHI.
1. Monitoring of coral reef habitats of the NWHI was initiated during this cruise. The process was begun prior to departure with the selection of long-term monitoring sites based on a rigorous coverage of the range of habitats present and their representative fish, coral, invertebrates and algae faunas, and the high probability of year-round access to the site. A list of sites was selected and refined during the course of the cruise. Both the fish and benthic survey teams participated in this monitoring effort. The fish team occupied 69 of these stations, and the benthic team occupied 77. At each site a complete fish and benthic survey was conducted on the same 25-m transect lines. The fish surveys were conducted along three transect lines, while the benthic survey used two. The benthic survey covers three components of the reef habitat: coral, non-coral invertebrates, and algae. The actual activities for each survey component are as follows:
 - a. Fish: A combination of standard belt transects and stationary point counts were used to ascertain species composition and abundance at all sites surveyed. During the process of these activities additional information was collected that pertains to the incidence of disease in representative groups, population dynamics between congeners, and the documentation of new species records for the Hawaiian Archipelago. Additionally, collections of fish specimens were conducted for research projects focused on larval fish recruitment dynamics and trace element composition and concentration.
 - b. Coral: Two consecutive transect lines were videotaped and the video footage was archived for analysis of coral coverage and to provide a record of the benthic habitat condition. The size distribution of coral colonies was enumerated along a 2X25-m belt transect and recorded in one of seven size class categories. In addition to this data, the incidence of bleaching and/or disease was documented through field observations and the collection of specimens.
 - c. Invertebrates: A set of representative Cnidarians, Mollusks, Echinoderms and Crustaceans were quantitatively enumerated along two 2X25 belt transects. Next, two 10X25 quadrats centered around two of the 25-m transect lines were enumerated by visual census to account for species not within the 2X25 belt transects. Species that could not be identified in the field were collected and returned to the research vessel for identification. During this process qualitative observations are made concerning overall species abundance and diversity and the presence of rare or endemic species.
 - d. Algae: Quantitative enumeration of algae species composition was accomplished through the use of a series of photoquadrats randomly placed along two 25-m transects. All species within each quadrat were collected for positive identification at a later date. In addition to this exercise, species located in the vicinity of the site were collected to generate an overall species

inventory. Finally, qualitative field observations were made concerning the population structure and presence of rare or endemic species.

- B. Conduct benthic habitat mapping of the reefs and submerged banks of the NWHI using multibeam sonar surveys, towed-diver habitat surveys, Quester Tangent Corporation (QTC) acoustic seabed classification, towed camera (TOAD) surveys, and bottom grab samples.
1. One hundred thirty-five towed-diver habitat transects were conducted, covering an estimated 216 linear nmi. QTC acoustic seabed classification data were collected much of the time when the ship was in less than 100 m of water; the total coverage of useable data cannot be quantified until the data are processed. Seventy-four TOAD camera deployments were conducted, which resulted in 1,894 still photographs and approximately 33 h of video data. Three bottom grab samples were collected.
 2. A multibeam survey was conducted at Midway Atoll. Approximately 73 sq. nmi of seabed surrounding the atoll were mapped. The survey depths ranged from 8 to 240 m with almost complete coverage between depths of 10 to 80 m. Limited areas were also surveyed inside the atoll.
- C. Conduct shipboard CTDs to a depth of 500 m and shallow water CTDs from small boats to a depth of ~30 m and run shipboard acoustic Doppler current profiler (ADCP) and bioacoustic surveys around reef ecosystems to examine physical and biological linkages supporting and maintaining these island/atoll ecosystems.
- The ship collected 19 CTDs ranging from 17 to 500 m. One hundred fifty-five shallow water CTDs were collected from small boats in depths ranging from 5 to 137 m. Bioacoustic surveys were conducted at six reef ecosystems; these surveys were conducted at varying times of day and night, resulting in 650 km of transects. Collection of ADCP transects in these areas was precluded because the ADCP sonar created acoustic interference with the EK60 sonar being used to collect bioacoustic and QTC data. Because TOAD, QTC and bioacoustic data collection also took all of the available time, ADCP data were only collected during transits between the reef ecosystems.
- D. Deploy an array of CREWS buoys, SST buoys, subsurface Ocean Data Platforms, and subsurface temperature recorders to allow remote long-term monitoring of oceanographic and environmental conditions affecting NWHI coral reef ecosystems.
1. Four SST buoys were replaced to extend the continuous temperature records for another year. Thirteen STRs were replaced and 10 other STRs were placed at new sites. One ODP was replaced, one was recovered, and its replacement was installed at a different location. The NWHI oceanographic observing system was augmented by new wave tide recorders at four locations to measure wave heights.

2. Four CREWS buoys were planned for deployment to replace buoys at existing sites. However, these buoys stopped telemetering data ashore a few days after departing Honolulu. The manufacturer was contacted but was unable to resolve the problem remotely. The existing buoys were left in place and their anchoring systems were refurbished to replace worn hardware. At Midway the nonfunctional CREWS buoys were off-loaded and repaired while the *Sette* was at Pearl and Hermes and Kure Atolls. The PIFSC Marine Debris team on the M/V *American Islander* was trained to replace the buoys and conducted that operation on their transit to Honolulu.

- E. Deploy array settlement plates at the base of the CREWS, ODP, and SST moorings to examine temporal and spatial variability of benthic settlement along the Hawaiian Archipelago.

Settlement plates were recovered and new plates installed at seven locations. The recovered plates will be analyzed upon their return to Honolulu.

- F. Deploy satellite-tracked surface drifters to evaluate the role of ocean currents in larval transport and recruitment along the archipelago.

Six drifters were deployed along the archipelago at sites chosen as likely sources of larval dispersion.

- G. A small collection of reef fishes will be collected at French Frigate Shoals, Pearl and Hermes Atoll, and Midway Atoll to examine population differences among species along the archipelago.

A total of 390 samples of damselfish and wrasses were collected for otolith work back ashore after the cruise. The trace element composition of these otoliths of these will be assayed for signatures of the planktonic environment during larval development. Water samples for trace element chemistry were collected on the forereefs of French Frigate Shoals, Pearl and Hermes Atoll, and Midway Atoll. A lagoonal water sample also was collected at Midway.

- H. Determine the existence of threats to the health of these coral reef resources from anthropogenic sources, including marine debris.

In addition to the monitoring activities described above, surveys were conducted at each station to quantify and further characterize coral disease. During this survey, evidence of coral disease was found at very low levels at 68.5% of the sites across all regions. The most common disease was *Porites* trematodiasis caused by the digenetic trematode, *Podocotyloides stenometra* (Aeby 1998). This disease was widespread (57.5% of the sites) and is known to exclusively affect *Porites* sp. coral. Numerous other conditions were also observed but at much lower frequency of occurrence (1.4% - 16.4% of the sites). The majority of the observed disease signs were distinct from what has been previously described from other coral reef systems. Numbers of colonies affected by *Porites*

trematodiasis were not enumerated, but other types of conditions were found to be present at low levels. The overall average prevalence of disease (# diseased colonies/total # colonies) was estimated at 0.5% (range 0-7.1%). A disease outbreak at one site at French Frigate Shoals resulted in massive tissue on large acroporid table corals.

- I. Survey the 100-fathom isobath surrounding Pearl and Hermes Atoll and Kure Atoll using the multibeam sonar onboard the AHI.

Multibeam surveys of the 100-fathom isobath were not conducted because the R/V AHI was not able to be deployed at Pearl and Hermes Atoll and Kure Atoll. Instead a multibeam survey of Midway Atoll was performed as noted above.

- J. Survey submerged cultural artifacts in the vicinity of Kure and Pearl and Hermes Atolls and Midway Island as time permits.

As noted above, the planned surveys of Pearl and Hermes Atoll and Kure Atoll could not be conducted. Several submerged cultural artifacts were tentatively located at Midway Atoll.

**SCIENTIFIC
PERSONNEL:**

Scott Ferguson, Chief Scientist, Mapping Team, Joint Institute for Marine and Atmospheric Research (JIMAR), University of Hawaii (UH), Pacific Islands Fisheries Science Center (PIFSC), Coral Reef Ecosystem Division (CRED)

Stephani Holzwarth, Acting Chief Scientist, Mooring Team, JIMAR, UH, PIFSC, CRED
Ed DeMartini, PhD, Fish Team, National Marine Fisheries Service (NMFS), Pacific Islands Fisheries Science Center (PIFSC)

Mark Albins, Fish Team, JIMAR, UH, PIFSC, CRED

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Scott Godwin, Benthic Team - Invertebrates, Bishop Museum

Kim Page, Benthic Team - Algae, JIMAR, UH, PIFSC, CRED

Jon Winsley, Benthic Team - Algae, JIMAR, UH, PIFSC, CRED

Joe Laughlin, Towboard Team - Fish, JIMAR, UH, PIFSC, CRED

Brian Greene, Towboard Team - Fish, JIMAR, UH, PIFSC, CRED

Joe Chojnacki, Towboard Team - Habitat, JIMAR, UH, PIFSC, CRED

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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
Acoustic Doppler Current Profile (ADCP) data
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
Still Photos of the seafloor from TOAD operations
QTC benthic acoustic signature data
EK60 mid-water acoustic signature data
Conductivity, temperature, and depth (CTD) profiles to 500 m
High-resolution multibeam bathymetry and acoustic imagery data collected at Midway

(/s/J. Scott Ferguson)

Submitted by: _____
J. Scott Ferguson
Chief Scientist

(/s/Samuel G. Pooley)

Approved by: _____
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Attachments

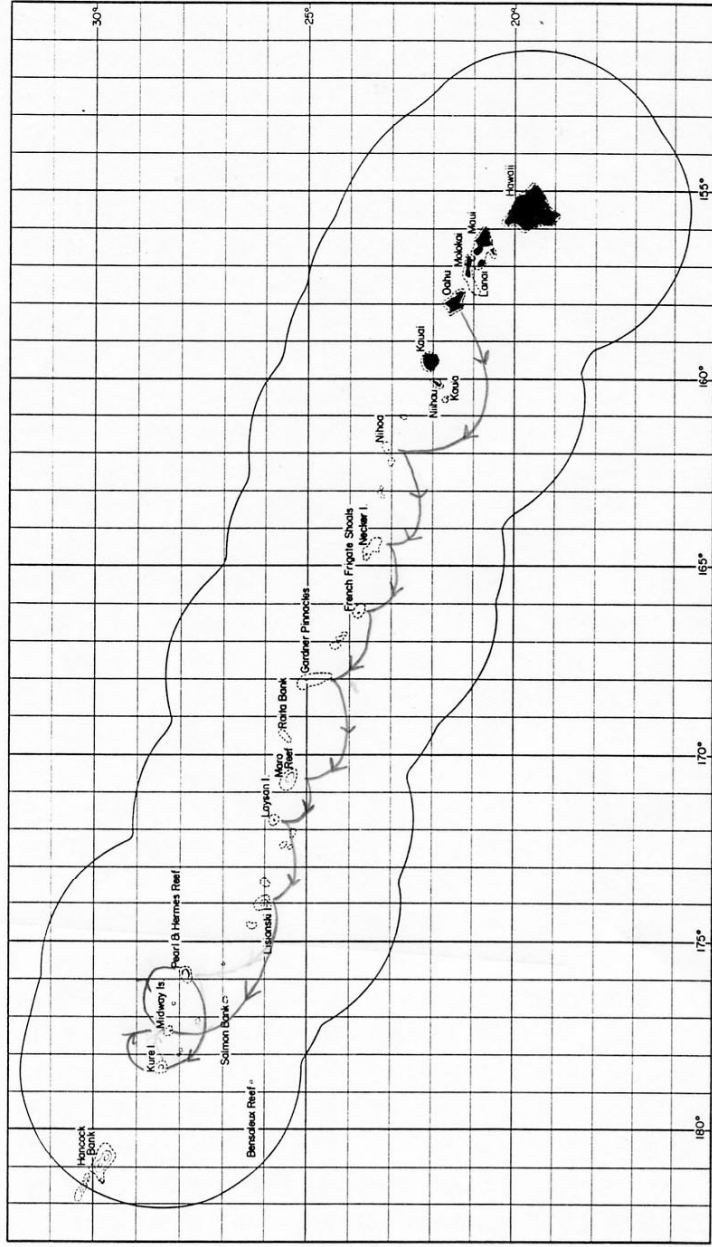


Figure 1.--Track of the NOAA ship Oscar Elton Sette OES-03-06 (OES-07), July 12 to August 17, 2003.

Appendix A: **Fish REA Team Activity Summary** (*Ed DeMartini, Steve Cotton, Mark Albins*)

A. Methods

Fish survey methods followed the same protocols that have been used during the period from 2000 to the present in the NWHI. At each station, fish surveys comprised three 25-m long (by 2- and 4-m wide) belt transects for fish less than and greater than 20-cm total length, plus four 312 sq. m stationary point counts (SPCs) at each station for the most mobile and largest-bodied species. All observations were used to generate station-specific species lists.

B. Results

1. Necker Island and French Frigate Shoals (FFS)

The Fish REA Team completed all scheduled fish monitoring surveys at Necker (three stations) and at FFS (nine stations). One species--the Indo-Pacific fangblenny, *Plagiotremus rhynorhynchus*--was observed for the first time in the NWHI at a forereef station near Disappearing Island, FFS, where it co-occurred with two endemic congeners (*P. ewaensis*, *P. goslinei*). Skin lesions on the endemic goldring surgeonfish (*Ctenochaetus strigosus*), observed on the 2000-02 cruises farther upchain in the NWHI, were noted for the first time (at a fraction of a percent incidence) at both on Necker and FFS. On the last day at FFS, @ 50 recruits total of 10 species of damselfishes and wrasses were collected for otolith work back ashore after the cruise. The latter work entails (1) characterization of planktonic larval durations based on growth increments prior to the settlement check and (2) analyses of trace element composition and concentration.

2. Gardner Pinnacles, Maro Reef, Laysan Island and Lisianski Island

The Fish REA Team completed all scheduled fish monitoring surveys at Gardner Pinnacles (three stations), Maro Reef (nine stations), Laysan Island (three stations), and Lisianski Island-Neva Shoal (nine stations). Data were unremarkable except for several new sightings for the NWHI Reef Assessment and Monitoring Program (NOWRAMP) cruise series: a memorable encounter with a wahoo or "ono" (*Acanthocybium solandri*) at Gardner; and a first-ever observation of the white-cheeked surgeonfish *Acanthurus nigricans* (formerly *A. glaucopareius*) on NWHI Fish REA surveys, notably at the far western end of Maro Reef. (A single *A. nigricans* was videographed on a towboard survey at FFS in 2002.) Skin lesions were noted on several individuals of the endemic goldring surgeonfish (*Ctenochaetus strigosus*) at Maro Reef. A sizeable percentage (probably >1%) of the *C. strigosus* population had lesions at one SE station on Neva Shoal. A nesting colony of two congeners (*Abudefduf abdominalis*, *A. vaigiensis*) was also observed at SE Neva Shoal. This is a noteworthy finding because the widely distributed Indo-Pacific species (*vaigiensis*) has been observed on Hawaiian reefs only since the early 1990s, and in places in both the MHI and the NWHI it has recently become more abundant than the Hawaiian endemic (*abdominalis*) species.

3. Midway Atoll, Pearl and Hermes Reef and Kure Atoll

The Fish REA Team completed all scheduled fish monitoring surveys at Pearl and Hermes (PHR), Kure (KUR), and Midway (MID) Atolls. These were: PHR (nine stations, three each on forereef, backreef, and lagoonal patch reefs); KUR (nine stations, as at PHR); and MID (nine stations, as at PHR and KUR). Thus, a grand total of 63 Fish REA stations were surveyed at the 9 NWHI reefs visited on cruise OES03-06.

No goldring surgeonfish (*Ctenochaetus strigosus*) individuals with epidermal lesions were encountered at any of the three atolls even though the species was patchily abundant at most stations visited.

Observations at the three atolls confirmed the spatially general extent of heavy reef fish recruitment throughout the NWHI in 2003. Large numbers of recruits were observed for many species, including likely long-lived species with usually low and sporadic or episodic recruitment such as the blacktail wrasse *Thalassoma ballieui* and the Hawaiian hogfish *Bodianus bilunulatus*. Even young knifejaws (both spotted *Oplegnathus punctatus* and banded *O. fasciatus*) were encountered.

Another 2 days and 1 day at PHR and MID, respectively, were spent collecting recently recruited damselfish and wrasses. About 190 individuals total of 2 damselfish and 5 wrasse species were collected from the backreef and shallow patch reefs at PHR; about 150 individuals total of 4 damselfishes and 3 wrasses were collected at MID. As explained in prior Fish REA Summary Reports, the trace element composition of the otoliths of these specimens will be assayed for signatures of the planktonic environment during larval development. Water samples for trace element chemistry were collected on the forereefs of PHR and MID, as previously at FFS. A lagoonal water sample also was collected at MID.

Dive Ops and Nav metadata for at least the first 60 (out of 63, see below) Fish REA stations were entered onto the data archive. Fish REA data collected by Mark Albins (MAA) and Steve Cotton (SPC) through the first six (of nine) stations at MID—i.e., through August 6--were put on a CD. Files of Ed DeMartini's (EED) Fish REA data collected thru August 5th (Stationary Point Counts at KUR) and July 19th (belt transects at Gardner Pinnacles) were also put on this CD. File names identified the observer by a 3-letter acronym and type of survey data (BELT=belt transect; SPC=Stationary Point Count). Due to time constraints, all data entry ceased on August 7; hence, the files do not include the last three Fish REA stations surveyed at MID on August 8. Ed DeMartini gave the CD containing all of the Fish REA files to Sunny Bak on August 7. All fish biological files will be updated through completion of sampling (and error-checked and corrected) by Ed DeMartini by 1 month post cruise; Ed DeMartini will transfer the updated, comprehensive OES03-06 fish biological files to the data archive at that time.

Appendix B: Coral REA Team Activity Summary (*Jean Kenyon, Greta Aeby, Jake Asher*)

A. Methods

Two 25-m transect lines previously laid out by the fish team were videotaped. The videotapes were archived for later analysis to quantify coral coverage and provide a permanent record of the condition of the benthos. One of the two 25-m transect lines were surveyed for coral colonies by size class. All corals whose colony center fall within 1 m on either side of the transect line were enumerated and placed into one of 7 size classes: <5 cm, 5-10, 10-20, 20-40, 40-80, 80-160, and >160 cm. In addition, surveys were conducted along the two transect lines to document incidence of coral bleaching and/or disease.

B. Results

1. Necker Island

07/14/2003: Surveys were conducted at 3 sites around Necker Island by the benthic team on July 14, 2003, including surveys by coral biologists, Dr. Jean Kenyon and Dr. Greta Aeby. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites. Due to sea conditions, however, only 2 of the candidate sites could be visited, and the third site was a previously-unsurveyed area that could be dived under ambient conditions. Site/dive depths ranged from 37 to 43 ft.

Kenyon videotaped the benthos along the two 25-m transects and enumerated coral colonies by size class. Aeby surveyed along the two transect lines for the incidence of bleaching and/or disease.

The habitats at all three sites can be characterized as pavement with <10% coral. A total anthozoan fauna of 11 species was enumerated, with *Porites lobata* and *Pocillopora meandrina* as the most abundant species.

2. French Frigate Shoals

Surveys were conducted at 12 sites around French Frigate Shoals by the benthic team from July 15, 2003 to July 18, 2003, including surveys by coral biologists, Dr. Jean Kenyon and Dr. Greta Aeby. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites.

07/15/2003: Three sites were surveyed (TC-H6, TC-21, TC22b). Depths ranged from 26 to 30 ft (taped depth) and 35 to 43 ft (maximum dive depths). Kenyon videotaped the benthos along two 25-m transect lines previously laid out by the fish team for TC-H6 and TC-21, followed by categorizing all corals by size class. Aeby surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites.

The habitat at TC-H6 was categorized as a spur and groove site with sand channels containing live coral growth. Coral cover was estimated at approximately 35%. A total (anthozoan fauna) of 10 species was recorded, with *Porites lobata* and *Acropora* as the most abundant species examined.

The habitat at TC-21 was categorized as a spur and groove site with sand channels, with coral cover estimated at 80%. A total (anthozoan fauna) of seven species were recorded, with *Acropora* and *Porites lobata* constituting the majority of coral cover.

The habitat at TC22b was categorized as linear reefs and rubble fields, with coral cover estimated at <1%. A total (anthozoan fauna) of nine species were recorded, with *Pocillopora damicornis* and *Cyphastrea ocellina* constituting the most abundant species.

07/16/2003: Three sites were surveyed (OES-1-03, TC32, R19-02). Depths ranged from 30 to 35 ft (maximum dive depths). No video transects were conducted. Aeby surveyed one 25-m transect lines per site previously laid out by the fish team, categorizing all corals into size classes. Aeby also surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites.

The habitat at OES-1-03 was categorized as patch reefs in sand channels, with coral cover estimated at 50%. A total (anthozoan fauna) of seven species were recorded, with *Porites lobata* and *Porites evermanni* constituting the most abundant species.

The habitat at TC32 was categorized as patch reefs, with coral cover estimated at 30%. A total (anthozoan fauna) of 15 species were recorded, with *Porites lobata* and *Porites evermanni* constituting the most abundant species.

A total (anthozoan fauna) of 13 species were recorded at R19-02, with *Porites lobata* and *Pavona duerdeni* being the most abundant species.

07/17/2003: Three sites were surveyed (TC12, R2-02, OES-2-03). Dive depths ranged from 30 to 37 ft (maximum dive depths). No video transects were recorded. Aeby surveyed one 25-m transect line categorizing all coral into size classes. Aeby also surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites.

The habitat at TC12 was categorized as 95% coral cover with *Acropora* constituting the predominant genus (no other coral genera recorded). *A. cytherea* corals on this reef had both tumors and tissue loss consistent with white plague.

The habitat at R2-02 was categorized as rocky, sediment covered patch reefs surrounded by sand, with coral cover estimated at 40%. A total (anthozoan fauna) of seven species were recorded, with *Porites lobata* and *Pavona duerdeni* being the most abundant species.

The habitat at OES-2-03 was categorized as spurs and grooves, with < 1% coral cover. A total (anthozoan fauna) of nine species were recorded, with *Porites lobata*, *Porites evermanni* and *Pocillopora damicornis* being the most abundant species.

07/18/2003: Three sites were surveyed (R3-02, TC23, TC30). Dive depths ranged from 5 to 18 ft (maximum dive depths). No video transects were recorded. Aeby surveyed one 25-m transect line categorizing all corals by size class. Aeby also surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites.

The habitat at R3-02 was categorized as backreefs composed of rubble and sand, with coral cover estimated at ~1%. A total (anthozoan fauna) of five species were recorded, with *Porites compressa* being the most abundant species.

The habitat at TC23 was categorized as lagoonal *Porites* patch reefs, with coral cover estimated at 95%. A total (anthozoan fauna) of six species were recorded, with *Porites lobata* and *Porites compressa* being the most abundant species.

The habitat at TC30 was categorized as lagoonal *Acropora* mixed patch reefs, with coral cover estimated at 60%. A total (anthozoan fauna) of seven species were recorded, with *P. lobata* dominant.

3. Gardner Pinnacles

7/19/03: three sites surveyed; Aeby surveyed one 25-m transect line categorizing all corals by size class. Aeby also surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites.

R4-02: max. depth 64 ft; est. coral <5%; flat algae covered area, strong current, lots of sharks, *P. lobata* dominant but small encrusting colonies; seven species of hard coral and one specie of zoanthid.

R2-02: max. depth 40 ft; est. coral cover 20%; boulder field; *Acanthaster* predation on Pocilloporids; small encrusting colonies of *P. lobata* dominant; five species of hard coral and one specie of zoanthid.

R3-02: max. depth 50 ft; est. coral cover <5%; at base of pinnacle; huge boulder field; dominated by small colonies of encrusting *P. lobata*; nine species of hard coral, one specie of soft coral and one specie of zoanthid.

4. Maro Reef

Surveys were conducted at nine sites around Maro Reef by the benthic team from July 20 to July 22, including surveys by coral biologist Dr. Greta Aeby. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites.

07/20/03: Maro Reef; Three sites were surveyed (R1-02, R2-02, R4-02). Dive depths ranged from 30 to 37 ft. No video transects were conducted. Aeby surveyed one 25-m transect line categorizing all corals by size class Aeby also surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites.

R1-02 was categorized as patch reefs, with 40% coral cover. A total (anthozoan fauna) of eight species were recorded, with *Montipora capitata*, *Cyphastrea ocellina* and *Porites evermanni* being the most abundant species. R2-02 was categorized as patch reefs, with an estimated 65-70% coral cover. A total (anthozoan fauna) of seven species were recorded, with *Porites lobata*, *Porites evermanni* and *Pavona duerdeni* being the most abundant species. R4-02 was categorized as patch reefs, with an estimated 70-80% coral cover. A total (anthozoan fauna) of six species were recorded, with *Porites compressa* and *Porites lobata* being the most abundant species.

07/21/03: Maro Reef. Three sites were surveyed (R5-02, R8-02, R1-00). Dive depths ranged from 37 to 40 ft. No video transects were conducted. Aeby surveyed one 25-m transect line categorizing all corals by size class. Aeby also surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites. R5-02 was categorized as patch reefs, with an estimated 80% coral cover. A total (anthozoan fauna) of 10 species were recorded, with *Porites lobata* and *Montipora capitata* being the most abundant species. R8-02 was categorized as patch reefs, with an estimated 60% coral cover. A total (anthozoan fauna) of nine species were recorded, with *Porites compressa* and *Porites lobata* being the most abundant species. R1-00 was categorized as patch reefs, with an estimated 85% coral cover. A total (anthozoan fauna) of 12 species were recorded, with *Pocillopora meandrina* and *Porites lobata* being the most abundant species.

07/22/03: Maro Reef. Three sites were surveyed (TC-8, TC-6, TC-22). Dive depths ranged from 18 to 35 ft. No video transects were conducted. Aeby surveyed one 25-m transect line categorizing all corals by size class. Aeby also surveyed along the two transect lines for the incidence of bleaching and/or disease along all three sites. TC-8 was categorized as patch reefs containing lots of coral rubble and coral cement, with an estimated 60% coral cover. A total (anthozoan fauna) of 11 species were recorded, with *Pocillopora damicornis* and *Porites compressa* being the most abundant species. TC-6 was categorized as patch reefs, with an estimated 65% coral cover. A total (anthozoan fauna) of seven species were recorded, with *Porites lobata* and *Porites compressa* being the most abundant species. TC-22 was categorized as oceanic patch reefs, with an estimated 70% coral cover. A total (anthozoan fauna) of 10 species were recorded, with *Montipora capitata* and *Porites lobata* being the most abundant species.

5. Laysan Island

7/23/03: Surveys were conducted at three sites (TC-5, R6, R3-02) around Laysan by the benthic team on July 23, 2003, including surveys by coral biologist, Dr. Greta Aeby and Marine Debris Specialist, Jake Asher. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites. Site and dive depths ranged from 40 to 50 ft.

Jake Asher videotaped the benthos along two 25-m transect lines previously laid out by the fish team at each site. Aeby surveyed one 25-m transect line categorizing all corals by size class. Aeby surveyed along the two transect lines for the incidence of bleaching and/or disease, while Asher provided assistance in collecting samples.

TC5: depth 48 ft; est. coral 5%; rocky formations; a lot of Pocilloporids half dead and covered with coralline algae; black triggerfish, *Stegastes*, *C. multicinctus*, *C. ornatissimus*, coral zits, huge schools of manini (*A. strigosus?*); *P. meandrina* dominant; nine species of hard coral.

R3-02: depth 48 ft; est. coral 30%; huge boulders with sandy patches between; blue-green algae on *Porites*; SW corner of island; lots of coral zits; *P. lobata* dominant; eight species of hard coral and one specie of zoanthid.

R6-02: depth 40 ft; est. coral 30% rocky area; blue-green algae on *Porites*; *Stegastes*, *C. multinctus*, coral zits, NW corner of island; *P. lobata* dominant; 11 species of hard coral.

6. Lisianski Island

Surveys were conducted at nine sites around Lisianski by the benthic team from July 24, 2003 through July 26, 2003, including surveys by coral biologist, Dr. Greta Aeby and Marine Debris Specialist, Jake Asher. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites. Overall site and dive depths ranged from 30 to 50 ft.

07/24/2003: Three sites were surveyed (TC-10, R10-02, R7-02). Jake Asher videotaped the benthos along two 25-m transect lines previously laid out by the fish team for each individual site. Aeby surveyed one 25-m transect line categorizing all corals by size class. Finally, Aeby surveyed along the 2 transect lines for the incidence of bleaching and/or disease, while Asher provided assistance in collecting samples.

R10-02: max. depth 44 ft; est. coral 75%; large old colonies of *Porites evermanni*, *P. evermanni* and *P. compressa* dominant; 15 species of hard coral.

TC-10: max. depth 44 ft; est. coral 90% *P. compressa* reef, murky water, coral zits, 15 species of hard coral; a lot of small coral recruits on dead areas of *P. compressa*

R7-02: max. depth 56 ft; patch reef, est. coral cover 90%; *P. compressa* & *P. evermanni* dominant; coral zits, nine species of hard coral.

07/25/2003: Operations at primary sites selected for operations were suspended due to high wind and sea conditions. Three alternative sites were surveyed (R16-02, OES1-03, OES2-03). A battery problem with the video camera prevented taping at the subsequent sites (OES1-03, OES2-03). Aeby surveyed one 25-m transect line categorizing all corals by size class. Dr. Aeby continued to categorize coral colonies and document incidence of bleaching and/or disease.

OES1-03: max. depth 56 ft; est. coral 50%, patch reef, murky water, *P. evermanni* dominant; coral zits; 14 species of hard coral.

R16-02: max. depth 47 ft; est. coral 0% ; transect was laid on sand; patch reef dominated by *P. evermanni* was at the end of transect 2. No video transects were conducted at this location.

OES2-03: max. depth 35 ft; est. coral 40%; *P. evermanni* dominant; a lot of sediment stress evident on *P. lobata*; coral zits; 12 species of hard coral.

07/26/03: Three sites were surveyed (RH-02, TC-12, R9-02). Jake Asher videotaped the benthos along two 25-m transect lines at each site previously laid out by the fish team at each site. Aeby surveyed one 25-m transect line categorizing all corals by size class. Aeby surveyed along the two transect lines for the incidence of bleaching and/or disease, while Asher provided assistance in collecting samples.

TC12: max. depth 40 ft; est. coral 20%; spur and groove; *P. lobata* dominant; *Acanthaster* predation, coral zits, nine species of hard coral

R14-02: max. depth 40 ft; est. coral 65%; *P. lobata* dominant; spur and groove, good visibility; coral zits; nine species of hard coral.

R9-02: max. depth 51 ft; est. coral 25%; canyons; *P. lobata* dominant; 12 species of hard coral.

7. Midway

July 28, 2003: Surveys were conducted at three sites (TC-2, TCH-10, R5-02) around Midway by the benthic team on July 28, 2003, including surveys by coral biologist, Dr. Greta Aeby and Marine Debris Specialist, Jake Asher. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites. Maximum dive depths ranged from 43 to 53 ft. Maximum dive depths ranged from 52 to 59 ft.

TC-2 was a forereef site along the eastern edge of the main channel leading into Midway harbor. The predominant habitat was composed of sand flats with patch reefs consisting of mostly algae and coral cement, with transect depths varying from 36 to 38 ft. Coral cover was estimated at < 1%. A total (anthozoan fauna) of three species were recorded, with *Porites lobata* and *Pocillopora ligulata* constituting the majority of coral cover.

TCH-10 was a forereef site located in the southwest near the southwestern edge of the atoll. The predominant habitat was composed of spurs and grooves (coral cement) interspersed with sand channels, with transect depths varying from 33 to 41 ft. Coral cover was estimated at < 1%. A total (anthozoan fauna) of four species were recorded, with *Porites lobata* and *Palythoa* constituting the majority of coral cover.

R5-02 was a forereef site located in the southern portion of the atoll facing the far end of the main runway. The predominant habitat was composed of spurs and grooves (coral cement) interspersed with sand channels, with transect depths varying from 41 to 43 ft. Coral cover was estimated at < 1%. A total (anthozoan fauna) of five species were recorded, with *Porites* constituting the majority of coral cover.

Surveys were conducted at nine sites (TC-3b, R13-02, TCH-11, R1-02, R18-02, R22-02, August 8 dive sites) around Midway by the benthic team from August 6 to August 8, 2003, including surveys by coral biologist, Dr. Greta Aeby and Marine Debris Specialist, Jake Asher. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites. Maximum dive depths ranged from 43 to 53 ft.

August 6, 2003: Maximum dive depths ranged from 9 to 30 ft.

TC-3b was a patch reef site composed of two small, isolated reef islets within sand flats adjacent to the recently deployed SST buoy. Transect depths varied from 29 to 30 ft, with coral cover estimated at < 1%. A total (anthozoan fauna) of five species were recorded, with *Porites compressa* constituting the majority of coral cover.

R13-02 was a patch reef site with transect depths varying from 5 to 7 ft. Coral cover was estimated at <1%. A total (anthozoan fauna) of four species were recorded with *Pocillopora damicornis* constituting the majority of coral cover.

TCH-11 was a patch reef site largely covered with algae. Transect depths varied from 14 to 15 feet, with coral cover estimated at <5%. A total (anthozoan fauna) of 2 species were recorded, with *Pocillopora meandrina* constituting the majority of coral cover.

August 7, 2003: Maximum dive depths ranged from the surface to 58 ft.

R1-02 was a spur and groove forereef site with transect depths varying from 37 to 47 ft. Coral cover was estimated at <1%. A total (anthozoan fauna) of two species were recorded, with *Porites lobata* constituting the majority of coral cover.

R18-02 was a back reef site with transect depths located near the surface (no depth registration on depth gauge). Coral cover was estimated at 10%. A total (anthozoan fauna) of four species was recorded, with *Porites lobata* constituting the majority of coral cover.

R22-02 was a back reef site with transect depths varying between 3-4 ft. A total (anthozoan fauna) of four species were recorded, with *Porites lobata* constituting the majority of coral cover.

Information regarding the last three dive sites visited on August 8 are not transcribed within this document. Information regarding species diversity, site details, etc. can be found within the data forms collected by Dr. Greta Aeby.

8. Pearl and Hermes

Surveys were conducted at 15 sites (R15-02, TC26, TC24) around Pearl and Hermes by the benthic team from July 29 to August 2, 2003, including surveys by coral biologist, Dr. Greta Aeby and Marine Debris Specialist, Jake Asher. Candidate sites (aside from one additional site adjacent to SE Island) were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites.

07/29/03: Maximum dive depths ranged from 6 to 61 ft.

R15-02 was a forereef site located in the northwestern section of Pearl and Hermes. The predominant habitat was composed of spurs with deep grooves, with transect depths varying from 38 to 47 ft. Coral cover was estimated at < 1%. A total (anthozoan fauna) of five species were recorded, with *Porites lobata* constituting the majority of coral cover.

TC26 was a back reef site located in the northeastern section of Pearl and Hermes in the vicinity of the engine block. The predominant habitat was Montiporid back reef, with transect depths varying from 4 to 6 ft. Coral cover was estimated at 30%. A total

(anthozoan fauna) of six species were recorded, with *Montipora capitata* and *Montipora flabellata* constituting the majority of coral cover.

TC24 was located in a section intermediate between TC26 and R15-02. The predominant habitat was a large patch reef with a vertical drop off to the transect sites, which varied in depth from 19 to 36 ft. Coral cover was estimated at < 5%. A total (anthozoan fauna) of four species were recorded, with *Porites compressa* constituting the majority of coral cover.

07/30/03: Maximum dive depths ranged from 16 to 57 ft.

R20-02 was a spur and groove forereef site located in the northwest. Transect depths varied between 48-52 ft, with coral cover estimated at 40%. A total (anthozoan fauna) of seven species were recorded, with *Porites lobata* constituting the majority of coral cover.

R22-00 was a back reef site composed of a series of patch reefs of mostly coral cement. Transect depths varied between 7-10 ft, with coral cover estimated at 20%. A total (anthozoan fauna) of nine species were recorded, with *Porites lobata* and *Montipora capitata* constituting the majority of coral cover.

TC-23 was a lagoonal reef site composed of a large patch reef with a vertical drop off to the transect lines, which varied in depth from 16 to 30 ft. Coral cover was estimated at < 1%. A total (anthozoan fauna) of seven species were recorded, with *Porites lobata* constituting the majority of coral cover.

07/31/03: Maximum dive depths ranged from 9 to 59 ft.

R2-02 was a southeastern forereef site composed of a series of patch reefs interspersed with sand channels. Transect depths varied between 38-48 ft, with coral cover estimated at 10%. A total (anthozoan fauna) of eight species were recorded, with *Porites lobata* constituting the majority of coral cover.

R7-02 was a southeastern *P. compressa* patch reef site found inside of the atoll adjacent to the eastern sand flats. Transect depths varied between 32-36 ft, with coral cover estimated at 95%. A total (anthozoan fauna) of one species was recorded, with *Porites compressa* constituting the majority of coral cover.

R-8-02 was a back reef site composed of mostly coral cement along the eastern edge of Pearl and Hermes. Transect depths varied between 3-4 ft, with coral cover estimated at 20%. A total (anthozoan fauna) of four species were recorded, with *Pocillopora meandrina* and *Pocillopora damicornis* constituting the majority of coral cover.

08/01/03: Maximum dive depths ranged from 3 to 44 ft.

OES-01-03 (new addition) was a predominantly flat forereef site near the western corner of Southeast Island composed of mostly coral cement and algae. Transect depths varied

between 36-39 feet, with coral cover estimated at <1%. A total (anthozoan fauna) of three species were recorded, with *Porites lobata* constituting the majority of coral cover.

TC22 was a back reef site located in the vicinity of the southern islets. Transect depths varied between 2-3 ft, with coral cover estimated at <1%. A total (anthozoan fauna) of six species were recorded, with *Pocillopora meandrina* constituting the majority of coral cover.

TC30 was a back reef site located in the vicinity of Seal Kittery (east side). Transect depths varied between 4-7 ft, with coral cover estimated at <5%. A total (anthozoan fauna) of four species were recorded, with *Pocillopora meandrina* constituting the majority of coral cover.

08/02/03: Maximum dive depths ranged from 27 to 55 ft.

R18-02 was a forereef site composed of low relief reef flats (low spurs and grooves) located in the proximity the western edge of Seal Kittery. Transect depths varied between 48-52 ft, with coral cover estimated at 20%. A total (anthozoan fauna) of seven species were recorded, with *Pocillopora meandrina* constituting the majority of coral cover.

TC31 was a back reef site composed of Montiporid patch reefs along the west side of Pearl and Hermes. Transect depths varied between 18-22 ft, with coral cover estimated at 50%. A total (anthozoan fauna) of three species were recorded, with *Montipora capitata* and *Montipora flabellate* constituting the majority of coral cover.

TC32 was a patch reef site also located in the western portion of Pearl and Hermes. Transect depths varied between 15-26 ft, with coral cover estimated at 40%. A total (anthozoan fauna) of seven species were recorded, with *Pocillopora meandrina* constituting the majority of coral cover.

9. Kure

Surveys were conducted at nine sites (R15-02, TC26, TC24) around Kure by the benthic team from August 3 to August 6, 2003, including surveys by coral biologist, Dr. Greta Aeby and Marine Debris Specialist, Jake Asher. Candidate sites were chosen from a pool of sites surveyed previously by scientists onboard the NOAA ship *Townsend Cromwell* and/or the *Rapture*, with the additional criterion of being appropriate long-term monitoring sites.

08/03/03: Maximum dive depths ranged from 5 to 49 ft.

TC-12-02 was a forereef habitat composed of spurs and grooves/reef flats with deep interspersed sand channels. Transect depths varied from 33 to 36 ft, with coral cover estimated at 10%. A total (anthozoan fauna) of six species were recorded, with *Porites lobata* constituting the majority of coral cover.

R-7-02 was a forereef habitat composed of mid-relief spurs and droves. Transect depths varied from 48 to 49 ft, with coral cover estimated at 50%. A total (anthozoan fauna) of five species were recorded, with *Pocillopora meandrina* constituting the majority of coral cover.

TC-17 was a back reef/patch reef site located in the western region of Kure. Transect depths varied from 3 to 5 ft, with coral cover estimated at 15%. However, there were a series of *Montipora* beds (*M. capitata* and *M. flabellata*) immediately adjacent to the second transect which contained >80% coral cover. A total (anthozoan fauna) of eight species were recorded (for the transects), with *Pocillopora damicornis* and *Porites lobata* constituting the majority of coral cover.

08/04/03: Maximum dive depths ranged from 7 to 56 ft.

TC 2-00 was a forereef site composed of spurs and grooves interspersed with deep sand channels. Transect depths varied from 36 to 46 ft, with coral cover estimated at 45%. A total (anthozoan fauna) of five species were recorded, with *Pocillopora meandrina* and *Porites lobata* constituting the majority of coral cover.

TC-18-02 was a *compressa* patch reef site bordered by deeper sand flats. Transect depths varied from 19 to 22 ft, with coral cover estimated at 80%. A total (anthozoan fauna) of three species were recorded, with *Porites compressa* constituting the majority of coral cover.

TC-9-00 was a patch reef site largely composed of coral cement and algal cover. Transect depths varied from 12 to 18 ft, with coral cover estimated at <1%. A total (anthozoan fauna) of two species were recorded, with *Pocillopora meandrina* and *Pocillopora damicornis* constituting the majority of coral cover.

R-10-02 was a back reef site which was highlighted as one of the main areas of bleaching for Kure in the previous years. Transect depths varied from 4 to 7 ft, with coral cover estimated at 25%. A total (anthozoan fauna) of nine species were recorded, with *Pocillopora meandrina*, *Pocillopora damicornis* and *Montipora flabellata* constituting the majority of coral cover. Following completion of the transect surveys, additional snorkel assessments revealed areas of *Montipora capitata* previously highlighted from prior-year surveys. New/additional waypoints were recorded by Greta Aeby.

08/05/03: Maximum dive depths ranged from 8 to 15 ft.

TC14 was a back reef site that was predominantly flat with large coral patches. Transect depths varied from 4 to 5 ft, with coral cover estimated at 30%. A total (anthozoan fauna) of seven species were recorded, with *Porites lobata* constituting the majority of coral cover.

R-9-02 was a patch reef site mainly composed of coral cement interspersed with algae. Transect depths varied from 10 to 11 ft, with coral cover estimated at 15%. A total

(anthozoan fauna) of three species were recorded, with *Pocillopora meandrina* constituting the majority of coral cover.

Appendix C: Algal REA Team Activity Summary (*Kimberly Page and Jon Winsley*)

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

The number of sites and photoquadrats for the nine areas surveyed are shown below .

	# sites visited	# quadrats photographed and sampled
1. Necker Island	1	12
2. French Frigate Shoals	12	144
3. Gardner Pinnacles	3	30*
4. Maro Reef	9	108
5. Laysan Island	3	36
6. Lisianski Island	9	108
7. Midway Island	11	132
8. Pearl and Hermes Reef	15	180
9. Kure Atoll	9	108

* One site had only one transect

1. Necker Island

	% of quads sampled containing alga	Rank of alga *
Turf	100	4.38
<i>Halimeda velasquezii</i>	100	3.84
<i>Laurencia</i> sp.	16.67	0.31
<i>Martensia</i> sp.	8.33	0.25
Blue-green	33.33	0.92

R6-00: Site was dominated by turf and *Halimeda velasquezii* and different blue-green species. Pavement type substratum with *Pocillopora meandrina* heads as well as a couple *Palythoa*. In addition to turf and *Halimeda velasquezii*, a species of *Laurencia* sp. was seen in one of the photoquads. In the random swim a *Martensia* sp., *Caulerpa webbiana*, *Dasya irredescens* and *Halychrysis* sp. were found. The depth ranged from 30 to 40 ft.

2. French Frigate Shoals

	% of quads sampled containing alga	Rank of alga*
Turf	84.03	4.06
<i>Halimeda velasquezii</i>	45.14	1.54
<i>Halimeda discoidea</i>	2.78	0.10
<i>Microdictyon</i> <i>setchellianum</i>	27.78	1.07
Crustose coralline	33.33	1.32
<i>Laurencia</i> sp.	4.86	0.15
Branched coralline	6.94	0.23
<i>Halimeda</i> sp.	4.17	0.15
Blue-green cyanobacteria	2.08	0.06
<i>Neomeris</i> sp.	0.69	0.03
<i>Laurencia parvipapillata</i>	2.78	0.08
<i>Liagora</i> spp.	2.08	0.06
Brown encrusting algae	6.25	0.25
<i>Turbinaria ornata</i>	4.17	0.10
<i>Dasya iredescens</i>	1.39	0.03
<i>Haloplegma duperreyi</i>	0.69	0.02
<i>Lobophora</i> sp.	16.67	0.49
<i>Caulerpa racemosa</i>	1.39	0.04
<i>Predaea</i> sp.	0.69	0.03
<i>Padina</i> sp.	2.08	0.05
<i>Bryopsis</i> sp.	0.69	0.01
<i>Peyssonnelia</i> sp.	2.08	0.08
<i>Dictysphaeria versluysii</i>	1.39	0.03

H6: Forereef site with spur and groove pattern dominated by *Porites lobata* for corals and *Halimeda velasquezii* for algae. Site had high relief with many overhangs with red crustose coralline and *Haloplegma* sp. living under. Depth ranged from 30 to 40 ft. Three species of *Halimeda* were found. *H. velasquezii*, *H. discoidea*, and *H. distorta*.

TC 21: Slight spur and groove (backreef) with *Acropora cytherea* as the dominant overall substrate; also, there was a high diversity of other corals including *Porites lobata*. Dominate alga was *Halimeda velasquezii*. In addition, *Turbinaria ornata*, *Neomeris* sp., *Caulerpa webbiana*, *C. taxifolia*, *Hallymenia*, *Haloplegma*, and *Halimeda distorta* were also seen and collected from the site. Average depth was 35 ft.

TC 22: Coral rubble linear patch reef within the lagoon. Reef was dominated by turf algae and *Microdictyon setchellianum*. There was also a common occurrence of *Ganonema* or *Liagora* sp. Very large *Mastophora rosea* were also common at the site. Depth was < 10 ft.

R19-02: This site was located on the eastern side of La Perouse pinnacle. The site was composed of very rugged topography with high diversity of corals and algae. What is

believed to be *Acrosymphyton brainardii* was found at the site and photographed. There were also many other “gooey” reds that were collected as well as *Caulerpa racemosa*, *C. webbianna*, *Asparagopsis taxiformis*, *Turbinaria ornate*. Although site was very diverse, photos were mostly composed of turf algae and *Porites lobata*. Depth 25 ft.

TC-32-02: Site was composed of coral rubble and *Porites compressa*. This was the back side of last year’s “Arc shell” reef. It had a very high abundance of *Microdictyon setchellianum* and *Halimeda velasquezii*. Other algae seen were *Dasya irredescens*, *Haloplegma* sp. *Hallychrysis coelestis*, and at least three different species of *Halimeda*.

OES-01-03: Lagoonal patch reef dominated by *Porites lobata*, turf algae, *Microdictyon setchellianum*, and crustose coralline algae. Also common was a brown encrusting alga which was most likely *Lobophora*. *Caulerpa webbianna*, *C. taxifolia*, *Halimeda gracilis*, *H. discoidea*, *Hallymenia* sp., *Haloplegma* sp., *Martensia* sp. were among the macrophytes seen and collected from this site. Depths ranged from 20 to 30 ft.

OES-02-02: Forereef site on the south east corner of FFS north of Disappearing Island. This site was composed of coral rubble and crustose coralline pavement with very little relief. There was little coral cover and high abundances of turf algae and *Microdictyon setchellianum*. The depth was ~ 30 ft.

R2-02: Patch reef in the southern part of the lagoon. This reef was very unique with *Pavona duerdini* as the dominating substrate. There was a high biomass of algae at this site with dominance of *Halimeda velasquezii*, *Lobophora variegata*, and a what is believed to be *Kallymenia* sp. (A thin bladed red gelatinous alga with holes in the blade). *Halimeda discoidea*, *Microdictyon setchellianum*, and *Gibsmithia hawaiiensis* were collected during the random swim. Depth was between 20-25 ft.

TC 12: Forereef area on the southern edge of the atoll. This site is referred to as the *Acropora* gardens. Very beautiful *Acropora cytherae* in high abundance and dominating benthic cover. Algae on transect was only turf and crustose coralline. In the random swim however, *Microdictyon*, *Caulerpa taxifolia*, *Gibsmithia hawaiiensis*, *Dicyosphaeria cavernosa*, *Dasya irredescens*, and *Haloplegma duerdinni* were collected and recorded. Depth was approximated at 35 ft.

R-03-02: Back reef area on the northeast of French Frigate Shoals. This site was composed primarily of coral rubble with turf algae and a few *Porites lobata* heads as well as a single large *Acropora*. *Halimeda velasquezii* was commonly seen as well as *Microdictyon setchellianum*. *Caulerpa serrulata* and a Liagoroid were found on the random swim. Depth was less than 10 ft.

TC 23-f: Patch reef just south west of Trig Island. This was a large patch reef similar to reefs inside Pearl and Hermes. It was dominated by both *Porites compressa* and *Porites lobata* with crustose coralline in between all of the fingers. A very high abundance of crustose coralline was observed with many red turf species including *Laurencia parvipapillata* and a species of *Dasya*. Depths ranged from 5 to 20 ft.

TC-30: Linear patch reef with many sand channels located near CREWS buoy. *Halimeda velasquezii* was the dominant alga at this *Acropora cytherae* and *Porites lobata* reef. Also very common was a relatively large and robust *Laurencia*. During the random swim, *Turbinaria ornata*, *Caulerpa webbianna*, *C. taxifolia*, *Haloplegma duerdeni*, and *Dasya irredescens* were found and collected. Depths ranged from 18 to 25 ft.

3. Gardner Pinnacles

	% of quads sampled containing alga	Rank of alga*
<i>Microdictyon setchellianum</i>	83.33	3.70
Blue-green cyanobacteria	70.00	2.37
Turf	46.67	2.27
<i>Halimeda velasquezii</i>	66.67	2.17
<i>Padina</i> spp.	30.00	0.90
Crustose coralline	10.00	0.40
Branched coralline	3.33	0.10
<i>Peyssonnelia</i> sp.	3.33	0.07

R-2-02: *Microdictyon setchellianum* and turf dominated the reef with very little coral cover. Topography of the reef was flat with a few boulders scattered about. Very large lobsters were seen as well as a highly abundant hydroid. In addition to *M. setchellianum*, *Halimeda velasquezii* and either a *Padina* sp. or *Stypopodium* sp. was seen commonly in the photoquadrats. *Dictyosphaeria cavernosa* was collected outside of the quadrats. The depth averaged at 50 ft.

R-4-02: This site was similarly dominated by *Microdictyon setchellianum*. In addition this site had a very abundant beige stringy blue-green algae that was epiphytic on the *M. setchellianum*. *Halimeda velasquezii* and the same *Padina* or *Stypopodium* sp. as site R-2-02. Two different Liagoroid species were also collected. This site was a 60-foot flat bedrock type site with very strong current.

R-3-02: Very interesting site with a combination of a bedrock/*Microdictyon* field and a boulder field, located on the south west fringe of Gardner. *Microdictyon setchellianum*, crustose coralline, and the stringy beige blue-green algae were the dominant algae in the photoquad. In shallower depths a *Laurencia* sp. and *Padina* (or *Sypopodium* sp.) were dominant. *Halimeda velasquezii*, *Dictyosphaeria cavernosa*, *Sargassum* sp., *Predaea* sp., *Jania* sp., *Caulerpa webbiana* were collected on the random swim. The depth ranged from 20 to 50 ft.

4. Maro Reef

	% of quads containing alga	Rank of alga*
Turf	84.259	3.722
Crustose coralline	57.407	2.435
<i>Laurencia</i> sp.	52.778	1.806
<i>Halimeda velasquezii</i>	45.370	1.352

	% of quads containing alga	Rank of alga*
<i>Halimeda</i> spp.	37.037	1.074
Branched coralline	16.667	0.657
Encrusted Brown	7.407	0.287
Blue-green cyanobacteria	7.407	0.213
Liagaroid	5.556	0.204
<i>Caulerpa webbiana</i>	6.481	0.130
<i>Hallymenia</i> sp.	4.630	0.111
<i>Gibsmithia hawaiiensis</i>	4.630	0.060
<i>Neomeris</i> sp.	3.704	0.056
<i>Martensia</i> sp.	1.852	0.056
<i>Laurencia parvipapalata</i>	0.926	0.046
<i>Chrysemenia</i> sp.	1.852	0.046
<i>Dictyosphaeria versluysii</i>	1.852	0.037
<i>Haloplegma duperreyei</i>	0.926	0.028
<i>Lobophora</i> sp.	0.926	0.028
<i>Caulerpa racemosa</i>	0.926	0.028
<i>Dictyosphaeria Cavernosa</i>	0.926	0.028
<i>Dasya irredescens</i>	0.926	0.019
<i>Predaea</i> sp.	0.926	0.019
<i>Bryopsis</i> sp.	0.926	0.009
<i>Codium</i> sp.	0.926	0.009
<i>Halimeda discoidea</i>	0.926	0.005

R-1-02, R-2-02, and R-4-02: Similar linear patch reefs in the southern section of Maro. These reefs were composed of mostly *Porites lobata* and *P. compressa*. All reefs visited had a very high diversity and abundance of algae. A robust *Laurencia* sp. was very common along with *Halimeda velasquezii* and another *Halimeda* sp. Branched coralline was also very common and particularly abundant at R-4-02. *Padina* sp., *Ulva* sp., *Halichrysis coelestis*, *Portiera hornemanni*, *Haloplegma* sp., *Gracilaria* sp., *Liagora* sp., *Hallymenia* were among the algae collected during the random swim. Depth ranged from 30 to 50 ft.

R-8-02: Patch reef with pinnacles going from 60 to 13 feet. This reef had an extremely abundant and diverse algal community. Large *Halimeda* sp. plants were abundant as well as a red blade with holes in it (either a *Hallymenia* or a *Kallymenia* sp.). Crustose and branching coralline algae were common as well as a *Laurencia* sp. and *Halimeda velasquezii*. *Caulerpa taxifolia*, *C. webbiana*, *C. racemosa*, *Haloplegma* sp., *Bryopsis* sp., *Portiera hornemanni*, and *Gibsmithia hawaiiensis* were also collected at this site.

R-5-02: (Recall Reef) This reef was a very beautiful patch reef with many overhangs near an area of exposed rock with high wave action. It was composed of *Porites lobata* and *Montipora* sp. and coralline red algae as well as turf algae. A large school of Galapagos sharks were also present. There was a diverse algal community although not

as abundant as R-8-02. *Martensia* sp, *Predaea weldii*, *Gibsmithia hawaiiensis*, *Caulerpa webbianna*, *Haloplegma* sp., *Portieri hornemanni*, *Hallychrysis*, and *Halimeda* sp. were collected from off the transect.

R-1-00: This site seemed to have high coral diversity with many different species of *Acropora*. In the photoquadrats, *Halimeda velasquezii*, turf, and crustose coralline were most abundant. However, there were many other plants seen and collected. One of particular interest that was collected is *Scinaia huismanii*. This species has just recently been described as a new species by Dr. Peter Vroom. Others seen are as follows: *Predaea weldii*, *Gibsmithia hawaiiensis*, *Dictyosphaeria cavernosa*, *Dictyota* sp., *Bryopsis* sp., and *Chrysemenia* sp.

TC-8: Lagoon patch reef with pinnacles reaching from 30 to 15 ft. The reef was composed of *Porites compressa* and *P. lobata*. In the sand channels below the reef there were large patches of *Halimeda* sp. in monotypic stands. Crustose coralline, turf, and blue-green algae were seen commonly in the photoquads along with *Halimeda velasquezii* and *Halimeda* sp. A small *Gibsmithia* sp. was also seen frequently. *Vanvoorstia* sp., *Caulerpa webbiana*, *C. racemosa*, *Hallymenia* sp., and *Dasya irredescens* were all collected during the random swim.

TC-6: Lagoon patch reef with coral rubble fields and *Porites lobata* and *P. compressa* patches. This reef had *Porites compressa* rubble with turf and coralline algae covering. *Laurencia* sp. and *Liagora* spp. were common on the rubble as well as *Halimeda* sp. During the random swim, *Hypnea* sp., *Caulerpa webbianna*, *Martensia*, and a couple of unknown reds were collected.

TC-22: Patch near edge of lagoon. Reef was composed of high coral diversity with *Montipora* spp., *Porites* spp, and *Pocillopora* spp. A large robust *Laurencia* sp. that is believed to be the same as those earlier was very abundant. *Laurencia parvipapillata*, *Halimeda velasquezii*, *Halimeda* sp., *Neomeris* sp., *Padina* sp., *Liagora* sp., *Caulerpa webbiana*, *C. taxifolia*, and an interesting brown alga were additionally collected from this site.

5. Laysan Island

	% of quads containing alga	Rank of alga*
Turf	88.889	4.167
<i>Halimeda velasquezii</i>	88.889	2.667
<i>Microdityon setchellianum</i>	55.556	2.125
Crustose coralline	47.222	1.778
<i>Laurencia</i> sp.	30.556	0.750
Branched coralline	8.333	0.278
<i>Mastophora rosea</i>	5.556	0.194
Blue-green cyanobacteria	5.556	0.139
Liagaroid	2.778	0.111
<i>Peyssonnelia</i> sp.	2.778	0.083

	% of quads containing alga	Rank of alga*
<i>Gibsmithia hawaiiensis</i>	5.556	0.056
<i>Martensia</i> sp.	2.778	0.056
<i>Padina</i> sp.	2.778	0.028
<i>Galaxara</i> sp.	2.778	0.028

TC-05: Northwest side of Laysan Island. This site consisted of a boulder field with *Pocillopora meandrina* heads among turf algae and crustose coralline algae. *Halimeda velasquezii* and *Laurencia* sp. were commonly seen in the photoquads. Also seen and collected were *Galaxura* sp. (relatively abundant), *Portieri hornemanni*, *Gibsmithia hawaiiensis*, *Martensia* sp., *Liagora* sp., and *Haloplegma* sp..

R-06-02 and R-3-02: Near island reefs on the southern side of Laysan. These reefs both had a medium level of relief with *Porites lobata* and *Pocillopora meandrina* common. Crustose coralline and branched coralline species were common including *Mastophora rosea* and *Peyssonelia* sp. at R-6-02. *Microdictyon setchellianum* was also very abundant and covered with epiphytes. *Halimeda velasquezii*, *Gibsmithia hawaiiensis* and *Galaxura* sp. were also commonly seen. In the random swim, *Turbinaria ornata*, *Halimeda discoidea*, *Sargassum* sp., *Dasya irredescens*, *Chrysemenia* sp., *Haloplegma* sp., *Laurencia* sp., *Padina* and *Liagora* sp. were collected.

6. Lisianski Island

	% of quads containing alga	Rank of alga*
Turf	87.963	4.000
<i>Halimeda velasquezii</i>	62.037	1.898
Crustose coralline	48.148	1.861
<i>Microdictyon setchellianum</i>	37.037	1.361
<i>Halimeda</i> sp.	22.222	0.694
Branched coralline	18.519	0.574
Blue-green cyanobacteria	15.741	0.565
<i>Neomeris</i> sp.	11.111	0.287
<i>Dictyosphaeria versluysii</i>	11.111	0.208
<i>Hallymenia</i> sp.	10.185	0.199
<i>Caulerpa webbiana</i>	5.556	0.130
<i>Asparagopsis taxiformis</i>	4.630	0.093
Encrusted Brown	2.778	0.065
<i>Dasya irredescens</i>	1.852	0.065
<i>Haloplegma</i> sp.	1.852	0.046
<i>Chrysemenia</i> sp.	1.852	0.023
<i>Halimeda discoidea</i>	0.926	0.028
<i>Laurencia</i> sp.	0.926	0.037

	% of quads containing alga	Rank of alga*
<i>Dictyosphaeria cavernosa</i>	0.926	0.009
<i>Martensia</i> sp.	0.926	0.009
<i>Halimeda distorta</i>	0.926	0.009
<i>Bryopsis</i> sp.	0.926	0.028
<i>Portieri hornemanni</i>	0.926	0.019
<i>Amphiroa</i> sp.	0.926	0.019

TC-10: This was a lagoonal reef that was predominantly *Porites compressa* on the first transect and predominantly a *Montipora* sp. reef on the second transect. *Halimeda* sp. and *Halimeda velasquezii*, and *Neomeris* sp. were common along the transect. *Halimeda discoidea*, *Martensia* sp., *Chrysemenia* sp., *Bryopsis* sp., *Dasya irredescens*, *Dictyosphaeria cavernosa*, *Caulerpa webbiana*, and *Hallymenia* sp. were additionally collected. The depth was between 30-45 ft.

R-10-02: This site was very similar to TC-10 and composed primarily of *Montipora* and *Porites* spp. *Halimeda velasquezii*, *Dictyosphaeria cavernosa*, and *Neomeris* sp. were commonly seen along the transect. In the random swim, *Halimeda discoidea*, *Haloplegma* sp., *Hallymenia* sp., and *Dictyota* sp. were collected.

R-7-02: This site had a unusually high abundance of *Neomeris* sp., *Dictyosphaeria cavernosa* and *Caulerpa webbiana*. Also, a high abundance of *Halimeda* spp. *Microdictyon setchellianum* was present but not dominant. *Dasya irredescens*, *Martensia* sp., *Caulerpa taxifolia*, and *Hallymenia* sp. were also collected at the site.

R-16-02: The transect were put on a sand patch near the reef rather than the reef itself, therefore the photos from the first site were not characteristic of the reef. However, samples were collected in the random swim on the reef. This reef was composed of *Porites* sp. covered with a fine layer of blue-green algae. *Halimeda* spp. was very common and abundant as well as *Microdictyon setchellianum*, *Asparagopsis taxiformis*, and a very interesting *Liagora* sp. that was pressed. Also seen and collected was *Gibsmithia hawaiiensis*, *Dictyosphaeria versluisii*, and *Laurencia* sp.. The depth at this site ranged from 35 to 48 ft.

OES-1-03: Lagoonal patch reef with high relief composed primarily of *Porites* sp. In the photoquadrats, crustose coralline, *Halimeda velasquezii*, *Asparagopsis taxiformis*, *Hallymenia* sp., *Microdictyon setchellianum*, *Dictyosphaeria versluisii* were present. Also found from the random swim was *Caulerpa webbiana*, *Neomeris* sp., and *Haloplegma*. The depth at this site ranged from 30 to 60 ft.

OES-2-03: Lagoonal patch reef with medium relief and poor visibility. There was heavy siltation on most benthic organisms. There was a high abundance of *Halimeda* spp. (*Halimeda velasquezii* and another more prostrate species). *Asparagopsis taxiformis*, *Hallymenia* sp., *Microdictyon setchellianum*, *Chrysemenia* sp, crustose coralline, branched coralline, were also common. *Caulerpa webbiana*, *Dasya irredescens*,

Martensia sp., and *Gibsmithia hawaiiensis* were found at this site as well. The depth at this site ranged from 25 to 40 ft.

Lisianski R-14-02: (7/26/03)

This was a reef on the northern section of Lisianski NW of the island. It had medium relief dominated by *Porites lobata* and *P. compressa*. *Halimeda velasquezii* and *Microdictyon setchellianum* were the dominant macrophytes present. *Chrysemenia* sp., *Hallymenia* sp., *Portieria hornemanni*, *Martensia* sp., *Neomeris* sp., *Liagora* sp., *Amphiroa* sp., and different *Halimeda* sp. were seen and collected from this site. The depth ranged from 40 to 46 ft with a deeper sand portion ~ 60 feet.

TC-12: Patch reef area near breaking reef on the southwest side of the Island. This site was dominated by *Microdictyon setchellianum*, upright branched coralline, and *Halimeda velasquezii*. Also seen in the photoquads at this site were crustose coralline and another species of *Halimeda*. In addition, *Caulerpa webbiana*, *Asparagopsis taxiformis*, *Haloplegma duperreyi*, *Halimeda discoidea*, *Martensia* sp., *Neomeris* sp., *Dictyosphaeria versluysii*, *Portiera hornemanni*, and *Chrysemenia* sp. were seen. The depth ranged from 25 to 35 ft.

R-9-02: This site was SW of the island, a patch reef of sorts. It had high relief and a mild current. The dominant macrophytes were *Microdictyon setchellianum* and *Halimeda* spp. (*Halimeda velasquezii* and *Halimeda opuntia* ??). Branched and crustose coralline were also very common. *Caulerpa taxifolia*, *Laurencia parvipapillata*, *Haloplegma duperreyi*, *Neomeris* sp., *Halimeda* sp. and *Portieria hornemanni* were additionally collected from the site. The depth of the site ranged from 23 to 42 ft with deep channels and caves.

7. Midway Atoll

TC-2: Forereef site just east of the southern channel entrance. Last year this site was remarkable due to the abundance of *Dictyota* sp. This year however the *Dictyota* sp. seemed to have been exchanged for *Trichlogloea* sp. and a *Trichleocarpa* sp. The photoquads were predominately sand, turf algae, and *Microdictyon setchellianum*. However, in the random swim, *Padina* sp., *Dictyosphaeria cavernosa*, *Dasya* sp., *Halimeda velasquezii*, *Laurencia* sp., and *Neomeris* sp. were collected. This site had little relief and was in ~40 ft of water.

H-10: Forereef site on the central west side of Midway. This site was scoured pavement with high vertical relief and hundreds of urchins. The photoquads were dominated by turf algae along with crustose coralline algae. *Microdictyon setchellianum*, *Laurencia* sp., *Halimeda velasquezii*, *Padina* sp., and *Lobophora* sp. were also seen in the quadrat area. In the random swim, *Turbinaria ornata*, *Stypopodium* sp., *Lobophora* sp., *Galaxura* sp., *Hallymenia* sp., *Dictyota* spp., *Trichleocarpa* sp., *Peyssonnelia* sp., *Haloplegma duperreyi*, and *Portieria hornemanni* were seen and/or collected. This site had medium high vertical relief with depth ranging from 35 to 43 ft.

R-05-02: Forereef site on the south central barrier reef. Very few macrophytes were seen in the photoquadrat area. The dominant for the photo was turf algae and a brown encrusting alga which might be *Lobophora* sp. Additionally, *Dictyota* sp., *Dictyosphaeria versluysii*, and a very small *Codium* sp. were also seen in the quadrat area. In the random swim, *Caulerpa racemosa*, *C. serrulata*, *Galaxura* sp., *Gracilaria* sp., and *Hallymenia* sp. were also seen and collected. This site had little relief with depth ranging from 37 to 43 ft.

TC-3b: This site is one of Jim Maragos's permanent study sites. It is consisted of two small patches just north of Eastern Island. There is also a mooring at this site. The reef is a dead *Porites compressa* reef with turf algae, *Microdictyon* sp., *Halimeda velasquezii*, *Dictyosphaeria versluysii*, *Lobophora* sp., and crustose coralline algae as the dominant algal community. *Caulerpa racemosa* and *C. serrulata* were also seen in the photoquad area. During the random swim, *Trichleogloea* sp., *Dasya* sp., and *Halimeda discoidea* were collected. The depth of the site ranged from 18 to 30 ft. Transects were placed partly on sand this year; next year it would be preferable to wrap them around the patch reef.

R-13-02: This was a shallow *Pocillopora* sp. patch reef (6-10 ft) near the large western pass. This site had high abundance and diversity of algae. Turf algae and *Laurencia galtsoffii* were the most prevalent however, *Dictyota* sp., *Dictyosphaeria versluysii*, *Microdictyon setchellianum*, *Dasya iridescens*, *Hydroclathrus* sp., *Asparagopsis taxiformis*, *Padina* sp., and *Lobophora* sp. were also seen in the photoquad area. *Trichleogloea* sp. and *Trichleocarpa* sp. were collected as well during the random swim.

TC-H11: This was a large patch reef in Whales Harbor that was dominated by *Pocillopora meandrina* and *Padina* sp. There were large rosettes of *Padina* sp. as well as large stands of *Turbinaria ornate* (although none were in the photoquadrat area). In the photoquadrat area, two species of *Padina* were seen, *Microdictyon setchellianum*, *Lobophora* sp., a blue-green cyanobacteria, crustose coralline, and *Dictyosphaeria versluysii*. *Dictyota* sp., *Boodlea* sp., *Codium* sp., *Dasya* sp., *Halimeda velasquezii*, *Caulerpa serrulata*, *Trichleocarpa* sp., and *Liagora* sp. were also collected from the site. The depth of this site ranged from 14 to 18 ft.

R-18-02: This was a shallow snorkel site on the southeast back reef of Midway Atoll. It was dominated by a few *Porites lobata* coral heads with turf algae, *Padina* sp., and *Laurencia galtsoffii* as the dominant algal substrate. *Microdictyon setchellianum*, *Dictyosphaeria cavernosa*, crustose coralline algae, *Dictyota* sp., *Hydroclathrus* sp., *Sargassum* sp., and an encrusting brown alga (possibly *Lobophora* sp.) were also seen in the photoquadrat area. During the random swim, *Tricleogloea* sp., *Turbinaria ornata*, *Dictyosphaeria versluysii*, and two species of *Liagora* were also collected.

R-22-02: This was a surgy, shallow back reef site on the southwest side of Midway. It was composed of pavement covered in turf algae with scattered heads of *Porites lobata*. Turf algae and an encrusting brown alga (possibly *Lobophora* sp.) were the dominant algal substrate. *Laurencia galtsoffii*, *Turbinaria ornata*, crustose coralline algae, *Dictyota* sp., and blue-green cyanobacteria were seen in the photoquadrat area. During the random

swim, *Dasya* sp., *Liagora* sp., *Caulerpa racemosa*, *Turbinaria ornata*, *Laurencia parvipapillata*, and *Hallymenia* sp. were collected.

To be completed: Three more back reef sites will be visited TC H-21, TC-1, and TC H14f. All three sites are back reef sites both TC H-21 and TC-1 are on the north back reef and TC-14f is on the southwest of the back reef.

8. Pearl and Hermes Atoll

	% of quads containing alga	Rank of alga*
Turf	92.778	4.311
<i>Microdityon setchellianum</i>	60.000	2.500
Crustose coralline	40.000	1.456
<i>Halimeda velasquezii</i>	40.000	1.175
<i>Laurencia galtsoffii</i>	15.000	0.467
<i>Halimeda discoidea</i>	13.333	0.394
Encrusted Brown	12.778	0.339
Blue-green cyanobacteria	8.889	0.311
<i>Halimeda</i> sp.	9.444	0.308
<i>Dictyosphaeria versluysii</i>	8.889	0.194
<i>Padina</i> sp.	6.111	0.189
Branched coralline	4.444	0.128
<i>Laurencia</i> sp.	4.444	0.117
<i>Dictyosphaeria cavernosa</i>	4.444	0.092
<i>Liagora</i> sp.	2.222	0.042
<i>Turbinaria ornata</i>	1.667	0.031
<i>Dictyota</i> sp.	1.667	0.022
<i>Laurencia parvipapillata</i>	1.111	0.022
<i>Lobophora</i> sp.	1.111	0.022
<i>Galaxura</i> sp.	0.556	0.022
<i>Neomeris</i> sp.	1.111	0.017
<i>Martensia</i> sp.	0.556	0.017
<i>Codium arabicum</i>	0.556	0.017
<i>Dasya irredescens</i>	0.556	0.011
<i>Caulerpa racemosa</i>	0.556	0.011
<i>Portieri hornemanni</i>	0.556	0.011

R-15-02: Forereef site on the North NW side of Pearl and Hermes Atoll. This reef had very high relief with caves and caverns throughout and depths ranging from 40 to 65 ft. The substrate was dominated by crustose coralline algae, turf, and *Halimeda velasquezii* with very little coral. In addition, *Dictyosphaeria cavernosa*, *D. versluysii*, *Caulerpa racemosa*, and *Portieria hornemanni* were seen in the photoquads. During the random swim, *Caulerpa serrulata*, *Halimeda* spp. (including *H. discoidea*), *Codium arabicum*, *Haloplegma* sp., *Chrysemenia* sp., *Dictyota* spp., *Hallymenia* sp., and what is believed to

be *Codium hawaiiensis* (A new species of *Codium* that has just recently been described by Dr. Isabella Abbott.

TC-26: This is a back reef site on the northwest side of Pearl and Hermes Atoll just north of the engine block. This reef represented the high amount of bleaching of the *Montipora* spp. that occurred last year. The dominant macrophyte was *Laurencia galtsoffii*. Also abundantly seen were *Microdictyon setchellianum*, *Halimeda velasquezii*, *Halimeda discoidea*, *Dictyosphaeria cavernosa*, and an unknown *Halimeda* sp.. In addition, *Codium arabicum*, *Laurencia parvipapillata*, *Caulerpa serrulata*, *Lobophora* sp., *Neomeris* sp., and *Turbinaria ornata* were seen at this sight. The depth ranged from 3 to 10 ft deep.

TC-24: This was the “Halimeda wonderland” site. At least four different species of *Halimeda* were all very abundant at the NW patch reef in Pearl and Hermes. Also seen and collected were a very fragile *Martensia* sp., a hairy *Galaxura* sp., *Laurencia galtsoffii*, *Dictyosphaeria cavernosa*, and *Hallymenia* sp. Many of the plants had a fine silt covering the blade; it may be difficult to analyze the photos. The depth ranged from 7 to 40 ft.

R-20-02: This was a forereef site located on the central west side of the atoll with depths ranging from 45 to 55 ft deep. This reef had a spur and groove topography with *Porites lobata* as the dominant coral. For algae, the reef was dominated by crustose coralline algae and *Halimeda* spp. (*Halimeda velasquezii*, *Halimeda discoidea*, and possibly two other species. *Dictyosphaeria cavernosa*, *Microdictyon setchellianum*, and *Haloplegma dupperayi* were also found at this site.

R-22-00: This was a back reef site on the west side of the atoll in depths ranging from 5 to 20 ft. There were large areas of sand and rubble with coral heads (*Porites lobata* and *P. compressa*) interspersed. Crustose coralline, turf algae, *Halimeda velasquezii*, *H. discoidea*, and *Laurencia galtsoffii* were the most common species seen in the photoquads. *Microdictyon setchellianum*, an encrusting brown alga, *Turbibaria ornata*, *Dictyota* sp., *Dictyosphaeria versluisii*, and *Laurencia parvipapillata*. *Caulerpa* sp., *Codium arabicum*, *Dasya iredescens*, and *Neomeris* sp. were collected on the random swim.

TC-23: This site is a patch reef on the west side of the lagoon and was the “*Codium* reef” from 2002. However, the transects were put on the opposite side of the patch reef where the dominant alga was *Halimeda* spp. rather than *Codium*. The *Codium* section of the reef was found on the north and west facing side of the patch reef. However, the slope of the area surveyed had very high abundance of *Halimeda* spp. covered in blue-green cyanobacteria. The shallow flat was dominated by turf algae, crustose coralline, *Laurencia galtsoffii*, and *Halimeda velasquezii*. Also collected and/ or seen from this site was *Padina* sp., *Hallymenia* sp., *Neomeris* sp., *Caulerpa webbiana*, *C. serrulata*, *C. racemosa*, *Hallychrysis coelestis*, *Turbinaria ornata*, *Dasya iredescens*, *Codium arabicum*, and the abundant species of *Codium* reported from the 2002 cruise.

R-2-02: This was a forereef site on the east side of Pearl and Hermes dominated by coral rubble with *Microdictyon setchellianum* and turf. Also seen in the quadrats were *Halimeda velasquezii*, *H. discoidea*, *Laurencia* sp., crustose coralline algae, and an encrusting brown alga. In the random swim, *Liagora* sp., *Neomeris* sp., *Dictyosphaeria cavernosa*, and *Trichleocarpa* sp. were seen and collected. The depth at this site ranged from 40 to 50 ft.

R-7-02: This was a typical “maze” patch reef with a *Porites compressa* slope and a coral rubble and blue-green algae ridge. There were no macrophytes in the photos which were taken in 30-40 ft, only turf algae and blue-green algae. However in the shallower water on the random swim, *Caulerpa racemosa*, *C. webbiana*, *Dictyosphaeria versluysii*, *Dasya* sp., *Microdictyon setchellianum*, *Laurencia galtsoffi*, *Halimeda* sp, and *H. discoidea* were collected.

R-8-02: This dive was on the back reef on the east side of the atoll. It is characterized by sand and coral rubble with *Microdictyon setchellianum*, turf, and *Pocillopora meandrina* as the dominant substrate. In addition to *M. setchellianum*, *Halimeda velasquezii*, *Dictyosphaeria cavernosa*, *D. versluysii*, and *Laurencia* sp. were seen in the quotes. During the random swim, a fine and fragile, branched coralline possibly *Neogoniolithon* sp. was found as well as *Liagora* sp., *Turbinaria ornata*, *Halimeda discoidea*, *Lobophora variegata*, and *Laurencia galtsoffi*. The depth was ~5 ft.

OES-01-03: This forereef site was located on the west side of SE Island. The dominant substrate was coral rubble covered in *Microdictyon setchellianum* and turf algae. In addition to *M. setchellianum*, *Dictyosphaeria cavernosa*, *D. versluysii*, *Halimeda velasquezii*, *H. discoidea*, and an encrusting brown alga (possibly *Lobophora* sp.) were seen in the esphotoquads. On the random swim, *Dasya iridescens*, *Laurencia galtsoffi*, and *Chrysemenia* sp. were also seen and collected. The depth at this site ranged from 35 to 40 ft; very nice fish on this dive.

TC-22: TC-22 is a very nice back reef site with coral rubble covered with *Microdictyon setchellianum* and turf as well as many scattered Liagoroid specimen which unfortunately did not make it into the photoquads. *M. setchellianum*, *Dictyosphaeria versluysii* and crustose coralline algae were documented with the photoquads. On the random swim, there were many caves and ledges with a large diversity of algae. *Hallychysis* sp., *Liagora* sp., *Halimeda velasquezii*, *Turbinaria ornate*, *Laurencia galtsoffi*, *Dasya iridescens*, *Caulerpa racemosa*, *C. webbiana*, *Bryopsis* sp., *Dictyota* sp., *Codium* sp., *Dictyosphaeria cavernosa*, and *Dasya* sp. were all seen and collected from this site. Average depth was 5 ft.

TC-30: This was a very surgy back reef dominated by dead *Pocillopora meandrina* covered with very sharp, branched coralline algae (possibly *Neogoniolithon* sp.) and coral rubble, covered in *Microdictyon setchellianum* and turf. In the photoquads, *M. setchellianum* along with *Laurencia galtsoffi*, *Laurencia* sp, *Dictyosphaeria versluysii*, and *Halimeda discoidea* were seen. During the random swim, *Liagora* sp., *Caulerpa serrulata* var. *spiralis*, *Dictyosphaeria cavernosa*, *Lobophora* sp., and *Dasya iridescens* were collected. Average depth was 5 ft.

R-18-02: This was a forereef site off from Seal Kittery Island with low relief. The substrate was dominated by *Pocillopora meandrina* heads as well as coral rubble covered with turf algae and *Microdictyon setchellianum*. In addition to *M. setchellianum*, there was *Halimeda velasquezii*, *H. discoidea*, *Dictyosphaeria versluysii*, *Liagora* sp., *Neomeris* sp., and crustose coralline algae seen in the photoquads. During the random swim, *Liagora* sp., *Halimeda* sp., *Hypnea* sp., and *Dasya* sp. were collected. Although the algae on this dive were less than spectacular, this was an amazing dive. A tiger shark, monk seal, and a sailfish were seen; a dive to remember. The depth ranged from 45 to 50 ft.

TC-31: This was a patch reef near the back reef on the southwest side of PHR. This site had heavy bleached *Montipora* spp. on the 2002 cruise. The dominant substrate was turf algae along with crustose coralline and *Microdictyon setchellianum*. *Dictyosphaeria versluysii*, *Halimeda discoidea*, and *Liagora* sp. were also seen in the photoquads. During the random swim, *Caulerpa serrulata*, *Halimeda discoidea*, *H. velasquezii*, *Padina* sp., *Liagora* sp., and *Hallychrysis coelestis* were seen and collected. The depth of this diver ranged from 10 to 30 ft.

TC-32: This was a patch reef north of Seal Kittery Island and was dominated with *Pocillopora meandrina*, *Microdictyon setchellianum*, and turf algae. Also, *Padina* sp. *Halimeda discoidea* and *Laurencia galtsoffii* were also seen in the photos. The highlight of this dive was the find of *Halophila* sp. There was a rather large meadow of seagrass at this site. Also in shallower water there were more species of plants, including *Dasya iridescens*, *Padina* sp., *Liagora* sp., *Lobophora* sp., and *Caulerpa serrulata*. The depth of the transect was between 19-26 ft with the seagrass bed in ~40 ft of water.

8. Kure Atoll

	% of quads sampled containing alga	Rank of alga
Turf	84.259	3.546
<i>Microdictyon setchellianum</i>	74.074	2.981
<i>Padina</i> sp.	60.185	2.079
Crustose coralline	39.815	1.218
<i>Sargassum</i> sp.	12.963	0.519
<i>Dictyota</i> sp.	19.444	0.472
<i>Laurencia galtsoffii</i>	14.815	0.380
Blue-green cyanobacteria	13.889	0.333
<i>Halimeda discoidea</i>	10.185	0.234
<i>Codium</i> sp.	9.259	0.222
<i>Dictyosphaeria versluysii</i>	10.185	0.220
Encrusted Brown	10.185	0.213
<i>Laurencia</i> sp.	10.185	0.185
<i>Turbinaria ornata</i>	6.481	0.176
<i>Dictyosphaeria Caverosa</i>	5.556	0.130

	% of quads sampled containing alga	Rank of alga
Branched coralline	3.704	0.065
<i>Lobophora</i> sp.	4.630	0.060
<i>Liagora</i> sp.	2.778	0.047
<i>Laurencia parvipapillata</i>	1.852	0.037
<i>Hydroclathrus</i> sp.	0.926	0.037
<i>Halimeda</i> sp.	0.926	0.009
<i>Dasya</i> sp.	0.926	0.009

TC-12-02: This site had a spur and groove forereef with deep and wide sand channels. The substrate was dominated by coral rubble covered with *Padina* sp. *Microdictyon setchellianum*, *Codium* sp., *Laurencia* sp., and an encrusting brown algae were also seen in the photoquads. During the random swim, *Caulerpa racemosa*, *Portieria hornemanni*, *Turbinaria ornata*, *Lobophora variegata*, *Codium arabicum*, *Haloplegma duperreyi*, and *Dictyosphaeria cavernosa* were also seen and collected. The depths at this site ranged from 30 to 40 ft.

R-7-02: This site is a forereef site west of the pass. This site had murky water and high relief with the depth ranging from 44 to 57 ft. The substrate was dominated by *Pocillopora* sp. and *Microdictyon setchellianum* as well as *Padina* sp. and an abundant prostrate *Codium* sp. (possibly *C. arabicum*). *Sargassum* sp. and *Dictyota* sp. were also collected from the quadrat area. *Halimeda discoidea* and what is possibly *Colpomenia* sp. were also found at this site and collected.

TC-17-02: This site was a shallow back reef (2-6 ft) on the southwest side of the atoll. The substrate was dominated by coral rubble and pavement covered in turf and crustose coralline algae. *Microdictyon setchellianum*, *Laurencia galtsoffii*, *Padina* sp., and *Microdictyon setchellianum* were common in the photoquads. *Halimeda discoidea* was also present at this site.

TC-02-00: This site was a deep and wide spur and groove site dominated with *Pocillopora meandrina* as well as *Padina* sp. and *Turbinaria ornata*. *Microdictyon setchellianum* was also seen abundantly. During the random swim *Halimeda discoidea*, *Haloplegma duperreyi*, *Portieri hornemanni*, *Codium arabicum*, and *Laurencia* sp. were seen and collected. The depths of this site ranged from 35 to 60 ft.

TC-18: This site was a patch reef near the center of this atoll next to the crews buoy. The substrate was dominated by *Porites compressa*. In the crevice of the *P. compressa*, *Microdictyon setchellianum*, turf, crustose coralline algae, *Dictyosphaeria cavernosa*, and *D. versluysii* were commonly seen. During the random swim, *Hypnea* sp., *Padina* sp., *Laurencia* sp., *L. parvipapillata*, *Mastophora rosea*, *Liagora* sp., reproductive *Halimeda discoidea*, *Predaea* sp., *Sargassum* sp. and *Gracilaria* sp. were seen and collected. The depths of this site ranged from 18 to 25 ft.

TC-9-00: This site was also a patch reef but was composed of *Pocillopora meandrina* heads and coral rubble covered with *Microdictyon setchellianum* as well as *Dictyota* sp. and *Padina* sp. In addition, a dichotomously branched *Codium* sp. was collected as well as *Tricleogloea* sp., *Dasya iridescens*, *Laurencia* sp., and *Dictyosphaeria versluysii*. The depths of the survey ranged from 11 to 17 ft.

R-10-02: This was a back reef site just to the north of the main pass. The substrate was dominated by coralline pavement covered in turf algae, *Microdictyon setchellianum*, *Padina* sp., as well as *Pocillopora meandrina* heads and pencil urchins. *Caulerpa serrulata*, *Halimeda discoidea*, *Laurencia galtsoffi*, *Laurencia parvipapillata*, *Lobophora* sp., and *Sargassum* sp. were also collected from this site. The depths ranged from 2 to 10 ft.

TC-14: This site was a back reef on the north side of the lagoon. The dominant coral was *Porites lobata* and a purple *Montipora* sp. There were also a high number of pencil urchins at this site. Turf algae and *Microdictyon setchellianum* dominated the quadrat area. However, crustose coralline, *Liagora* sp., *Lobophora* sp., *Laurencia galtsoffi*, *Dictyosphaeria versluysii*, *Turbinaria ornata*, and an upright branched coralline were also documented inside that quadrat area. During the random swim, reproductive *Halimeda discoidea* was found along with, *Neomeris* sp., *Lyngbya* sp., *Galaxura* sp., and *Dictyosphaeria cavernosa*. This was a shallow site with depths ranging from 2 to 5 ft.

R-9-02: This site was a patch reef located near the back reef just east of the pass. This site seemed to be dominated by *Phaeophyta* (brown algae) and *Pocillopora meandrina*. The dominant alga was a *Sargassum* sp. Also seen abundantly was *Dictyota* sp., *Padina* sp., *Turbinaria ornata*, and *Microdictyon setchellianum*. During the random swim, *Hydroclathrus* sp., *Dasya* sp., and a blue-green cyanobacteria were collected. The depth of this reef was between 10 and 15 ft.

Appendix D: **Macroinvertebrate REA Activity Summary** (*Scott Godwin*)

A. Methods

The purpose of the activities for OES-06-03 was to select sites surveyed during previous rapid ecological assessments 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.

Quantitative counts for specific target marine invertebrates were done along two separate 2X25 meter belt transects. This was followed by a zigzag pattern that extended 5 m on either side of the transect line that was done for each of the two lines to record species not within the belt transect. The counts from these two 10X25 quadrats were combined for a 10X50 meter area.

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

These target species were:

CNIDARIA

Zoanthids – rubber corals

ECHINODERMS

Echinoids – sea urchins

Holothuroids – sea cucumbers

Ophiuroids – brittle stars (generally cryptic but are visible in some cases)

MOLLUSCA

Bivalves – ark shells, spondylid oysters, pearl oysters

Nudibranchs – sea slugs

Gastropods – snails

Cephalopods – Octopus

CRUSTACEA

hermit crabs, lobsters, large crabs and shrimp

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

The marine invertebrate species recorded and identified during the course of the field operations for OES-06-03 represent the non-cryptic 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 non-cryptic, that dwells in these habitats that are not included in the monitoring scheme. Previous efforts between 2000 and 2002 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.

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

Necker Island	3
French Frigate Shoals	12
Gardner Pinnacles	3
Maro Reef	9
Laysan Island	3
Lisianski Island/Neva Shoals	7
Pearl and Hermes Reef	15
Kure Atoll	9
Midway Atoll	11

B. Results

1. Necker Island

R-06-00: Flat basaltic pavement with a sand veneer covering the surface. Many shallow depressions with overhangs. The boring urchins *Echinostrephus aciculatus* and *Echinometra mathaei* were common with the occasional presence of the holothuroids *Holothuria whitmaei* and *Actinopyga obesa*. The cone shell gastropods *Conus lividus* were abundant and the nudibranch *Pteraeolidia ianthina* was quite numerous. Gall crabs (*Cryptochiridae*) were occasional in the *Pocillopora* heads. Many medium size heads of the sponge *Spongia oceania* were seen at the site.

OES-01-03: Flat basaltic pavement with a sand veneer covering the surface. Many shallow depressions with overhangs. The boring urchins *Echinostrephus aciculatus* and *Echinometra mathaei* were common with the occasional presence of the holothuroids *Holothuria whitmaei* and *Actinopyga obesa*. The sea star *Linckia multifora* was quite common in the area. The zoanthid *Zoanthus pacificus* was seen occasionally on the walls of the depressions in the substrate. The gastropods *Drupa morum*, *Conus lividus* and *Latirus nodatus* were noted rarely at the site.

TC-02: Complex basalt and boulder habitat with numerous overhangs, pinnacles and sand channels. The zoanthid *Zoanthus pacificus* was abundant at the site but there were very few other species other than the gastropod *Drupa morum*.

2. Necker Island

H6: Forereef habitat north of Tern Island. The dominant coral was *Porites* 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 as well as bivalve mollusks. The echinoids were *Echinostrephus aciculatus* and *Echinometra mathaei*, while the holothuroids were *Actinopyga obesa*, *Holothuria atra*, and *Holothuria whitmaei*. The molluscan species were primarily the bivalves, *Spondylus violacescens* and the nudibranch, *Pteraeolida ianthina*. Small colonies of the zoanthid *Palythoa caesia* were common throughout the habitat.

TC-21: Reef 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 *Trochus intextus* and *Turbo sandwichensis*. The alien hydroid, *Pennaria disticha*, was present at the site but was only occasional. Echinoid, holothuroid, and ophiuroid echinoderms were present, with the echinoid *Echinostrephus aciculatus* being the most numerous and *Echinothrix diadema* being rare.

TC-22b: Patch reef area near both Whale Island and Skate Island. Coral almost absent, except for a few *Pocillopora* heads and small *Acropora* colonies. This site was dominated by echinoid echinoderms and gastropod mollusks. The echinoids were *Euclidaris metularia*, *Echinostrephus aciculatus*, *Echinometra mathaei*, *Echinometra oblongata*, *Heterocentrotus mammilatus* and *Echinothrix calamaris*. The gastropods were *Conus lividus*, *Conus flavidus*, *Terebra maculata*, *Morula granulata* and *Turbo sandwichensis*. There were numerous individuals of the starfish *Mithrodia fisheri*.

R-19-02: Southside of La Perouse Pinnacle on the slope. Complex carbonate reef habitat with high coral cover. There were abundant gastropod and bivalve mollusks but few echinoderms. The gastropods were *Conus lividus*, *Conus flavidus*, *Conus abbreviatus*, *Conus rattus*, *Cypraea granulata* and *Cypraea helvola*. The nudibranch, *Pteraeolida ianthina*, was abundant as were the bivalve mollusks, *Spondylus violacescens* and *Arca ventricosa*. The zoanthid, *Palythoa caesia*, was recorded as common at the site.

TC-32: Lagoon reef area composed of ark shells and cliff oysters. This unique habitat had abundant invertebrate macrofauna that was both cryptic and non-cryptic. 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. The starfish, *Mithrodia fisheri*, was common, as was *Holothuria whitmaei* and *Actinopyga obesa*. There was one hydroid species of note: *Pennaria disticha*, which is considered an alien species. The gastropods, *Turbo sandwichensis* and *Trochus intextus* were common, as were two species of hermit crab, *Calcinus hazletti* and *Calcinus latens*.

OES-01-03: A lagoon reef with rare occurrence of the boring urchins *Echinostrephus aciculatus* and *Echinometra mathaei* and the holothuroid *Actinopyga obesa*. The most

numerous invertebrate was the Ark shell, *Arca ventricosa*, which was in association with fewer *Spondylus violacescens*. The hermit crab, *Calcinus hazletti*, was rare at the site.

OES-02-03: Flat forereef site with many different invertebrates. Colonies of *Palythoa caesia* were common, as was *Echinostrephus aciculatus*. The starfish, *Linckia guildingi*, was occasional as were the gastropods, *Conus miles* and *Rhinoclavis sinensis* and the holothuroids, *Holothuria atra* and *Holothuria whitmaei*. The echinoid, *Echinothrix calamaris* and *Echinometra mathaei*, were also occasional. The brittle star, *Ophiocoma pica*, was observed as common, and *Ophiocoma erinaceus* was rare.

R-02-02: Patch reef habitat dominated by *Pavona duerdeni*. This was a complex habitat of coral associated with a broad sand expanse. The marine invertebrates commonly noted at the site were the gastropods, *Turbo sandwicensis* and also the coralliophilid, *Coralliophila violacea*. The hermit crab, *Calcinus hazletti*, was common and there was a rare occurrence of the echinoid, *Tripneustes gratilla* and the holothuroid, *Actinopyga obesa*.

TC-12: 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 *Echinothrix calamaris*, which was common. There were rare occurrences of the hermit crab, *Calcinus hazletti*, and the zoanthid, *Palythoa caesia*.

R-03-02: Back reef habitat that was composed of rubble and scattered coral bommies. Echinoderms were the dominant group of marine invertebrates. Four species of holothuroid were documented: *Holothuria atra*, *Holothuria whitmaei*, *Bohasdschia paradoxa*, and *Holothuria difcilus*. The echinoids, *Echinometra mathaei*, *Echinothrix calamaris*, and *Echinothrix diadema* were common in the habitat. There was a rare occurrence of the asteroid, *Mithrodia fisheri*. The gastropod mollusk, *Rhinoclavis sinensis* was common; another gastropod, *Latirus nodatus*, was rare. There was also a rare occurrence of the hermit crab, *Calcinus laurentae* and the terebellid annelid worm, *Loimia medusa*.

TC 23: This was a *Porites compressa* patch reef that also contained *Porites lobata* and *Pavona duerdeni*. There was a complete lack of echinoderms present, and the site was dominated by gastropod mollusks. The common species were *Coralliophila violacea*, *Morula dumosa*, *Thais armigera*, and a rare occurrence of *Latirus nodatus* and *Mitra coffea*. The hermit crab, *Calcinus hazletti*, was occasional.

TC -30: A complex lagoon reef habitat made up of *Acropora* and *Porites lobata*. The habitat was high-relief reef structure with sand channels. All echinoderms present were rare in abundance and were: *Echinostrephus aciculatus*, *Holothuria atra*, *Mithrodia fisheri*, *Ophiocoma pica*, and *Ophiocoma erinaceus*. Hermit crabs of the genus *Calcinus* and the gastropods *Turbo* sp. and *Trochus intextus* were occasional in abundance. Further, the gastropods, *Coralliophila* sp. and *Cymatium* sp., as well as the bivalve mollusks, *Arca ventricosa* and *Spondylus violacescens* were present but rare.

3. Gardner Pinnacles

R-02-02: Flat basalt pavement with scattered islands of boulders and rock outcrops. With the exception of a ubiquitous red sponge and *Palythoa caesia*, most marine invertebrates were cryptic in nature. Small boulders created small islands of protected habitat and contained urchins, holothuroids, and gastropods and hydroids. The urchins were *Echinometra mathaei* and *Echinostrephus aciculatus*; the holothuroids were *Holothuria whitmaei* and the “chocolate chip” cucumber. Gastropods were represented by *Morula dumosa*, *Cypraea gaskoini*, and *Trochus intextus*. The hydroid, *Sertularella diaphana*, was growing in a few small colonies in the vicinity of the transect line. There were signs of crown-of-thorns starfish (COT) predation on pocilloporid corals at the site.

R-04-02: Flat scoured basalt pavement with thin sand veneer. Low growing *Microdictyon* algae and corals made up the majority of the community. The obvious invertebrates were the zoanthid, *Palythoa caesia* the sea urchin, *Echinostrephus aciculatus* and the occasional cone shell, *Conus lividus*. Two COTS were noted in the vicinity of the two transects.

R-03-02: Boulder field at the base of the west side cliffs. Sparse coral cover by *Pocillopora meandrina* and the soft coral, *Sinularia abrupta*. *Palythoa caesia* colonies were common as well as four species of hydroid: *Macrorhynchia philippina*, *Gymangium hians*, *Sertularella diaphana*, and *Dynamene*. Two species of nudibranch, *Pteraeolida ianthina* and *Caloria indica*, were commonly seen. The hermit crabs, *Calcinus laurentae* and *Calcinus hazletti*, were occasional as were the holothuroids, *Holothuria atra* and *Holothuria whitmaei*. The terebellid worm, *Loimia medusa*, was rare at the site.

4. Maro Reef

R-01-02: Patch reef with moderate relief and high algae abundance. Very few macroinvertebrates present and the ones that were present were not abundant. The gastropods, *Thais armigera*, *Turbo sandwicensis*, *Conus abbreviatus* and *Morula dumosa* were present but not abundant. There were numerous shells of *Periglypta reticulata* throughout the site but no live individuals were noted. The echinoid, *Echinostrephus aciculatus*, was very rare and a single holothuroid, *Holothuria whitmaei*, was noted within the vicinity of the transect. The only common macroinvertebrate was the zoanthid, *Palythoa caesia*.

R-02-03: Patch reef with moderate relief and moderate algae cover. There were numerous macroinvertebrates but was not overly abundant. Echinoderms and mollusks were the prevalent species, although the zoanthid, *Palythoa caesia*; the anemone, *Heteractis malu*; and the hermit crab, *Calcinus hazletti* were present at low numbers. None of the echinoderms present was numerous and was made up of all common species: *Ophiocoma erinaceus*, *Ophiocoma dentata*, *Ophiocoma pica*, *Echinothrix diadema*, *Holothuria whitmaei*, and *Echinostrephus aciculatus*. There were not abundant either and were represented by the bivalves, *Arca ventricosa* and *Spondylus violaceus* and the gastropods, *Coralliophila violacea*, *Morula dumosa*, and *Cypraea teres*.

R-04-02: Patch reef with moderate relief and moderate algae abundance. Macroinvertebrates were not numerous and made up of mollusks and echinoderms, with the exception of the terebellid polychaete worm, *Loimia medusa*. The echinoderms were made up of the holothuroid, *Actinopyga obesa*; the echinoid, *Echinostrephus aciculatus*; and the ophiuroid, *Ophiocoma pica*. The mollusks were the bivalves, *Spondylus violascens* and *Trachycardium orbita* and the gastropod, *Latirus nodatus*. The hermit crab, *Calcinus hazletti*, was rare at the site.

R-08-02: Patch reef with high relief and very abundant algae. The site was unusually devoid of macroinvertebrates except for the bivalve mollusks, *Spondylus violascens* and *Arca ventricosa*. A single sighting of the Cephalaspidea opisthobranch, *Philipine pilsbryi*.

R-05-02: Patch reef with high relief and steep sloping sides. There was a plethora of macroinvertebrates and the dominant sessile organism (none coral) was the zoanthid, *Palythoa caesia*. The dominant mobile organism was the aeolid nudibranch, *Pteraeolidia ianthina*, which was located throughout the habitat. There were rare occurrences of the flatworm, *Pseudoceros didmidatus* and the pinnid bivalve mollusk, *Streptopinna saccata*.

R-01-00: Patch reef with high relief and steep sloping sides. There were abundant macroinvertebrates. There were many bivalve mollusks present: *Arca ventricosa* and *Spondylus violascens*. *Pteraeolidia ianthina* and *Chromodoris vibrata* were the nudibranchs present, and *Latirus nodatus* and *Morula dumosa* were the gastropods. Echinoderms were uncommon and were represented by *Echinothrix calamaris* and *Ophiocoma pica*. A single sighting of a crown-of-thorns starfish was noted at this site.

TC-08: Patch reef with pinnacles composed of *Porites compressa*, *Porites lobata*, and *Montipora capitata*. There was high algae cover and relatively few macroinvertebrates throughout the site other than low numbers of the holothuroids: *Holothuria atra*, *Holothuria whitmaei*, and *Actinopyga obesa*. Of note for this site, the alien hydroid, *Pennaria disticha* was noted on a single transect. There were many *Spondylus* bivalves that were dead at this site and overall, the reef community looked to be stressed.

TC-06: Patch reef with moderate relief and a vast rubble slope. Algae cover was high and macroinvertebrates had low abundance except for the bivalve, *Arca ventricosa*. Within the rubble, the echinoid, *Eucidaris metularia* was common and a species of *Turbo* was occasional. The nudibranchs, *Hypselodoris maridadalus* and *Pteraeolidia ianthina*, were noted at the site but were rare.

TC-22: Patch reef with steep slope with caves and overhangs. There was moderate algae cover and there was respectable coral cover by *Montipora capitata*, *Porites lobata*, and *Porites compressa*. The most numerous species of macroinvertebrate was the bivalve, *Arca ventricosa*. There was a single small COTS recorded for the site.

5. Laysan Island

TC-05: Scoured pavement, outcrops, and boulders with moderate algae cover and low growing *Porites lobata* and *Pocillopora meandrina*. There were numerous boring urchins, *Echinometra mathaei* and *Echinostrephus aciculatus*. The remainder of the fauna was low in number and included the zoanthid, *Palythoa caesia*; the hermit crabs, *Aniculus maximus* and *Calcinus hazletti*; the nudibranchs, *Hexabranchnus sanguineus* and *Pteraeolida ianthina*; the gastropods, *Thais armigera*, *Morula dumosa*, *Drupa morum*, and *Conus rattus*.

R-06-02: Scoured pavement, outcrops, and boulders with moderate algae cover of *Microdictyon* and low growing *Porites lobata* and *Pocillopora meandrina* corals. The hermit crab, *Calcinus hazletti*, was common and one other species, *Ciliopaguris strigatus*, was rare. The gastropods, *Turbo sandwicensis* and *Trochus intextus* were common but another gastropod, *Morula dumosa* was rare. Echinoderms were not common at the site with the echinoids, *Echinostrephus aciculatus* and *Echinometra mathaei* and the holothuroid, *Actinopyga obesa* being rare.

R-03-02: Site very similar to previous two but with a greater diversity of macroinvertebrates. All echinoderms recorded at the site were common: the holothuroids, *Holothuria atra*, *Holothuria whitmaei*, and *Actinopyga obesa*; the urchins, *Echinostrephus aciculatus* and *Echinometra mathaei*; and the ophiuroids, *Ophiocoma pica* and *Ophiocoma dentate*. Hermit crabs were common and were composed of two species: *Calcinus hazletti* and *Dardanus sanguinocarpus*. Gastropods were represented by *Coraliophilla violacea*, *Quoyula madreporarum*, *Conus flavidus*, *Drupa morum*, and *Homalocantha anatomica*.

6. Lisianski Island

TC-10: Neva Shoals area. High coral cover, mostly *Porites compressa* sand patches between coral stands. Not a great deal of macroinvertebrates at this site. The ark shell, *Arca ventricosa*, was common at the base of all the coral stands. The hydroid, *Pennaria disticha*, was seen on both transects and was patchily distributed. The cone shell, *Conus marmoratus*, was noted at the site and the hermit crabs, *Calcinus hazletti* and *Ciliopaguris strigatus*, were rare.

Note: *Pennaria disticha* was much more abundant at this site in 2002. This is an alien species to the Hawaiian Archipelago and was documented in the Neva Shoals area in 2002 by CREI.

R-10-02: Very similar to TC-10. Extensive *Porites compressa* reef with moderate algae cover and low abundance and diversity of marine invertebrates. Few echinoderms were recorded except for a single collector urchin, *Tripneustes gratilla* and the brittle stars, *Ophiocoma pica* and *Ophiocoma brevipes*. Gastropods were extremely rare and only a few *Trochus intextus* and a single *Latirus nodatus* were recorded. The hermit crab, *Calcinus hazletti* and the alien hydroid, *Pennaria disticha* were rare at the site.

R-16-02: Extensive *Porites compressa* patch reef that was mostly overgrown with macroalgae. The green algae, *Microdictyon*, was the dominant species but many other species were present as well. The alien hydroid, *Pennaria disticha*, was common at the site and was prevalent at the crest of the patch reef. The sand dwelling anemone, *Isarachnanthus bandanensis*, was seen occasionally in the sand expanses surrounding the reef. Echinoderms were rare and were only presented by two species of sea urchin: *Echinothrix calamaris* and *Echinostrephus aciculatus*. The hermit crab, *Calcinus hazletti*, was rare at the site.

OES-01-02: Extensive *Porites compressa* patch reef 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 hydroid, *Pennaria disticha*, was common at the site and was located at the crest and under ledges along the slope.

OES-02-02: No Invert Dive due to equipment difficulties.

R-14-02: Extensive *Porites compressa* and *Porites lobata* patch reef with abundant *Microdictyon* macroalgae. Low abundance of macroinvertebrates with the exception of the boring urchins, *Echinostrephus aciculatus* and *Echinometra mathaei*. The other echinoderms present, the ophiuroid, *Ophiocoma pica* and urchin, *Heterocentrotus mammilatus* were rare. The gastropod, *Thais armigera*, and the terebellid polychaete worm were also noted and were rare.

TC-12: High relief *Porites compressa* and *Porites lobata* 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 aciculatus*. The other echinoderms present were the urchins, *Heterocentrotus mammilatus* and *Echinothrix calamaris*; the hermit crabs, *Dardanus sanguinocarpus* and *Calcinus hazletti*; the gastropods, *Latirus nodatus* and *Coraliophilla violacea*; and the terebellid polychaete worm, *Loimia medusa*, all of which were rare. The alien hydroid, *Pennaria disticha*, was present but also rare.

R-09-02: Site was similar to TC-12. *Pennaria disticha* was common at the site and was located primarily growing on the tips of *Porites compressa* colonies. The boring urchin, *Echinostrephus aciculatus* was abundant, while the remainder of the macroinvertebrate species were rare. Two hermit crabs species, *Calcinus hazletti* and *Calcinus argus* were noted, as was a single flatworm species, *Pseudoceros dimidiatus*.

7. Midway Atoll

TC-3b and R-13-02 were done in addition to the following sites but there was no marine invertebrate survey.

TC-02: South facing reef area near Seal Spit Island. Complex carbonate structure with abundant sand patches and overhangs. The predominant coral was *Pocillopora*, which was mostly grown over with algae. Urchins (*Echinostrephus aciculatus*) and holothuroids (*Actinopyga obesa*, *Holothuria atra* and *Holothuria whitmaei*) were the dominant macroinvertebrate organisms. The hydroid, *Macrorhynchia philippina*, was recorded at this site and was common.

H10: Southwest facing outside reef. This reef area was extremely scoured and contained an abundant macroinvertebrate population, especially *Echinostrephus aciculatus*, *Actinopyga obesa*, *Holothuria atra*, and the zoanthid, *Palythoa*. The bivalve, *Spondylus violacescens* was common when surveyed in 2002 but a live individual was rare in 2003. There was an extensive population of the predatory muricid snail, *Chicoreus insularum*, which is known to be bivalve predator. This could account for the change from the previous year. The cone snail *Conus flavidus* was commonly seen.

R-05-02: South facing reef area with complex carbonate structure. The site was dominated by the boring urchins, *Echinostrephus aciculatus* and *Echinometra mathaei*. An unknown elysidae nudibranch was abundant at the site. The gastropods, *Conus abbreviatus* and *Charonia midas* were present but were not abundant.

TC-H11: Patch reef north of Sand Island. From the perspective of marine invertebrates, this patch reef was dominated by the sea urchins, *Echinometra mathaei*, *Heterocentrotus mammilatus*, and *Echinostrephus aciculatus*, with a rare occurrence of *Pseudobolentia indiana*. The brittle stars, *Ophiocoma pica*, *Ophiocoma erinaceus*, *Ophiocoma brevipes*, and *Ophiocoma dentata* were common, and *Linckia multifora* and *Linckia guildingi* were rare. The sea cucumbers, *Actinopyga obesa*, *Holothuria atra*, *Holothuria whitmaei*, and *Euapta godeffroyi* were present but not in great abundance. The gastropods, *Conus flavidus*, *Conus pennaceus*, and *Conus abbreviatus* were present but rare.

R-01-02: Forereef site on the southwest corner. Complex carbonate reef structure with caves, crevasses, and overhangs with sand patches. Surfaces in the open were basically bare with low growing *Porites lobata*. In the crevasses and within caves there was a diverse assemblage of sessile macroinvertebrates such as hydroids, bryozoans, and mollusks. There were two common hydroids, one being *Sertularella diaphana* and the other being unknown. The remainder of the organisms recorded were the bivalves, *Spondylus* and *Pinctada margaritifera*; the bryozoan, *Crisina radians*; the gastropod, *Chicoreus insularum*; and the flatworm, *Pseudoceros dimidiatus*. There were single records of *Acanthaster planci* and the spiny lobster, *Panulirus marginatus*.

R-18-02: Back reef site on the east side of the atoll. This site was dominated by echinoid echinoderms and had numerous *Heterocentrotus mammilatus*, *Echinostrephus aciculatus*, and *Echinometra mathaei*. There was a single species of holothuroid, *Holothuria atra* and two species of gastropod, *Conus abbreviatus* and *Conus flavidus*.

R-22-02: Back reef site on the southwest side of atoll. This site was dominated by echinoid echinoderms and had numerous *Heterocentrotus mammilatus*, *Echinostrephus aciculatus*, *Echinometra mathaei*, and there was a rare occurrence of *Pseudobolentia*

indiana. There was a single species of holothuroid, *Holothuria atra* and two species of gastropod, *Conus abbreviatus* and *Conus flavidus*.

TC-H21: Back reef area at the “Reef Hotel.” Dominated by *Montipora capitata*, *Montipora turgescens*, and *Porites*. Because of the low diversity of macroinvertebrates, the dominant taxa was sea urchins (*Echinostrephus aciculatus*, *Echinometra mathaei*, and *Heterocentrotus mammilatus*). There were abundant sea cucumbers (*Holothuria atra* and *Actinopyga obesa*) throughout the habitat. The nudibranch, *Plakobranthus ocellatus* was recorded at this site as were the gastropods, *Conus ebraeus*, *Conus flavidus*, *Conus abbreviatus*, *Conus sponsalis*, and *Conus leopardus*, which were all occasional. The hermit crab, *Calcinus hazletti*, was rare at the site.

TC-01: Back reef area dominated by *Montipora capitata* and *Montipora turgescens*. There was low diversity and abundance throughout the habitat. This site and TC-H21 experienced a bleaching event in 2002, but TC-01 had much less species than TC-H21. With the exception of a few holothuroids and a few boring urchins, there was little in the way of macroinvertebrates. The holothuroids, *Holothuria atra*, *Holothuria whitmaei*, and *Actinopyga obesa* were common at the site but the boring urchins, *Echinostrephus aciculatus* and *Echinometra mathaei* were rare. The sacoglossan sea slug, *Plakobranthus ocellatus* was rare at the site as was the gastropod, *Conus abbreviatus* and the hermit crab, *Calcinus hazletti*.

8. Pearl and Hermes Reef

R-15-02: Forereef at the northwest end of the atoll. Complex carbonate reef structure dominated by crustose coralline algae and *Halimeda*. Very little in the way of abundance of diversity in visible macroinvertebrates. The zoanthid, *Palythoa caesia*, was the only common macroinvertebrate apparent at the site. There were rare sightings of the urchins, *Echinostrephus aciculatus* and *Eucidaris metularia*; the crown-of-thorns starfish, *Acanthaster planci*; the terebellid polychaete worm, *Loimia medusa*; and the gastropod mollusk, *Modulus tectum*.

TC-26: Shallow back reef 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 urchin species, *Echinometra mathaei* and *Echinostrephus aciculatus* as well as the holothuroids, *Actinopyga obesa* and *Holothuria whitmaei*. There was a single octopus recorded from one transect, and the gastropods, *Thais armigera* and *Conus abbreviatus*, were rare. A single lobster, *Panulirus marginatus*, was recorded from the vicinity. An abundance of the tests of the heart urchin, *Brissus latecarnatus*, were present throughout the site.

TC-24: Central northern part of the lagoon. Patch reef dominated by the macroalgae, *Halimeda* and sessile bivalve communities. The slope of this patch reef was composed mainly of *Arca ventricosa* and *Spondylus violacescens*, with *Pinctada margaritifera* appearing occasionally. There was a purple and slender green sponge (see photos) at the site that was recorded elsewhere at PHR in 2002. The urchins, *Echinometra mathaei* and *Echinostrephus aciculatus*, were present but not very common. There were only a small

number of holothuroids, which were *Actinopyga obesa*, *Holothuria atra*, and *Holothuria whitmaei*. The gastropod, *Conus leopardus*, was recorded from the site but was rare.

R-20-02: Forereef spur and groove with scoured surface. Low diversity and abundance of visible macroinvertebrates. The zoanthid, *Palythoa caesia*, was the only numerous macroinvertebrate while the boring, *Echinostrephus aciculatus*, was only occasional. The bivalve mollusk, *Spondylus violascens* and gastropod mollusk, *Conus flavidus* were rare.

R-22-00: Back reef area with complex reef structure and broad rubble/sand expanses. The most numerous visible macroinvertebrate was the boring urchin, *Echinometra mathaei*. The cone shell gastropods of *Conus lividus*, *Conus flavidus*, *Conus abbreviatus*, and *Conus vitulinus* were common at the site. Other mollusks seen were the gastropods of *Trochus intextus*, *Drupa grossularia* and *Morula dumosa*, and the pinnid bivalve of *Streptopinna saccata*, but they were rare. The hermit crab, *Ciliopaguris strigatus*, was common while *Calcinus laurentae* was rare. The holothuroids, *Holothuria atra* and *Actinopyga obesa*, were common throughout the site.

TC-23: Patch reef in the west lagoon. Top of patch reef was scoured carbonate with abundant algae holes inhabited by the urchins, *Echinometra mathaei* and *Heterocentrotus mammilatus*. The slopes of the patch reef were covered by thick macroalgae (*Halimeda*) and fine sand sediment. There were numerous large holes and overhangs but very little abundance of macroinvertebrates other than holothuroids and bivalves. There were three holothuroid species present: *Actinopyga obesa*, *Holothuria atra*, and *Holothuria whitmaei*. The bivalves were a major component of the slope substrate and the species were *Arca ventricosa*, *Spondylus violascens*, and the pearl oyster, *Pinctada margaritifera*. The spiny lobster, *Panulirus marginatus* and the hydroid, *Pennaria disticha* were present but rare.

R-02-02: Forereef spur and groove with scoured surface. Low diversity and abundance of visible macroinvertebrates. The zoanthid, *Palythoa caesia* and the boring urchin, *Echinostrephus aciculatus* were the only numerous macroinvertebrates. The bivalve mollusk, *Spondylus violascens* and the holothuroids, *Actinopyga obesa* and *Holothuria atra* were rare. A single spiny lobster, *Panulirus marginatus*, was recorded.

R-07-02: *Porites compressa* patch reef with low abundance and diversity of macroinvertebrates. A purple sponge also recorded at TC-24 was seen commonly at the site. The sacoglossan nudibranch, *Plakobranchus ocellatus*, was common and the starfish, *Linckia multifora* was occasional. A single black-lipped pearl oyster, *Pinctada margaritifera*, was recorded from the site.

R-08-02: Back reef site with numerous holothuroids and boring urchins. The holothuroids were *Actinopyga obesa* and *Holothuria whitmaei* and the boring urchins were *Echinometra mathaei*. Hermit crabs were occasional and the species were *Calcinus laurentae*, *Calcinus hazletti*, *Ciliopaguris strigatus*, and *Dardanus sanguinocarpus*. The gastropod, *Conus flavidus*, was seen rarely at the site.

OES-01-03: Forereef site that was flat with sand patches, no spur and groove. The boring urchin, *Echinostrephus aciculatus*, was very abundant while *Echinometra mathaei* was common. Hermit crabs were present but not abundant. The species present were *Ciliopaguris strigatus* and *Dardanus sanguinocarpus*. Gastropod mollusks were diverse but not abundant. The species present were *Cerithium mutatum*, *Conus rattus*, *Conus pertusus*, and *Conus flavidus*. A single spiny lobster, *Panulirus marginatus*, was present and a small number of the holothuroids, *Actinopyga obesa* and *Holothuria whitmaei*.

TC-22: Back reef site with a scoured and pitted surface and having numerous dead and living *Pocillopora* coral heads. The boring urchin, *Echinometra mathaei*, was abundant at the site as was the ophiuroid, *Ophiocoma pica*, which was exploiting the dead *Pocillopora* heads. The gastropods, *Rhinoclavis sinensis*, *Mitra stictica*, *Conus abbreviatus*, and *Conus flavidus* were present but not abundant. A single spiny lobster, *Panulirus marginatus*, and the octopus, *Octopus cyanea* were present but rare.

TC-30: Back reef on central south side of lagoon. Low relief site with scoured carbonate pavement and *Pocillopora* heads covered with macroalgae. Majority of coral heads were dead and harbored a variety of marine invertebrates. The dominant taxonomic group was echinoid echinoderms, which were *Echinometra mathaei*, *Echinostrephus aciculatus*, *Heterocentrotus mammilatus*, and *Tripneustes gratilla*. Ophiuroid echinoderms were the next most abundant organism. The particular species were *Ophiocoma pica* and *Ophiocoma erinaceus*. The starfish, *Mithrodia fisheri*, was present but was rare.

R-18-02: 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 aciculatus* while *Echinometra* was only common. Many other species of echinoderm were also present: the crown-of-thorns starfish, *Acanthaster planci*; the holothuroids, *Holothuria whitmaei* and *Actinopyga obesa*; and an unknown species (Chocolate chip). The hydroid, *Pennaria disticha*, was commonly noted at the site.

PHR-31: Reticulated reef area with steep walls and large sand channels. There was very little abundance of any macroinvertebrate groups. Urchins were very rare at the site and only a few ophiuroid species (*Ophiocoma pica* and *Ophiocoma erinaceus*) were present. The one common macroinvertebrate was the gastropod, *Terebra maculata*, which was present in the sand channels. A single Ceriathid tube anemone was seen on the slope of the reef.

PHR-32: Patch reef area with broad sand expanse associated with the habitat. There was a low abundance of macroinvertebrate fauna overall. The most common species were *Echinometra mathaei* and *Pseudobolentia indiana*. *Terebra maculata* was present in the sand expanses in the area. Also, there was a *Halophila* sea grass species present on the sand expanse.

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TC-12: Forereef site with spur and groove habitat. The polychaete, *Spirobranchus*, was very common at these sites within *Porites* colonies and within the carbonate substrate. Echinoderms were by far the dominant taxa present, which included *Echinostrephus aciculatus*, *Echinometra mathaei*, *Heterocentrotus mammilatus*, *Holothuria atra*, *Holothuria whitmaei*, *Actinopyga obesa*, and *Linckia multifora*. The anemone, *Heteractis malu*, was recorded at the site but was rare.

R-07-02: Forereef site with complex reef structure dominated by dead and living *Pocilloporia* and sand channels. Echinoderms were the most abundant taxa present and was represented by holothuroids and echinoids. The dominant echinoid was the boring urchins, *Echinostrephus aciculatus* and *Echinometra mathaei*, and there was a rare occurrence of the pencil urchin, *Heterocentrotus mammilatus*. Both the anemone, *Heteractis malu* and the gastropod, *Charonia midas* were present but rare. Gastropods, *Modulus tectum* and *Bursa bufonia*, were present but rare.

TC-17: Back reef site with *Montipora* and *Porites lobata*. This site was dominated by echinoid echinoderms and has numerous *Heterocentrotus mammilatus*, *Echinostrephus aciculatus*, and *Echinometra mathaei*. Very little else for macroinvertebrates existed except for a single gastropod, *Conus leopardus*.

TC-02: Forereef site with a classic spur and groove habitat with abundant *Pocillopora* coral heads and macroalgae. The dominant macroinvertebrates were the boring urchins, *Echinostrephus aciculatus* and *Echinometra mathaei* and the zoanthid, *Palythoa caesia*. The holothuroids, *Holothuria whitmaei* and *Holothuria atra* and the asteroid, *Linckia multifora* were occasional. The serpulid worm, *Spirobranchus gigantea* was very abundant within the *Porites lobata* coral and within the carbonate substrate.

TC-18: Isolated patch reef system in the central part of the lagoon composed of *Porites compressa*. The habitat was made up of shallow rubble flat (1-2 m deep), reef crest and steep slope down to 25 ft. The slope was exclusively *Porites compressa* and terminated in a broad sand expanse. The reef crest has experienced a bleaching event and has been taken over by low growing algae. The rubble created by the dead corals plus the algae has created a habitat for abundant macroinvertebrates. There were abundant sea urchins, starfish, brittle stars, and gastropods throughout the rubble area. The urchins were *Echinostrephus aciculatus*, with a rare occurrence of *Leptodiadema purpureum*, while the starfish were predominantly *Linckia multifora*, *Linckia guildingi*, and *Dactylosaster cylindricus*. Two species of brittle stars were very abundant: *Ophiocoma pica* and *Ophiocoma erinaceus*. Holothuroids were extremely abundant and the species present were *Holothuria whitmaei*, *Holothuria atra* and *Bohadschia paradoxa*. The gastropods were represented by *Trochus intextus* and *Rhinoclavis sinensis*, with rare occurrences of *Cypraea rashleighana* (or *alisonae*) and *Conus leopardus*. The tests of the heart urchin, *Brissus latecarinatus*, were apparent everywhere at this site, suggesting local abundance of this species. The octopus, *Octopus cyanea*, was recorded at the first and second transect.

TC-09: Patch reef composed of rubble with *Pocillopora* and *Microdictyon*. The holothuroid, *Actinopyga obesa*, was quite abundant, as was the boring urchin *Echinometra mathaei*. With the exception of the coralliophilid snail, *Quoyula madreporarum*, gastropods were rare at the site, with the species *Morula dumosa* and *Conus abbreviatus* being recorded. The asteroid, *Linckia guildingi*, was recorded but was not common.

R-10-02: Back reef site with *Montipora* and *Porites lobata*. This site was dominated by echinoid echinoderms and has numerous *Heterocentrotus mammilatus*, *Echinostrephus aciculatus*, and *Echinometra mathaei*. Very little else for macroinvertebrates existed except for a single gastropod, *Conus leopardus*.

TC-14: Back reef site from the north side of the atoll. Macroinvertebrate fauna dominated by sea urchins, with *Heterocentrotus mammilatus* being abundant. Echinoderms were the most abundant taxa overall and there were *Echinostrephus aciculatus*, *Echinometra mathaei*, *Holothura atra*, *Holothuria whitmaei*, *Actinopyga obesa*, *Ophiocoma pica*, and *Ophiocoma erinaceus* recorded commonly. Another holothuroid, *Euapta goddefroyi* was rare and the hermit crabs, *Calcinus hazletti* and *Calcinus elegans* were also rare.

R-09-02: Patch reef near the main channel with the boring urchin, *Echinometra mathaei*, being abundant. The brittle star, *Ophiocoma pica* and the coralliophilid gastropod, *Coralliophila violacea* were common. The three hermit crabs, *Calcinus hazletti*, *Calcinus lateens*, and *Dardanus sanguinocarpus* were present but only occasional. The holothuroids, *Holothuria atra*, *Actinopyga obesa*, and *Holothuria whitmaei*; the asteroid, *Linckia multifora*; and the gastropod, *Conus flavidus* were rare.

Appendix E: **Towed Diver Habitat/Fish Survey Team Activity Summary** (*Joe Chojnacki, Molly Timmers, Brian Greene, Joe Laughlin*)

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 min, recorded habitat type and complexity, and tallied the quantity of macroinvertebrates. Each towboard was equipped with a SBE 39 which 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. Towed-diver surveys were conducted across multiple habitats including the forereef, backreef, lagoon, and insular shelf.

B. Results

The Towboard team conducted four to six tows per day for the duration of the cruise. During 25 days of operations, the primary Towboard Team completed 103 tows, surveying an estimated 175.1 mi of reef.

Location	Tow type & quantity	Habitat Type	
1. Necker Island	Monitoring: 2	Bank:	4
	Assessment: 2		
2. French Frigate Shoals	Monitoring: 15	Lagoon: 2	
	Assessment: 1	Back Reef: 2	
		Fore Reef: 7	
		Pass: 2	
		Bank: 2	
		Bank Slope: 1	
3. Gardner Pinnacles	Monitoring: 1	Bank: 2	
	Assessment: 1		
4. Maro Reef	Monitoring: 12	Bank: 12	
5. Laysan Island	Monitoring: 4	Bank: 5	
	Assessment: 1		
6. Lisianski Island	Monitoring: 10	Lagoon: 1	
	Assessment: 2	Bank: 11	
7. Midway	Monitoring: 16	Back Reef: 7	
	Assessment: 1	Fore Reef: 7	
		Pass: 3	
8. Pearl & Hermes Reef	Monitoring: 16	Lagoon: 2	
	Assessment: 6	Back Reef: 9	
		Fore Reef: 9	
		Pass: 2	
9. Kure	Monitoring: 10	Lagoon: 1	
	Assessment: 3	Back Reef: 4	
		Fore Reef: 7	
		Pass: 1	

In addition the Mooring Team has supplemented the towboard coverage by completing four tows at French Frigate Shoals, two tows at Lisianski, seven tows at Maro Reef, and eight tows at Pearl & Hermes. The tow team also conducted 6 swim habitat surveys at Pearl and

Hermes in the interior Maze habitat, which brings the total number of tows to 124, and the number of surveyed sites to 130. Between the two teams, it is estimated that 216.8 miles of reef have been videoed, photographed and assessed by fish and habitat observers.

Appendix F: **Mooring Deployments and Oceanographic Data Collection** (*Stephani Holzwarth, Ron Hoeke, Jamie Gove*)

A. Results

Continuous, large-scale oceanographic monitoring began in 2001 with the installation of the first CREWS buoys deployed by the NOAA ship *Townsend Cromwell* to initiate a continuous time-series of oceanographic measurements in the major reef and atoll environments of the region. This cruise continued that effort. Oceanographic monitoring was accomplished by:

- Continuous recording of surface and subsurface water temperatures as a function of depth during all towed diver operations, providing a broad and diverse spatial temperature sampling method.
- Shallow Water CTDs (max 30 m), including turbidity measurements at regular spaced intervals around each work area, sample vertical profiles of water properties, providing indications for water masses and local sea water chemistry changes.
- Deep Water CTDs (max 500 m) along the NWHI which provided information on overall oceanographic structure, including chlorophyll and dissolved oxygen, and circulation patterns surrounding the work area.

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

- Wave and Tide Recorders (WTRs) which measure spectral wave energy, high precision tidal elevation, and subsurface water temperature.
- Sea Surface Temperature (SST) Buoys: Surface buoys which measure high resolution water temperature which telemeter data in near real-time.
- Ocean Data Platforms (ODPs) which measure subsurface temperature and salinity, current profiles, directional spectral wave energy, and high precision tides.
- Subsurface Temperature Recorders (STRs) which measure high resolution subsurface temperatures.
- Satellite Drifters, Lagrangian devices which provide surface layer circulation information and water temperatures which telemeter data in near real-time.

B. Results

Oceanographic measurements and instrument deployments were performed as described by the following brief narratives. Detailed information regarding the deployment and recovery of each instrument is then provided in tabular form.

1. Necker Island

We successfully located and retrieved the ODP and settlement plates deployed in 2002 and deployed a new top plate and new set of settlement plates. The operation went smoothly and we were able to use the original anchor. We utilized two separate dive teams (one to find the ODP, and one to replace it), the pinger locator, and a 500-lb liftbag. Monty Spencer, ship's diver, assisted with the operation. In the afternoon we recovered the 2002 SST buoy and replaced it with a new one. We did four CTD casts.

2. French Frigate Shoals

Retrieved the 2002 CREWS buoy and settlement plates, deployed the 2003 CREWS buoy and settlement plates, and then retrieved it and replaced it with the 2002 buoy upon discovering there was a transmitting problem with the new buoys. We used the new accumulator, but were forced to use a 2002 shackle to attach the accumulator to the CREWS buoy because none of the new shackles fit. The shackle was not corroded and we applied aqualube/electrical tape, so we expect it to last another year without a problem. We also retrieved two STRs and deployed four (two in new places). We now have STRs near La Perouse, Whale Skate, Disappearing Island, and Little Gin Island. During afternoons when we were not involved in mooring deployments, we towed. We completed four tows total (two forereef, two backreef), using Rob Roe and Keith Golden, both ship's divers, to complete our towboard team of divers. We did 16 CTD casts.

3. Gardner Pinnacles

We snorkel surveyed the underwater portion of the south wall of the rock, located a suitable attachment site for an STR in 30 ft of water, and installed the STR. It was programmed to sample at 1800-second intervals (twice the setting of 900-second intervals at other locations) so the instrument would last 2.8 years in case it was not retrievable next year due to sea state. We finished the afternoon with nine CTD casts along the 100-ft contour.

4. Maro Reef

We replaced one STR (in a central coral garden) and installed another (in a scruffy patch reef area in the south part of Maro). We changed out the hardware and settlement plates on the 2002 CREWS buoy and attached an SBE 39 to the underwater arm. We did 14 CTD casts and also 7 tows to supplement the tow team's effort.

5. Laysan Island

We changed out the SST buoy and installed two STRs, one in the coral pools along the south shoreline in 3 ft of water and the other on a small patch reef just offshore on the north side in 4.5 ft of water. We finished the day with eight CTD casts.

6. Lisianski Island

We deployed two Wave and Tide Recorders (WTRs), one at the far south end of Neva Shoal in 53 ft of water and one at the north end of the reef near the island in ~85 ft of water. The WTRs were programmed to measure tides once per hour and spectral waves once every 4 hours, a sampling scheme that allows over 1 year of data collection. We changed out the SST buoy and its associated settlement plates. The site was extremely murky (less than 3 ft visibility as we worked on the plates) and the plates and anchor

accumulator were covered in fuzzy algae. We also changed out the STR in the shallow shoreline reef on the east side of Lisianski. We completed 3 tows and 11 CTD casts which were arduous due to windy conditions (a constant 20-30 knots) and rough seas.

7. Midway Atoll

We changed out the SST mooring and associated settlement plates. We retrieved and replaced four STRs, one of which had come loose from its original attachment site of two metal stakes. We deployed an ODP at the south end of the western channel (Seward Roads) in 73 ft of water in the company of ~30 Galapagos sharks. We completed 19 shallow water CTDs.

8. Pearl and Hermes Atoll

We changed out the mooring hardware and settlement plates on the CREWS buoy and attached an SBE 39 to the in-water arm of the buoy. We recovered and replaced three STRs (NE, NW, SW) and installed two new ones (SE, center of maze). We did 37 shallow-water CTD casts. We completed eight tow surveys and six tow-swims along areas of the maze where it was more effective to swim than tow along a steep contour. For this activity we utilized a team of three divers. One diver swam with a video camera mounted on handles with an SBE 39 attached and a line towing the GPS at the surface in a pelicase. A second diver recorded benthic habitat and invertebrate data, and a third diver recorded fish over 50 cm TL. In the case of micro-atolls, we utilized a fourth person on snorkel gear (ship's diver) to video-survey the inside edge of the reef. Using this technique which is a more developed version of free-swim video surveys used in earlier years to document shallow reef crest habitat, we were able to assess habitat and large, roving fish populations in areas previously omitted due to logistical constraints. Ulua and Galapagos sharks were abundant along some of these microatolls and maze reefs, and we also recorded Blackfin sharks (*Carcharhinus limbatus*) on two separate reefs in their preferred habitat of turbid lagoon waters. The sharks approached closely enough to be positively identified by field marks (black on all fins except the top of the caudal, a distinctive snout, and light striping along the body). This may be a new record for PHR.

9. Kure Atoll

We changed out the mooring hardware and settlement plates on the CREWS buoy. The CREWS buoy itself was exchanged for a new model the day following our departure by a team of debris divers and Ron Hoeke aboard the *American Islander*. We retrieved an ODP and installed two wave gauges (WTRs), one off the south side in 49 ft of water and the other off the north side in 88 ft of water. An 8-ft tiger shark cruised past us during the south-side deployment, but showed no more than passing interest in our operation. We retrieved and replaced 2 STRs and completed 22 shallow water CTDs.

Table F-1: CTD Stations taken by the *Oscar Elton Sette*

Cast ID	Location	Time (HST)	Position	Depth
OES001	NIHOA Station	13 July 2003 1130	22 32.216 N 161 59.912 W	4134
OES002	NECKER Station	14 July 2003 0254	23 11.149 N 164 42.596 W	3406
OES003	FFS Station	15 July 2003 0445	23 34.116 N 166 18.155 W	3897
OES004	GARDNER Station	19 July 2003 0127	24 07.997 N 167 39.873 W	3561
OES005	MARO Station	20 July 2003 0318	24 59.952 N 169 59.903 W	4435
OES006	LAYSAN Station	23 July 2003 0240	25 34.002 N 171 32.051 W	3547
OES007	LISIANSKI Station	24 July 2003 0511	25 50.250 N 173 39.891 W	2776
OESS01	LIS EK60 Transect	27 July 2003 0415	25 57.071 N 174 03.594 W	22
OES008	MIDWAY Station	28 July 2003 0619	28 06.059 N 177 21.341 W	2101
OES009	P&H EK60 Transect A	30 July 2003 0028	27 59.714 N 175 43.323 W	95
OES010	P&H EK60 Transect B	31 July 2003 0254	27 47.922 N 176 01.636 W	70
OES011	P&H EK60 Transect C	1 August 2003 0251	27 46.504 N 175 49.375 W	103
OES012	P&H EK60 Transect D	2 August 2003 0257	27 45.282 N 175 48.375 W	185
OES013	P&H	2 August 2003 1947	27 40.291 N 175 49.803 W	3597
OES014	Kure EK60 Transect A	4 August 2003 0240	28 23.726 N 178 24.059 W	57
OES015	Kure EK60 Transect B	5 August 2003 0300	28 25.837 N 178 25.493 W	178
OES016	KURE	5 August 2003 1438	28 11.941 N 178 19.961 W	3472
OES017	Midway EK60 Transect East	7 August 2003 0320	28 10.885 N 177 21.066 W	112
OES018	Midway EK60 Mid A & B	8 August 2003 0303	28 10.284 N 177 24.090 W	77

Table F-2: Shallow-water CTD Stations taken by Oceanography Team

Cast ID	Time (HST)	Position
NEC001	14 July 2003 13:53	23 35.040 N 164 42.463 W
NEC002	14 July 2003 14:08	23 34.540 N 164 41.263 W
NEC003	14 July 2003 14:16	23 33.895 N 164 41.459 W
NEC004	14 July 2003 15:07	23 34.073 N 164 42.584 W
FFS001	16 July 2003 09:55	23 47.275 N 166 17.345 W
FFS002	16 July 2003 10:10	23 45.684 N 166 16.533 W
FFS003	16 July 2003 10:30	23 44.301 N 166 15.127 W
FFS004	16 July 2003 10:45	23 42.851 N 166 14.063 W
FFS005	16 July 2003 11:19	23 45.086 N 166 11.972 W
FFS006	16 July 2003 11:36	23 47.104 N 166 13.451 W
FFS009	17 July 2003 09:03	23 38.092 N 166 05.503 W
FFS010	17 July 2003 09:20	23 37.310 N 166 07.255 W
FFS011	17 July 2003 09:45	23 38.043 N 166 10.158 W
FFS012	17 July 2003 12:32	23 41.224 N 166 10.486 W
FFS023	18 July 2003 15:08	23 50.122 N 166 19.363 W
FFS024	18 July 2003 15:19	23 51.539 N 166 20.417 W
FFS025	18 July 2003 15:34	23 52.708 N 166 18.247 W
FFS026	18 July 2003 15:49	23 52.999 N 166 16.372 W
FFS027	18 July 2003 16:03	23 53.096 N 166 14.481 W
FFS028	18 July 2003 16:29	23 48.647 N 166 18.316 W
GAR001	19 July 2003 13:21	25 00.441 N 168 00.666 W
GAR002	19 July 2003 13:30	25 00.417 N 167 59.973 W
GAR003	19 July 2003 13:39	25 00.389 N 167 59.389 W
GAR004	19 July 2003 13:46	24 59.925 N 167 59.463 W
GAR005	19 July 2003 13:53	24 59.433 N 167 59.498 W

Table F-2 (cont.): Shallow-water CTD Stations taken by Oceanography Team

GAR006	19 July 2003 13:59	24 59.410 N 168 00.068 W
GAR007	19 July 2003 14:06	24 59.414 N 168 00.684 W
GAR008	19 July 2003 14:13	24 59.946 N 168 00.662 W
GAR009	19 July 2003 14:25	24 59.895 N 168 00.165 W
MAR001	22 July 2003 16:21	25 23.108 N 170 36.787 W
MAR002	22 July 2003 16:36	25 21.139 N 170 36.638 W
MAR003	19 July 2003 22:19	25 20.325 N 170 29.411 W
MAR004	19 July 2003 22:43	25 21.436 N 170 27.330 W
MAR005	19 July 2003 23:03	25 23.467 N 170 28.554 W
MAR006	20 July 2003 01:53	25 19.933 N 170 32.254 W
MAR007	20 July 2003 02:09	25 19.152 N 170 30.348 W
MAR008	21 July 2003 12:10	25 28.760 N 170 42.559 W
MAR009	21 July 2003 13:07	25 27.066 N 170 39.972 W
MAR010	21 July 2003 15:17	25 29.684 N 170 38.689 W
MAR011	21 July 2003 15:48	25 31.510 N 170 37.538 W
MAR012	21 July 2003 16:02	25 32.464 N 170 39.987 W
MAR013	21 July 2003 16:24	25 30.670 N 170 41.886 W
MAR014	21 July 2003 16:39	25 27.937 N 170 42.227 W
LAY001	23 July 2003 13:49	25 48.284 N 171 43.129 W
LAY002	23 July 2003 14:05	25 47.162 N 171 41.636 W
LAY003	23 July 2003 14:16	25 45.457 N 171 42.135 W
LAY004	23 July 2003 14:27	25 43.945 N 171 43.019 W
LAY005	23 July 2003 14:38	25 44.356 N 171 44.944 W
LAY006	23 July 2003 14:48	25 45.569 N 171 45.696 W
LAY007	23 July 2003 15:03	25 46.814 N 171 46.067 W
LAY008	23 July 2003 15:44	25 48.298 N 171 45.027 W

Table F-2 (cont.): Shallow-water CTD Stations taken by Oceanography Team

LIS001	26 July 2003 10:21	26 06.671 N 173 58.849 W
LIS002	26 July 2003 13:44	26 05.492 N 174 00.629 W
LIS003	26 July 2003 13:51	26 04.585 N 174 01.036 W
LIS004	25 July 2003 14:04	26 01.843 N 174 02.210 W
LIS005	25 July 2003 14:15	26 00.546 N 174 02.069 W
LIS006	25 July 2003 14:21	26 00.457 N 174 02.666 W
LIS007	25 July 2003 14:37	25 59.143 N 174 01.969 W
LIS008	25 July 2003 14:45	25 58.213 N 174 02.459 W
LIS009	25 July 2003 14:54	25 57.072 N 174 02.357 W
LIS010	25 July 2003 15:04	25 56.079 N 174 02.069 W
LIS011	25 July 2003 15:20	25 55.089 N 174 01.863 W
LIS012	25 July 2003 15:36	25 55.404 N 174 00.811 W
PHA001	30 July 2003 09:01	27 56.436 N 175 52.073 W
PHA002	30 July 2003 14:40	27 58.242 N 175 46.601 W
PHA003	30 July 2003 14:50	27 58.015 N 175 48.558 W
PHA004	30 July 2003 17:52	27 53.722 N 175 50.793 W
PHA005	30 July 2003 17:58	27 53.729 N 175 50.125 W
PHA006	30 July 2003 18:07	27 54.426 N 175 51.656 W
PHA007	30 July 2003 19:51	27 55.399 N 175 53.692 W
PHA008	31 July 2003 17:11	27 46.083 N 175 53.957 W
PHA009	31 July 2003 17:28	27 47.210 N 175 52.369 W
PHA010	30 July 2003 22:51	27 47.065 N 175 50.373 W
PHA011	30 July 2003 23:02	27 46.702 N 175 48.466 W
PHA012	30 July 2003 23:13	27 47.085 N 175 46.567 W
PHA013	30 July 2003 23:23	27 48.036 N 175 44.842 W
PHA014	30 July 2003 23:32	27 49.762 N 175 44.380 W
PHA015	30 July 2003 23:41	27 51.451 N 175 43.758 W

Table F-2 (cont.): Shallow-water CTD Stations taken by Oceanography Team

PHA016	30 July 2003 23:48	27 53.158 N 175 43.223 W
PHA017	30 July 2003 23:57	27 54.934 N 175 42.891 W
PHA018	01 August 2003 10:53	27 49.571 N 175 48.114 W
PHA019	01 August 2003 11:01	27 50.718 N 175 48.450 W
PHA020	01 August 2003 11:08	27 51.163 N 175 49.092 W
PHA021	01 August 2003 11:15	27 51.496 N 175 49.662 W
PHA022	01 August 2003 11:36	27 52.479 N 175 49.826 W
PHA023	01 August 2003 11:41	27 52.996 N 175 50.293 W
PHA024	01 August 2003 11:47	27 53.399 N 175 50.519 W
PHA025	01 August 2003 11:54	27 53.487 N 175 51.320 W
PHA026	01 August 2003 14:20	27 52.556 N 175 48.783 W
PHA027	01 August 2003 16:27	27 52.454 N 175 48.763 W
PHA028	01 August 2003 16:34	27 52.037 N 175 47.856 W
PHA029	02 August 2003 09:07	27 45.492 N 175 55.820 W
PHA030	02 August 2003 09:23	27 46.301 N 175 59.365 W
PHA031	02 August 2003 12:22	27 48.212 N 175 56.666 W
PHA032	02 August 2003 12:36	27 51.008 N 175 55.818 W
PHA033	02 August 2003 12:58	27 54.446 N 175 55.328 W
PHA034	02 August 2003 13:08	27 53.759 N 175 57.160 W
PHA035	02 August 2003 13:18	27 52.956 N 175 58.907 W
PHA036	02 August 2003 13:30	27 50.984 N 176 00.001 W
PHA037	02 August 2003 13:53	27 47.642 N 176 00.478 W
MID001	28 July 2003 15:47	28 13.272 N 177 23.993 W
MID002	28 July 2003 16:06	28 14.004 N 177 22.516 W
MID003	28 July 2003 16:16	28 14.071 N 177 21.540 W
MID004	28 July 2003 16:25	28 13.048 N 177 21.305 W
MID005	28 July 2003 16:33	28 11.892 N 177 21.267 W

MID006	28 July 2003 16:41	28 11.522 N 177 20.204 W
MID007	28 July 2003 16:50	28 11.879 N 177 19.159 W
MID008	28 July 2003 17:01	28 12.637 N 177 18.449 W
MID009	07 August 2003 15:31	28 14.106 N 177 25.857 W
MID010	07 August 2003 15:43	28 15.438 N 177 25.407 W
MID011	07 August 2003 15:57	28 16.464 N 177 24.454 W
MID012	07 August 2003 16:07	28 17.223 N 177 23.231 W
MID013	07 August 2003 16:17	28 17.243 N 177 21.657 W
MID014	07 August 2003 16:28	28 16.756 N 177 20.216 W
MID015	07 August 2003 16:37	28 15.591 N 177 19.548 W
MID016	07 August 2003 17:04	28 11.340 N 177 22.001 W
MID017	07 August 2003 17:15	28 11.246 N 177 23.565 W
MID018	07 August 2003 17:25	28 11.493 N 177 25.047 W
MID019	07 August 2003 17:37	28 12.781 N 177 26.061 W
KUR001	05 August 2003 09:37	28 24.806 N 178 19.826 W
KUR002	05 August 2003 09:46	28 25.109 N 178 20.672 W
KUR003	05 August 2003 10:01	28 25.382 N 178 21.204 W
KUR004	05 August 2003 10:10	28 24.930 N 178 21.786 W
KUR005	05 August 2003 10:16	28 24.560 N 178 21.461 W
KUR006	05 August 2003 10:29	28 24.250 N 178 22.982 W
KUR007	05 August 2003 10:48	28 24.679 N 178 23.370 W
KUR008	05 August 2003 10:55	28 25.582 N 178 22.781 W
KUR008	04 August 2003 13:55	28 27.647 N 178 21.043 W
KUR009	04 August 2003 14:04	28 27.870 N 178 19.616 W
KUR010	04 August 2003 14:12	28 27.509 N 178 18.167 W
KUR011	04 August 2003 14:22	28 26.576 N 178 17.041 W
KUR012	04 August 2003 14:33	28 25.424 N 178 16.440 W
KUR013	04 August 2003	28 24.092 N

	14:42	178 16.368 W
KUR014	04 August 2003 14:53	28 23.045 N 178 17.275 W
KUR015	04 August 2003 15:03	28 22.698 N 178 18.709 W
KUR016	04 August 2003 15:11	28 22.770 N 178 20.202 W
KUR017	04 August 2003 15:20	28 22.966 N 178 21.656 W
KUR018	04 August 2003 15:46	28 23.815 N 178 22.886 W
KUR019	04 August 2003 15:55	28 24.136 N 178 21.947 W
KUR020	04 August 2003 16:03	28 23.907 N 178 21.018 W
KUR021	04 August 2003 16:29	28 23.829 N 178 20.029 W

Table F-3: CTD Stations taken by R/V AHI in Midway

Cast ID	Time (HST)	Position	Depth
20030728-04a	28 July 2003 17:17	28 10.98 N 177 21.34 W	100
20030729-01	29 July 2003 12:14	28 12.43 N 177 16.69 W	77
20030801-01	01 August 2003 11:00	28 15.16 N 177 27.97 W	102
20030803-01	03 August 2003 09:15	28 10.94 N 177 21.34 W	120
20030803-02	03 August 2003 14:33	28 10.85 N 177 21.17 W	123
20030804-01	04 August 2003 10:08	28 10.60 N 177 22.00 W	135
20030805-01	05 August 2003 09:09	28 10.83 N 177 21.26 W	135
20030805-02	05 August 2003 11:01	28 19.13 N 177 21.34 W	121
20030805-03	05 August 2003 11:45	28 18.41 N 177 26.02 W	67
20030805-04	05 August 2003 13:08	28 20.30 N 177 24.92 W	137
20030806-01	06 August 2003 09:57	28 10.74 N 177 21.09 W	150
20030807-01	06 August 2003 14:23	28 13.35 N 177 21.43 W	14
20030807-02	07 August 2003 11:16	28 12.32 N 177 27.22 W	124
20030807-03	07 August 2003 14:22	28 11.72 N 177 20.52 W	18

Table F-4: Drifter Deployments

Drifter #	ARGOS ID	Deployment Time, HST	Position	Depth(m)
001	29097	13 July 2003 0650	22 21.004 N 161 13.307 W	4390
002	29098	14 July 2003 1755	23 33.652 N 164 47.904 W	32
003	29105	19 July 2003 1627	24 59.040 N 168 01.586 W	15.3
004	29106	23 July 2003 1709	25 45.949 N 171 47.976 W	28.0
005	29102	27 July 2003 0704	26 02.098 N 174 06.689 W	28.5
006	29101	5 August 2003 1505	28 11.913 N 178 19.000 W	

Table F-5: Coral Reef Early Warning System (CREWS) Buoy Deployments and Recoveries

Location	Serial Number	Argos ID	Time, HST	Position	Depth	Notes
French Frigate Shoals	279-001	27267	15 Jul 2003 0930	23 51.407 N 166 16.31 W	27 ft	Recovery.
French Frigate Shoals	261-002	26461	15 Jul 2003 1300	23 51.407 N 166 16.310 W	27 ft	Deployment. Replaces 279-001
French Frigate Shoals	279-001	27267	18 Jul 2003 0930	23 51.407 N 166 16.310 W	27 ft	Recovery. This new buoy was removed because no satellite transmissions were received.
French Frigate Shoals	261-002	26461	18 Jul 2003 1300	23 51.407 N 166 16.310 W	27 ft	Re-deployment. The old buoy was returned with a new accumulator installed.
Maro	262-003	26082	21 Jul 2003 1030	25 26.791 N 170 38.029 W	8 m	Changed accumulator and shackles.
Pearl & Hermes	280-003	21376	31 Jul 2003 1000	27 51.245 N 175 48.954 W	7.9 m	Changed accumulator; attached STR to arm (see STR table)
Kure	280-002	21531	03 Aug 2003 1400	28 25.118 N 178 20.673 W	28 ft	Changed accumulator. Need to change chain

Table F-6: Ocean Data Platform (ODP) Deployments and Recoveries

Location	Serial Number	Pinger Info.	Date Time, HST	Position	Depth	Notes
Necker	267-004	7874B 72 kHz 996 ms	14 Jul 2003 0956	23 34.080 N 164 42.738 W	25 m 82ft	Recovery.
Necker	267-006	4294D 75kHz	14 Jul 2003 0956	23 34.080 N 164 42.738 W	25m 82ft	Deployment. Replaces 267-004. SBE-37 may not be programmed properly
Midway	267-???	7873D 66 kHz 999 ms	07 Aug 2003 1050	28 13.810 N 177 25.567 W	79ft	Deployment. located in a puka in a very small channel (groove).
Kure	267-005	7875B 84 kHz 1000 ms	04 Aug 2003 0940	28 25.782 N 178 22.668 W	91ft	Recovery. ADP tilted far beyond perpendicular to water surface; This could be a problem!

Table F-7: Sea Surface Temperature (SST) Buoy Deployments and Recoveries

Location	Serial Number	Argos ID	Date Time, HST	Position	Depth	Notes
Necker	268-011	28830	14 Jul 2003 1234	23 34.291 N 164 41.865 W	15.2m 50ft	Recovery.
Necker	268-007	28828	14 Jul 2003 1234	23 34.291 N 164 41.865 W	15.2m 50ft	Deployment. Replaces 22830.
Laysan	268-010	28829	23 Jul 2003	25 43.374 N 171 44.551 W	2.5m	Recovery. Buoy and line appeared in excellent condition.
Laysan		22043	23 Jul 2003	25 43.374 N 171 44.551 W	2.5m	Deployment. Replaces 28829.
Lisianski	268-008	12195	24 Jul 2003 1114	25 58.060 N 173 54.966 W	9.8m	Recovery. Line extremely twisted and bunched in knots. Old CREWS buoy anchor with no swivel!
Lisianski		22064	24 Jul 2003 1135	25 58.060 N 173 54.966 W	9.8m	Deployment. Replaces 12195. New settlement plates attached; probably want to use a new anchor with swivel next time.
Midway	268-009	28831	28 Jul 2003 1131	28 13.073 N 177 20.641 W	8.5m	Recovery. Hardware in very good condition. No swivel, but line was not fouled.
Midway	268-016	21961	28 Jul 2003 1131	28 13.073 N 177 20.641 W	8.5m	Deployment. Replaces 28831. Using old CREWS Buoy anchor; no swivel; attached new settlement plates.

Table F-8: Subsurface Temperature Recorder (STR) Deployments and Recoveries

Location	Serial Number	Date Time, HST	Position	Depth	Notes
French Frigate Shoals	3929252 - 0905	15 Jul 2003 1502	23 51.967 N 166 13.180 W	2 m	Recovery. Near Whale/Skate.
French Frigate Shoals	3930159 - 0834	15 Jul 2003 1510	23 51.967N 166 13.180 W	2 m	Deployment. Replaces STR 0905. Near Whale/Skate on W side of coral head;
French Frigate Shoals	3929252 - 0898	16 Jul 2003 0915	23 46.134 N 166 15.684 W	4 m	Recovery. La Perouse Pinnacle.
French Frigate Shoals	3930159 - 0838	16 Jul 2003 0930	23 46.134 N 166 15.684 N	4 m	Deployment. Replaces STR 0898. SW side of La Perouse, ~60 feet east of underwater arch, out of obvious sight in a hole midway down pinnacle wall.
French Frigate Shoals	3930159 - 0835	17 Jul 2003 1047	23 38.687 N 166 10.410 W	2 m	Deployment.
French Frigate Shoals	3930159 - 0836	17 Jul 2003 1147	23 44.289 N 166 10.011 W	2 m	Deployment.
Gardner Pinnacles	3930159 - 0839	19 Jul 2003 1224	24 59.930 N 167 59.971 W	34 ft	Deployment. Gardner Pinnacle, SW of channel between rocks.
Laysan	3930159 - 0840	23 Jul 2003 1019	25 45.536 N 171 43.765 W	3 ft	Deployment. Coral pools, SE Laysan; under corner of rock that breaks surface, in area with larger rocks
Laysan	3930159 - 0841	23 Jul 2003 1330	25 46.772 N 171 44.334 W	4 ft	Deployment. Coral pools, N Laysan; in coral head. Watch out for grey reefs!
Lisianski	3929252 - 0902	26 Jul 2003 1310	26 03.821 N 173 57.660 W	0.5 m	Recovery.
Lisianski	3932718 - 1109	26 Jul 2003 1310	26 03.821 N 173 57.660 W	0.5 m	Deployment; replaces 0902; just inside small cove on side of emergent reef.
Maro	3930159 - 0843	20 Jul 2003 1002	25 22.017 N 170 30.824 W	14 ft	Deployment; E Maro Reef; on NW side of coral head with two steeper coral heads to the NW and SE.
Maro	3929252 - 0901	20 Jul 2003 1044	25 23.050 N 170 32.383 W	1.5 m	Recovery; SE Maro Reef

Table F-8 (cont.): Subsurface Temperature Recorder (STR) Deployments and Recoveries

Maro	3930159 - 0842	20 Jul 2003 1109	25 23.050 N 170 32.383 W	1.5 m	Deployment; SE Maro Reef Replaces; STR 0901
Maro	3930159 - 0830	21 Jul 2003 1130	25 26.791 N 170 38.029 W	8 m	Co-located with Maro CREWS buoy (on buoy arm) to maintain SST time series should CREWS die.
Pearl & Hermes	3929252 - 0906	29 Jul 2003 1111	27 57.450 N 175 46.850 W	1 m	Recovery.
Pearl & Hermes	3932718 - 1070	29 Jul 2003 1111	27 57.459 N 175 46.849 W	0.5 m	Deployment. Replaces 0906. Snuggled up against SE side of Motu Mama, in a small hole.
Pearl & Hermes	3929252 - 0900	30 Jul 2003 0953	27 54.710 N 175 53.657 W	2.5 m	Recovery.
Pearl & Hermes	3932718 - 1069	30 Jul 2003 0953	27 54.707 N 175 53.657 W	8 ft	Deployment. Replaces 0900. On top of P. Lobata Head
Pearl & Hermes	3932718 - 1048	30 Jul 2003 1105	27 53.878 N 175 49.880 W	1 m	Deployment. In middle of "mini" atoll in maze on P. Compressa head.
Pearl & Hermes	3932718 - 1047	31 Jul 2003 1000	27 51.245 N 175 48.954 W	0.5 m	Deployment. Attached to CREWS buoy arm to ensure SST continuity in case of buoy failure
Pearl & Hermes	3932718 - 1046	01 Aug 2003 1046	27 48.159 N 175 36.461 W	5 ft	Deployment. Near arch/hole/swimthrough, near small pass on SE corner
Pearl & Hermes	3929252 - 0899	2 Aug 2003 1010	27 46.489 N 175 58.720 W	2 m	Recovery. Near SW Pass, Seal-Kittery
Pearl & Hermes	3932718 - 1048	2 Aug 2003 1010	27 46.489 N 175 58.722 W	2 m	Deployment. Replaces 0899.
Midway	3929252 - 0904	28 Jul 2003 1351	28 16.665 N 177 22.071 W	0.3 m	Recovery
Midway	3932718 - 1071	28 Jul 2003 1351	28 16.658 N 177 22.071 W	0.3 m	Deployment. Replaces 0904. Tie-wrapped to a metal girder in dock wreckage.
Midway	3930159 - 0831	28 Jul 2003 1308	28 14.662 N 177 19.401 W	0.5m	Recovery.
Midway	3932718 - 1073	28 Jul 2003 1308	28 14.662 N 177 19.401 W	0.5 m	Deployment. Replaces 0831. Tie wrapped to two metal stakes.

Midway	3930159 - 0832	28 Jul 2003 1519	28 11.617 N 177 24.109 W	1m	Recovery. No Data - battery was never fully inserted.
Midway	3932718 - 1072	28 Jul 2003 1519	28 11.617 N 177 24.109 W	1 m	Deployment. Replaces 0832. On small isolated coral head near patch reef.
Midway	3930159 - 0833	28 Jul 2003 1441	28 16.263 N 177 23.160 W	0.5 m	Recovery. STR was not on its original location. Looks as though a storm moved it.
Midway	3932718 - 1108	28 Jul 2003 1441	28 16.263 N 177 23.160 W	0.5 m	Deployment. Replaces 0833. Slightly different position than before. Tie wrapped to a Jim Marigos' stake.
Kure	3929252-0903	3 Aug 2003 1431	28 26.844 N 178 18.365 W	2.5 ft	recovery; on wreck
Kure	3932718-1043	3 Aug 2003 1431	28 26.844 N 178 18.362 W	2.5 ft	deployment; replaces 0903; on old pipe or rail, part of the wreck
Kure	3929252-0907	3 Aug 2003 1705	28 25.756 N 178 22.105 W	2 ft	recovery;
Kure	3932718-1044	3 Aug 2003 1705	28 25.756 N 178 22.105 W	2 ft	deployment; replaces 0907; on west side of emergent rock.

Table F-9: Wave and Tide Recorder (WTR) Deployments and Recoveries

Location	Serial Number	Pinger Info	Date Time, HST	Position	Depth	Notes
Lisianski	2632718-0363	5295D 78 kHz 993 ms	24 Jul 2003 1001	25 56.590 N 173 53.073 W	49 ft	Deployment. SE Neva Shoals in a small low area SW of a coral head somewhat larger than other in area. Forgot to sync time to UTC!
Lisianski	2632718-0363	5293D 76.8 kHz	26 Jul 2003 1145	26 06.008 N 173 59.880 W	75 ft	Deployment. Near large dead end sand channel ~100 ft
Kure	2632718-0357	5290D 57 kHz 994 ms	03 Aug 2003 1000	28-23.446 N 178-16.979 W	49 ft	Deployment. 45 psia. Located in small depression on large spur
Kure	2632718-0359	5289D 54 kHz 1008 ms	04 Aug 2003 1250	28-27.171 N 178-21.432 W	88 ft	Deployment. 200 psia. Located in small small channel(groove), between two much larger grooves.

Appendix G: **Shipboard Benthic Habitat Mapping** (*John Rooney and Joyce Miller*)

A. Method

Benthic acoustic surveys using the QTC Acoustic Seabed Classification System were conducted throughout the Northwestern Hawaiian Islands (NWHI) during cruise OES0306. Surveys were primarily conducted at night to leave the ship free for diving-related work during daylight hours. However, when the ship was operating in shallow enough water and, with appropriate settings on the EK60 Echosounder, surveys were conducted during daylight hours as well. The Towed Optical Assessment Device (TOAD) was deployed, in conjunction with QTC surveying, during night operations. Available night operations time was evenly split between QTC/TOAD work and bioacoustic surveys.

Processed QTC data from previous cruises were available in ArcView GIS 3.2 and used as the primary tool for identifying QTC survey/TOAD targets on OES0306. For each island or atoll, a number of sites characterized by single representative acoustic classes or borders between different acoustic class areas were identified. These locations covered wide geographic and depth ranges and included several times more sites than there was time to survey. Since the schedule and location of night operations was dictated by the needs of daylight operations, the advanced identification of a large number of survey sites enable night operations scientists to work around this limitation and to quickly respond when the *Sette's* drift velocity was different from what had been anticipated. The latter problem became a significant consideration in the northern half of the NWHI, where the drift direction during TOAD deployments varied, at times more than 90 degrees, between sites only a few kilometers apart.

The TOAD was deployed from the longline pit located amidships on the *Sette's* port side, using a J-frame located there and a capstan on the deck above. Deployments were done using three ship's personnel, including Senior Survey Technician Phil White, a winch operator, and line tender. Prior to deployment, the Officer of the Deck would maneuver the ship so as to have no way on and be as close to a preselected location as possible, with the wind broad on the port beam. A scientist in the ship's Electronics Lab, watching echo sounder displays and a monitor showing the video being recorded by TOAD cameras, controlled the tow by radioing appropriate commands to the winch operator. The *Sette* typically drifted at 0.5–1.0 knots over the ground, enabling the TOAD to be “flown” within 1-2 m of the seafloor. The generally tight control over TOAD altitude enabled the collection of high quality photographs and video that show not only habitat type, but also often allow the identification of benthic organisms to the species level.

B. Results

QTC surveys and TOAD deployments were completed at all major islands and atolls visited during OES0306. Exceptions include Necker Island, where systems were still being set up and tested, and Laysan Island, where scheduling constraints precluded night operations. Table 1 summarizes QTC/TOAD data collection during this cruise. Individual TOAD deployments and concurrent QTC data collection averaged about 30 min duration. QTC data collection occurring during non-TOAD deployment periods was typically of

several hours duration. Until completion of QTC data processing during the transit to Saipan, linear kilometers of QTC data cannot be measured or reported.

Location	No. TOAD deployments	No. still photos	No. video segments	No. grab samples
1. Necker Island	0	0	0	0
2. French Frigate Shoals	11	655	11	1
3. Gardner Pinnacles	2	38	1	0
4. Maro Reef	8	210	7	0
5. Laysan Island	0	0	0	0
6. Lisianski Island	13	360	12	1
7. Midway Island	10	353	10	0
8. Pearl and Hermes Atoll	19	210	19	1
9. Kure Atoll	11	68	7	0
Total	74	1894	67	3

One sediment sample was retrieved by a ship's diver while at anchor at French Frigate Shoals. Two other sediment samples, from Lisianski Island and Pearl and Hermes Atoll, were collected from two and three individual deployments respectively, of the grab sampler. Despite multiple attempts, in both of these cases, insufficient samples were collected to conduct a meaningful analysis. Discussions between the Ship's Captain and Field Operations Officer (FOO), night operations scientists, and the chief scientist were initiated in an attempt to increase the number of sediment samples recovered. Unfortunately, although small enough to be manipulated by two scientists, regulations require that shipboard personnel deploy the grab sampler. This requirement, along with overtime constraints, precluded obtaining grab samples during daylight operations when the ship was over sediment fields and not actively engaged in other activities. Both the Captain and FOO were supportive of grab sampling during hours reserved for TOAD/QTC operations and using personnel already scheduled to support them. However, time requirements to reposition the ship and deploy the grab sampler and the poor recovery obtained from grab samples generally resulted in the decision to continue scheduled TOAD/QTC operations rather than attempt to sample sediment fields.

QTC System: An inspection of previously processed QTC data, particularly from the portion of French Frigate Shoals where there is good coverage, suggests that the system is capable of differentiating between at least some benthic habitats. However, attempts to construct tables relating acoustic classes to specific benthic substrates indicate that a single acoustic class identified in multiple areas may correspond to significantly different habitats or substrates.

A possible approach for utilizing QTC data in benthic habitat mapping may start with a GIS-based spatial averaging technique to filter some of the variability out of an acoustic classification. That step might be followed with a comparison of acoustic classes and benthic habitats identified from photographs on either side of an acoustic boundary. For situations in which standard statistical tests indicate that differences between acoustic classes correspond to differences in benthic habitats, QTC data could then be used to define that same benthic habitat boundary in similar areas.

It appears that, at the very least, QTC data can be used to establish at least preliminary habitat boundaries under certain limited circumstances. For example, habitat boundaries could be delineated between two spots on a single acoustic boundary that are shown by photographic analysis or diver observation to mark the boundary between two habitat types as well. However, whether it will be possible to extrapolate boundary delineation beyond that remains to be seen. While the QTC system does a reasonable job of collecting and pre-processing acoustic data sets and differentiating individual acoustic data points, it does not appear to be highly effective in separating data points into acoustic classes. A comparison of results of QTC classification of OES0306 data versus those using another method (Legendre, 2002) are planned for areas in which groundtruthing data exists to test whether the latter may enhance our ability to utilize QTC data for habitat mapping.

The QTC system appears to have been designed, and used more often, for differentiating between sediment types than for distinguishing between the more common substrates found in the NWHI. However, classifying submarine sediments may be of more interest in the main Hawaiian or other U.S. Pacific Islands where beach erosion is a significant problem. One of the primary barriers to beach renourishment, in the main Hawaiian Islands at least, has been the identification of suitable offshore sand resources. Sandy beach and dune littoral systems are an important ecological, recreational, and cultural resource as well as a keystone of the visitor industry. Given their significance and the ~25% decrease in beach area reported over the last half century on the islands of Oahu and Maui, the development of offshore sand resources is receiving increasing attention. Offshore sediment fields have also been reported to serve as heavily utilized habitats for some species of commercially important juvenile bottomfish. The QTC system may be a useful tool for mapping these ecologically significant and potentially soon-to-be-exploited resources.

TOAD System: Deployments during OES0306 have led to several observations regarding the TOAD system. The initial setup was more cumbersome and complex than is necessary given the TOAD's current configuration. The system was originally designed to be towed by a vessel and "flown" by remotely manipulating control surfaces. Unfortunately, the TOAD's original configuration was unable to reliably provide this useful ability. However, the electronics required by that system are still in place, even though the TOAD is controlled by onboard winch today. Occasional problems with the system have resulted in the delay of deployments on several occasions and suggest that streamlining the system may be worthwhile. This option will be investigated further upon return to Honolulu.

There have also been several problems with the Canon G1 Powershot still camera system, which is currently unable to reliably take photographs. Although possibly related to the electronics mentioned above, the camera cable connections on the TOAD are receiving the correct voltage. Another possible source of this problem is the timing circuit within the housing, but the timing option on the camera has turned off a few minutes into deployment on several recent occasions, suggesting that the problem may be with the camera itself. Slaved to the camera, the Ikelite Ds-125 strobe flooded on two separate occasions, despite great care on the second occasion to prevent a reflooding. The strobe has not been used since, and photographs taken higher in the water column have been too dark, although ones taken closer to the bottom have been acceptable. A further issue with the still camera is that the

straight down perspective it provides often obscures elevation differences between benthic features and makes them harder to identify. Finally, the camera's Ikelite housing is only rated to 60 m. For a TOAD deployment expected to exceed that depth, the G1 must be left behind. This is likely to be the case for most TOAD deployments in the CNMI, where the seafloor descends quickly to depths in excess of 100 m.

One advantage that the still camera has provided over the video system is the ability to "hotlink" individual photographs, by the location where they were taken, into the appropriate ArcView GIS project. Sun He Bak, the CRE Division Data Manager wrote a script during the cruise that facilitates fast and efficient hotlinking of photographs, which in turn enhances our ability to evaluate benthic habitats. During the transit to Saipan we plan to install and test Adobe Premiere software, which is expected to give us the capability to extract individual images at regular time intervals (e.g., every minute) from TOAD videos. Assuming this approach is successful, a still camera may no longer be necessary.

Remotely Operated Vehicles are another possible option for replacing or augmenting the TOAD system. Commercially available systems exist that can be operated from vessels too small to support the TOAD and offer other useful options such as the ability to maneuver a video camera, enabling an operator to record a more comprehensive view of the benthos. This option will also be investigated upon return to Honolulu.

Appendix H: **Launch-based Benthic Habitat Mapping at Midway Island** (*Joyce Miller and Scott Ferguson*)

A. Results

As part of the benthic habitat mapping done during OES0306, the first shallow water NWHI multibeam sonar survey was conducted at Midway Island using CREI's new survey launch R/V AHI. The AHI was off-loaded from the *Sette* on July 28, 2003 at the Midway small boat harbor and all vessel and survey systems were tested that afternoon. The AHI remained at Midway independent from the *Oscar Elton Sette* and conducted surveys around Midway from July 29, 2003 through August 7, 2003. During this period the two surveyors used accommodations and facilities for berthing and fueling at Midway Island. Eight to 10 h of survey was done daily at speeds varying from 7 to 13 knots, except for two half day periods (one to repair air conditioning problems and one for a survey demonstration to students and volunteers from Midway). Survey conditions in general were exceptionally good with winds less than 10 knots and seas less than 4 ft. Between one and four CTD casts were done each day to provide sound velocity corrections for the multibeam data. On August 8, 2003, the AHI was once again loaded aboard the *Oscar Elton Sette* for transit to Saipan and Guam.

Surveys were conducted mostly outside of the shallow lagoon at Midway in water depths ranging from 8 to 250 m. Limited areas inside the lagoon in shallower depths were also mapped. An estimated 24 sq. km (~7.3 sq. nmi) of data were collected per survey day for a total coverage of approximately 240 sq. km (73 sq. nmi). (It should be noted that the exceptionally good survey conditions and continuous performance without failure of systems aboard the AHI allowed much higher survey rates than had been estimated during planning.) Bathymetry and backscatter data were processed aboard the *Sette* during the August 8-18, 2003 transit from Midway to Saipan and preliminary data products produced.

Appendix I: **Bioacoustics** (*Marc Lammers*)

A. Results

The nighttime midwater biomass occurring near and on the banks of six Northwestern Hawaiian Islands was investigated using the *Oscar Sette*'s EK60 sonar. The locations investigated included French Frigate Shoals, Maro Reef, Lisianski Island/Neva Shoals, Pearl and Hermes Atoll, Kure Atoll, and Midway Atoll. The waters between the islands were also anecdotally surveyed during transits between locations. A total of 106 survey lines were recorded. Surveys were designed to sample parallel and/or shore-normal locations at each site at different times of the night between 10 PM and 7 AM local time. Daytime control runs of each transect were also conducted when the ship's schedule allowed it.

The following table summarizes the duration and transect length of the data collected at each location.

Location	Collection duration, hours	Total transect length, naut. mi.
French Frigate Shoals	15	65
Maro Reef	10	45
Lisianski/Neva	15	60
Pearl and Hermes	17	90
Kure	8	36
Midway	11	55
Transits between islands	86	770

Preliminary results indicate that a strong diurnal trend exists in the presence of midwater sound scattering organisms at all six locations visited. An informal analysis of the data reveals that a dense community of organisms accumulates on the edge of each island and its associated banks each night between the 20 and 100-fathom bathymetry contours. The densest mass of organisms appears to restrict its horizontal movement to depths of 40 meters or deeper, but considerable increases in biomass along shallower parts were also often observed. The northern islands of Kure, Midway and Pearl and Hermes Atolls exhibited more patchy distributions than the southern islands. These patches were among the densest observed, particularly on the southern side of Pearl and Hermes Atoll.

The composition of the biomass is presently unclear. Simultaneous observations with the TOAD camera system revealed dense clouds of zooplankton mixed with small fish and other micronecton associated with strong returns on the EK60. However, due to the high likelihood of light avoidance on the part of vertically migrating organisms it is likely that these observations may be somewhat biased and not representative of the biomass' composition. The current operation protocol does not allow for direct sampling using a trawl net due to conflicts with other ongoing operations such as the CTD and TOAD.

To complement the sonar data, CTD casts were conducted each night at the northern islands of Kure, Midway and Pearl and Hermes Atolls. A preliminary assessment of this data suggests that a correlation exists between chlorophyll levels and biomass density. The

significance of this correlation is not clear, but points to a relationship with lower trophic levels.

A data reduction and analysis protocol has been developed using Echoview software, but the bulk of the data set will require a more powerful processing computer than is presently available due to the very large file sizes associated with each survey transect.