CRUISE REPORT[1]

VESSEL: *Hiialakai*, Cruise HI-06-02 (Fig. 1)

CRUISE PERIOD: February 9–March 10, 2006

AREA OF OPERATION: American Samoa Archipelago: Swains Island, Tutuila/Aunuu Islands/Taiema Bank, Manua Islands (Olosega, Ofu, Tau), and Rose Atoll

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Division (CRED), Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), NOAA, and partners, conducted coral reef assessment/monitoring and mapping studies in waters surrounding the islands of American Samoa. This American Samoa Archipelago Reef Assessment and Monitoring Program (ASRAMP) cruise is part of NOAA's Coral Reef Conservation Program (CRCP) to conduct biennial monitoring surveys.

ITINERARY:

9-10 Feb. Embarked Robert Schroeder (fish), Paula Ayotte (fish), Craig Musburger (fish), Doug Fenner (corals), Bernardo Vargas Angel (corals), Holly Bolick (macroinvertebrates), Nancy Daschbach (algae), Meghan Dailer (algae), Ben Richards (towboard/fish), Stephane Charette (towboard/fish), Elizabeth Keenan (towboard/habitat), Amy Hall (towboard/habitat), Ron Hoeke (oceanography), Kyle Hogrefe (oceanography), Jamie Gove (oceanography), Stephani Holzwarth (divemaster), Jim Bostick (chamber operator), Katie Fagan (data manager), Scott Ferguson (mapping), Jeremey Jones (mapping), Emily Lundblad (mapping), Jamie Smith (mapping), and Frances Le'iato (local college student/observer). The NOAA ship *Hi'ialakai* departed Pago Pago Harbor at 0900 on 10 February en route to Swains Island (note: change in cruise schedule prompted by poor weather and sea conditions around Tutuila).

[1] PIFSC Cruise Report CR-07-006
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11-13 Feb. Arrived at Swains Island ~0800. REA (rapid ecological assessment) fish and benthic (coral, macroinvertebrates, algae) teams completed surveys at eight monitoring sites along the outer reef slope (Table 1). Tow team (fish and benthic-habitat) completed 14 tows covering the island's entire periphery (at several depths). Oceanography team exchanged (old for new) an STR (subsurface temperature recorder) and placed two new STRs along the west side of island, completed 27 shallow-water conductivity-temperature-depth (CTDs) samples around the island (and in the enclosed brackish water lagoon) with water sampling profiles (for chlorophyll [chl], nutrients, and dissolved inorganic carbon [DIC]) taken at 10 sites. Benthic mapping team in the *AHI* (Acoustic Habitat Investigator) and from the ship, at night, completed multibeam mapping of all substrates to 3000 m around the island. Food provisions sent from Pago Pago were delivered to the few island residents. Ship departed Swains ~1700 en route to Pago Pago.

14-17 Feb. Ship arrived at Pago Pago ~1500; all scientists disembarked (except Holzwarth and Jones) to allow for NOAA-NOS National Marine Sanctuaries (NMS) cruise (HI-06-03). NMS conducted three daily education and outreach cruises from ship for groups of local students to Fagatele Bay NMS.

At same time, the CRED mapping team conducted daily multibeam mapping along north and east sides of Tutuila from the *AHI*. The Oceanography team conducted work in Fagatele Bay, as requested by the Sanctuary (e.g., mooring installations, etc.).

Around 1600 on February 17, embarked Robert Schroeder (fish), Paula Ayotte (fish), Todd Wass (fish), Doug Fenner (corals), Bernardo Vargas Angel (corals), Holly Bolick (macroinvertebrates), Aline Tribollet (algae), Meghan Dailer (algae), Edmund Coccagna (towboard/fish), Stephane Charette (towboard/fish/divemaster), Amy Hall (towboard/fish/ divemaster), Elizabeth Keenan (towboard/habitat), Eric Dobbs (towboard/habitat), Kevin Wong (oceanography), Kyle Hogrefe (oceanography), Charles Young (oceanography), Jim Bostick (chamber operator), Katie Fagan (data manager/ oceanography), Scott Ferguson (mapping), Emily Lundblad (mapping), Jamie Smith (mapping), and Della Tuamoheloa (local college student/observer). Ship departed Pago Pago Harbor by 1800. Conducted shipboard night operations around Tutuila.

18-25 Feb. Conducted field monitoring surveys around Tutuila Island (with Taiema Bank and Aunuu Island), including 22 fish and benthic REA surveys, and 44 fish and habitat towed-diver surveys (~80 km). Deployed or installed 7 STRs, 4 EARs (Ecologcial Acoustic Device), 3 sea-surface temperature (SST) recorders, 1 wave-tide recorder (WTR), and 1 boat mooring (in Fagatele Bay); completed 113 shallow-water CTD casts, with 33 water

samples, and 19 deepwater CTD casts, with 8 water samples (both with chl, nutrients, DIC sampling). The *AHI* conducted daytime multibeam mapping and ship mapped at night to complete detailed bathymetric maps of these areas. On 24 February, disembarked Doug Fenner (corals) and Della Tuamoheloa (local student) from small boat; embarked Jean Kenyon (corals) and an additional ship crew member. On February 25, Oceanography team worked in Fagatele Bay NMS: exchanged a WTR, STR, installed new EAR, SST, and conducted four shallow CTDs (included in above total counts). Departed Tutuila for Ofu/Olosega ~2330.

26 Feb-1Mar. Conducted monitoring surveys around Olosega and Ofu Islands, including 12 fish and benthic REAs and 22 fish and habitat towed-diver surveys (36 km). Deployed or replaced 7 STRs and conducted 34 shallow-water CTDs, with 17 water samples, and 6 deepwater CTD casts, with 6 water samples, (both with chl, nutrients, DIC sampling). Also, completed ~110-km acoustic Doppler current profiler (ADCP) box around the three Manua Islands. The Mapping team from the *AHI* conducted TOAD (towed video camera) operations from 20 to 50 m around these islands and obtained usable video of coral reef substrate and fishes. Some multibeam mapping was conducted from the ship at night to complete gaps from previous visit (Feb 2004) and to map the top of nearby Northeast Bank.

2-4 Mar. Conducted monitoring surveys around Tau Island (~10 km southeast of Olosega), including 9 fish and benthic REAs, and 15 fish and habitat towed-diver surveys (35 km). Deployed or replaced 2 STRs and 1 SST (off village on west side of island) and conducted 35 shallow-water CTDs, with 7 water samples (with chl, nutrients, DIC sampling). Ship repeated the ADCP box around the Manua Islands, as conducted a few days earlier. The *AHI* conducted TOAD (towed video camera) operations around Tau and over the shallow (50 m) seamounts between Tau and Olosega. At night, ship finished mapping top of Northeast Bank, some gaps around Tau, part of Two-Percent Bank (to southwest), and Vailuluu seamount (to northeast).

5-9 Mar. Conducted monitoring surveys around Rose Atoll (outer reef slope and in lagoon), including 14 fish and benthic REAs and 21 fish and habitat towed-diver surveys (47 km). Deployed or replaced 7 STRs and 1 CREWS buoy with settlement plates and conducted 31 shallow-water CTDs, with 7 water samples and 17 deep-water CTD casts, with 13 water samples, (both with chl, nutrients, DIC sampling). The *AHI* conducted shallow-water multibeam mapping of the seafloor around the entire atoll and in the lagoon. On night of 8 March, ship completed a large ADCP transect box around the atoll with deep CTD water samples (totaled above). U.S. Fish and Wildlife Service (USFWS) coral biologist monitored coral population parameters at 14 permanent transect sites both in and outside the atoll.

10 Mar. Completed transit from Rose Atoll and arrived at Pago Pago Harbor ~0800. Disembarked all but six scientists (team leads). For VIP cruise, embarked Governor Tulafono, Lt. Gov. Sunia, and over 30 other agency heads and local leaders/VIPs. Scientific team leads (Schroeder-Chief Scientist/fish REA, Kenyon-benthic REA, Charette-towboard, Hogrefe-oceanography, Ferguson-mapping, and Hall-divemaster) gave short presentations and discussed their research and monitoring activities around the American Samoan Islands with the VIPs.

Oceanography team, operating from steel-tow SAFE boat, conducted work in Fagatele Bay NMS (as requested by Sanctuary Manager): EAR deployment, removed large tree trunk from bottom that was breaking corals, etc.

End of cruise.

Table 1: Cruise statistics for HI-06-02, American Samoa.

	Swains Island	Tutuila	Ofu and Olosega	Ta'u	Rose Atoll
Towed-diver habitat/fish surveys	14	44	22	15	21
Combined tow lengths (km)	18.20	79.84	36.13	34.55	46.61
Fish rapid ecological assessments	8	22	12	9	14
Benthic rapid ecological assessments	8	22	12	9	14
Wave tide recorder (WTR) recovered		1			1
WTR deployed		1			1
SST buoys recovered		4			
SST buoys deployed		4		1	
STRs recovered	1	6	3	3	3
STRs deployed	3	7	7	3	6
EARs deployed		4			
CREWS buoys recovered					1
CREWS buoys deployed					1
Sub-surface boat mooring		2			
SVP drifters		1			2
Small vessel CTDs (33-m max)	27	113	35 + 1 swim	35	31
Small vessel CTDs					

	Swains Island	Tutuila	Ofu and Olosega	Ta'u	Rose Atoll
(200-m max)					
Small vessel water quality profiles (30-m max) taken - 1 profile consists of chlorophyll and nutrient samples at 1 to 4 depths as depth allows.	11	33	17	7	7
Shipboard CTDs (500-m max)	8	14	10		12
Shipboard water quality profiles (1 profile typically consists of chlorophyll and nutrient samples at 2 to 6 different depths.)	8	14	10		12
Nutrient samples – total (shallow + deep CTD)	22 + 48	111 + 51	61 + 44	28 + 0	23 + 40
Cholorophyll samples – total	22 + 48	111 + 51	61 + 44	28 + 0	23 + 40
Dissolved inorganic carbon (DIC) total (Shallow + deep CTD)	9 + 7	30 + 20	35 + 8	18 + 0	15 + 18
ADCP lines run, km	2	3	1	1	4
Multibeam mapping (sq. km)	256	400	Gap fills	Gap fills	269
Scuba dives	101	274	135	99	163

MISSIONS AND RESULTS:

A. Conduct ecosystem monitoring of 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 American Samoa.

1. Continued the monitoring of coral reef habitats of Tutuila, Ofu, Olosega, Ta'u, Rose, and Swains during this cruise. The process included 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. 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 methodology used to survey those sites is documented in Appendix A.3. Survey summaries and Descriptions of sites visited at Tutuila, Ofu & Olosega, Ta'u, Swains and Rose are included within the Benthic Environment and Fish sections of Appendices B, C, D, E, and F, respectively.

2. Towed-diver survey methods were used to provide a general description of reef habitat, invertebrates, and reef fishes over a large spatial scale. This method, described in Appendix A.4, allows monitoring large-scale disturbances and general distribution and abundance patterns of corals, macroinvertebrates, and reef fishes over 50 cm total length. The initial summaries of these data are integrated into the Benthic Environment and Fish sections.

B. Conduct benthic habitat mapping of the reefs and submerged banks surrounding the Tutuila, Ofu, Olosega, Ta'u, Rose, and Swains using ship-based and launch-based multibeam echosounders and underwater towed cameras.

1. Shallow-water multibeam surveying was conducted from the launch *AHI* around the American Samoan Islands to complete coverage of benthic habitat maps initiated in 2004 (OES-04-02). Concentric mapping surveys were conducted at progressively deeper depths around the islands, where needed. In addition, several nearby seamounts were also mapped. The shallow lagoon of Rose Atoll was mapped for the first time. Details, including sample maps, are included in appropriate Appendices.)

2. Towed-diver survey methods were used to record video data that will provide data to ground-truth the high-resolution bathymetry and imagery data collected in depths less than 30 m.

C. Conduct near and offshore oceanographic surveys and deploy a variety of surface and subsurface oceanographic instruments with the goal to quantify, assess, and gain a better understanding of the overall hydrographic environment (e.g., water temperature, salinity, nutrients, currents).

1. The Oceanography Team deployed a variety of surface and subsurface oceanographic instruments and conducted near and off-shore oceanographic surveys at Swains Island, Tutuila Island, Ofu-Olesega Islands, Ta'u Island and Rose Atoll in order to quantify and assess the overall hydrographic environment affecting these coral reef systems. Water sample profiles were conducted at a subset of the CTD sites. Deepwater CTD casts and water sample collections were performed along acoustic Doppler current profiler (ADCP) transects around each study area. ADCP data were also collected during all mapping activity and transits. For the most part, the data collected by the oceanography team require extensive post-cruise processing and analysis not allowing for an immediate summary of findings. Refer to See Appendix A.2 for a description of methodologies and to Appendices B.2, C.2, D.2, E.2, and F.2 for summaries of the work conducted at each site.

2. Both shallow (30 m, day) and deep (500 m, night) shipboard CTD casts were conducted; water samples were collected for nutrient, carbon, and chlorophyll analysis. Shipboard ADCPs were also obtained.

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

Initiated the monitoring of coral and coralline algal diseases in reef habitats during this cruise. Surveys were conducted in conjunction with the continued long-term monitoring of fish, coral, invertebrates, and algae. The methodology used is documented in Appendix A.3. Survey summaries and Descriptions of sites visited are included within the Benthic Environment sections of Appendices B, C, D, E, and F respectively.

E. Continue efforts at education and outreach for local students.

Two local students from the American Samoa Community College participated on the cruise as observers. Frances Le'iato participated on the leg to Swains Island and Della Tuamoheloa participated on the leg around Tutuila. Both had opportunities to participate and interact with all of the small-boat field survey teams. Their experience proved to be very positive, and local student participation is recommended for future cruises.

SCIENTIFIC PERSONNEL:

Robert Schroeder, Chief Scientist, Fish REA Team, University of Hawaii (UH)-Joint Institute for Marine and Atmospheric Research (JIMAR)/Coral Reef Ecosystem Division (CRED)
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Paula Ayotte, Fish REA Team, UH-JIMAR/CRED
Todd Wass, Fish REA Team, UH-JIMAR/CRED
Doug Fenner, Benthic REA Team (corals), Am. Samoa DMWR
Bernardo Vargas-Angel, Benthic REA Team (corals), UH-JIMAR/CRED
Jean Kenyon, Benthic REA Team (corals), UH-JIMAR/CRED
James Maragos, Benthic REA Team (corals), U.S. Fish and Wildlife Service
Holly Bolick, Benthic REA Team (macroinvertebrates), B.P. Bishop Museum
Nancy Daschbach, Benthic REA Team (algae), NOAA-Fagatele Bay NMS
Meghan Dailer, Benthic REA Team (algae), UH-JIMAR/CRED
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Stephani Holzwarth, Towboard Team-Fish/Divemaster, UH-JIMAR/CRED
Ben Richards, Towboard Team-Fish/Data Mgr./Divemaster, UH-JIMAR/CRED
Stephane Charette, Towboard Team-Fish/Divemaster, UH-JIMAR/CRED
Amy Hall, Towboard Team-Fish/Divemaster, UH-JIMAR/CRED
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Jamie Smith, Mapping Team, HMRG-Univ. Hawaii
Jim Bostick, Chamber Operator, NOAA-NDC
Frances Le'iato, Student observer, Am. Samoa Comm. College
Della Tuamoheloa, Student observer, Am. Samoa Comm. College

DATA COLLECTED:

- Fish REA numerical and biomass densities by species
- Digital images of fish-habitat associations
- Target REA macroinvertebrate counts
- Macroinvertebrate voucher specimens
- Algal voucher specimens
- Algal REA field notes of species diversity and relative abundance
- Digital images from algal photoquadrats

- Quantitative towboard surveys of large fish species (>50 cm TL)
- Digital video surveys of fish from towboard transects
- Benthic composition estimations from towboard surveys
- Macroinvertebrate counts from towboard surveys
- Digital images of the benthic habitat from towboard surveys
- Habitat lineation from towboard surveys
- Shallow-deep conductivity, temperature and depth (CTD) profiles
- Water samples for nutrient analysis (including chlorophyll)
- Multibeam maps of benthic habitat around the islands and select seamounts

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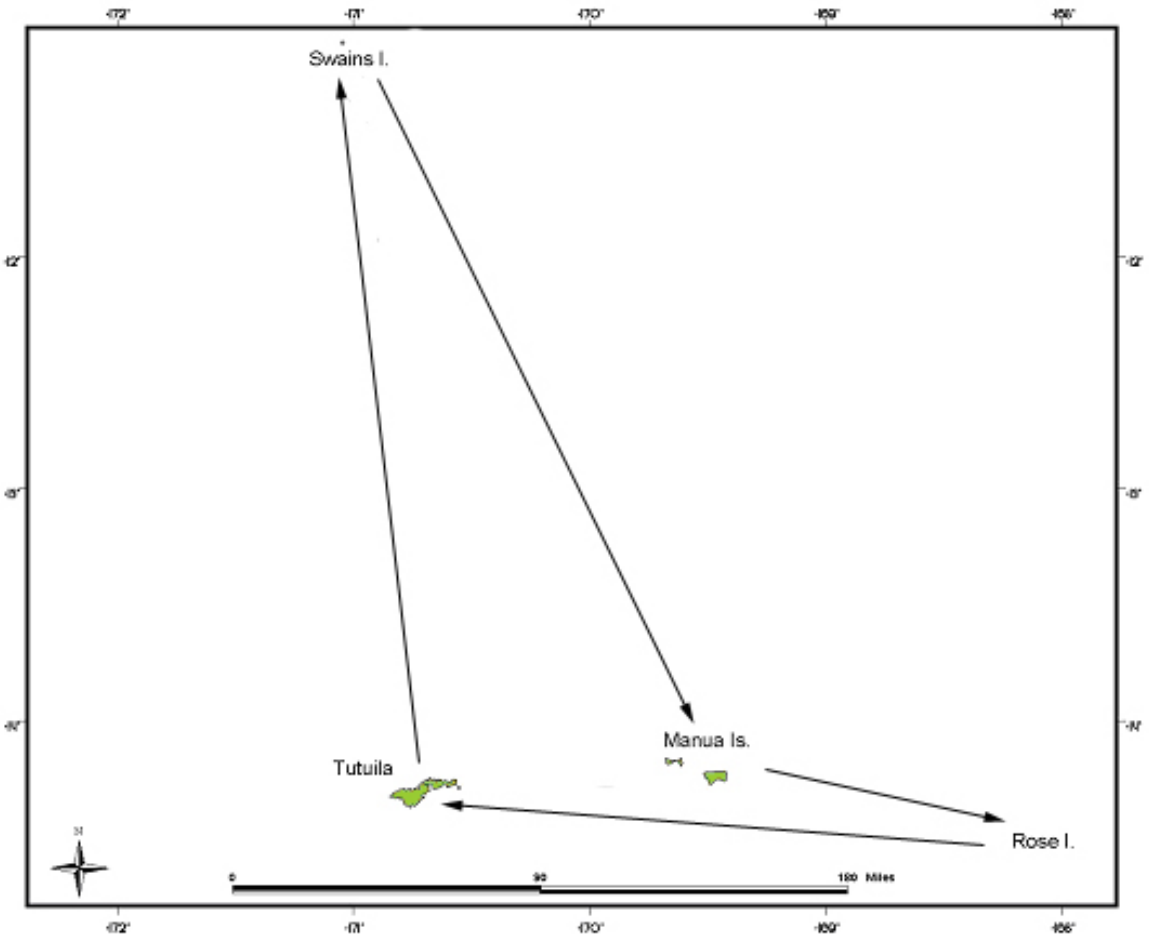

Figure 1.--American Samoan Islands surveyed on HI-06-02.

Appendix A: Methods

A.1. Benthic Habitat Mapping Methods
(Emily Lundblad, Jeremey Jones, Jamie Smith, and Scott Ferguson)

System Descriptions
Multibeam mapping capability for cruise HI0602 included two shipboard multibeam echosounders (Kongsberg EM300 and EM3002D) and the Reson 8101ER multibeam aboard the 8-m launch R/V *AHI*. Table A-1 provides an overview of the three multibeam sonars and their capabilities.

Table A-1 HI0501 Sonar Capabilities

Sonar	Vessel	Freq. (kHz)	Depth Range (m)	Beam Size (deg)	Number of Beams
EM300	*Hi'ialakai*	30	30-3000	1 ½ x 1 ½	135
EM3002D	*Hi'ialakai*	300	2-150	1 x 1	320-508
Reson 8101ER	*AHI*	240	2-250	1 ½ x 1 ½	101

In addition to the multibeam sonars, each vessel was equipped with an Applanix Position Orientation Sensor for Marine Vessels (POS/MV) vertical reference system, which provides timing, position, velocity pitch, roll, heave, and heading information for correction of motion in the multibeam data. Three different conductivity-temperature-depth (CTD) sensors were used to provide sound velocity profiles (SVPs) that are critical for proper correction of sound velocity errors associated with multibeam data.

All sensors on both vessels were interfaced to the SAIC ISS-2000 data acquisition and survey control system, which includes survey planning, data acquisition, and data processing capabilities.

Methods for acquisition and post processing
Prior to the HI0602, data were assembled to provide a baseline for acquisition of multibeam data. These data included: grids of multibeam bathymetry data from previous cruises to American Samoa; IKONOS imagery; predicted tides for stations 170000 Pago Pago; tide zones corrections (provided by NOAA Center for Operational Oceanographic Products and Services); and preliminary survey plans. At Tutuila, Northeast Bank, Two-Percent Bank, Vailulu'u, and the Manu'a Islands, Pago Pago predicted tides were used with no corrections; at Rose Atoll, Pago Pago tides were used with +0.1 hr time correction and a range ratio of 0.92; and at Swains Island, Pago Pago predicted tides were used with a -0.5 hr time correction and a 1.12 range ratio. These data were integrated into the ISS-2000 software either before or during the first part of the cruise. In addition, existing grids, and tow location data from 2001 to 2004 cruises were assembled and integrated into the Arc 9 Geographic Information System (GIS).

The ISS-2000 survey system is used on both the ship and the launch, enabling seamless sharing of data between the two vessels. The Generic Sensor Format (GSF), which is implemented in the ISS-2000 system, allows logging of multibeam data from a variety of

multibeam sonars into a single, standardized format; the GSF also provides integrated metadata within the real-time multibeam files. In addition, the ISS-2000 creates digital message logs that allow full traceability of software and real-time events.

During system configuration, all vessel offsets are entered into either the POS/MV, the sonar, or into the ISS-2000. In addition, predicted tides are calculated for all tide zones to be surveyed and then recorded into the data in real time. Survey plans can be loaded into the real-time system on both vessels; coverage grids that are generated in real time during data acquisition can be viewed during planning, acquisition, and processing phases.

SVPs are taken at the beginning of each 12-hour period of surveying on the ship and each 8-hour day of surveying on the *AHI*. Standardized survey procedures, including a 2-minute warm-up on deck and a 2-minute surface equilibration, are used on every cast. After the sound velocity cast is done, the data are downloaded with VelocWin software on the ship and with the SeaBird software on the launch. Sound velocity profiles are loaded using the ISS-2000 download utility; the downloaded profiles are sent to the two Kongsberg sonars on the ship and to the Reson sonar on the *AHI*, and the sound velocity information is logged as a part of the GSF. A real-time probe is used on the ship to monitor the surface sound velocity; if a difference between the surface sound velocity SSV and the sound velocity profile (SVP) at the surface is greater than 3 m/sec, an alarm is generated. The sonar on the *AHI* is less susceptible to SSV errors, and the daily casts are generally sufficient to correct for sound velocity. In all cases, the data are carefully monitored for sound velocity artifacts using the real-time displays.

During real-time operations, the ISS-2000 operator starts the ISS-2000 software, making sure to load the appropriate system configuration file. The System Control and Message windows are loaded at that time. The operator creates a dataset for the entire cruise that is named with the corresponding cruise delineator; *Hi'ialakai* and *AHI* data were logged into separate datasets (HI0602 and AHI0602) for file management purposes. After the dataset is created and all configurations are checked, "Start Survey" is selected and the Navigation Manager, Multibeam Manager, and Helm Display windows are opened. Text icons for all programs appear in the System Control window; the icons can be colored white, yellow, red, or green. White means that the program is selected but not activated; yellow means the program is activated but not logging; red means that there is a problem with the program; and green means that the program is operating and data are being logged. Files are automatically created for all multibeam sensors, for navigation inputs, for the POS/MV vertical reference, and for the messages generated by the system. Predicted tide files that can be used throughout 2006 were prepared before the cruise and were applied to the multibeam data in real time.

After the ISS-2000 Navigation Manager is started, a survey plan created is chosen and one or more surveys are selected for execution. Tide zones, existing coverage grids, and navigational charts can be loaded into the display, if desired. The navigated ship icon appears on the screen. Survey lines are then selected from the survey file or made in real time and loaded into a Survey Schedule; lines can be selected in any order and their

azimuth can be reversed; these lines appear on the screen when loaded into the schedule. When survey lines are being run in Survey Mode, the multibeam data is almost always logged (if logging is activated), but may be flagged as either "on-line" or "offline." During transits, survey can be done in the "Underway Mode," but a flag must be set to not flag the off-line data during transits. If a coverage grid is loaded using the Coverage Monitor program and enabled for real-time logging, multibeam data is added to the coverage grid in real-time.

The Helm Display is also activated when the survey is started. This Helm Display appears both on the survey lab screens and on a screen on the bridge, and screen display parameters can be manipulated at either location. The same coverage grids, navigation charts, and survey lines selected in the Navigation Manager interface appear on the Helm Display as well; however, the display of these grids, charts, and lines can be turned on and off in the Helm Display independently of the Navigation Manager. The Helm Display can also be changed to different scales and color schemes than what is displayed on the Navigation Manager. The ISS-2000 feature, display of the coverage grids on the Helm Manager, enabled the bridge to steer lines in underway mode based upon existing coverage rather than always needing to create a formal survey line for the bridge to follow.

The Multibeam Manager is used to monitor the status of data files, to view and apply SVPs, and to view the multibeam bathymetry and backscatter data in real time. Many problems with the data can be detected immediately using feedback from these real-time displays. The Kongsberg SIS interfaces for the EM300 and the EM3002 are mounted above the two ISS-2000 screens and other multibeam displays that provide different views of the data are available through SIS. Backscatter displays for all systems showed distinct and intriguing bottom types, but the ultimate quality of the data from the different sonars cannot be evaluated until data processing is complete.

During HI0602 aboard ship, multibeam data were collected during night operations and, when data gaps existed closer to shoals than 1.8 km, during the day time. The EM300 was used for depths between 100 m and 3500 m, where the mapping limits of data acquisition are reached. Shipboard mapping commenced for 6 nights at Tutuila, 2 nights and 1 day at Swains, 1 night and 1 day at Rose, 4 nights filling data gaps near the Manu'a group, and 4 nights at other seamounts.

The *AHI* was deployed for 9 days at Tutuila, 1 day at Swains, and 2 days at Rose. The *AHI* was operated from 0800 to 1630, and data collection was concentrated in depths between 10 and 250 m.

HI0602 data were logged to two disks simultaneously in real time. The ISS-2000 AutoArchive program, which copies the data to a third permanent archive disk was run as needed during post processing. The AHI0602 dataset was logged on the real-time computer in the launch, and a second copy of the data was manually made on a portable disk; the disk was then moved to the ship and connected to the shipboard computers, and the data were read to the permanent archive disk. A final copy of all data was made to

the PIBHMC network disks, and data processing was done on only this copy of the data. The SABER data processing package, which provides full multibeam processing capability, was primarily used to manually edit the multibeam data in GSF, to plot tracklines, to update SVPs and tide data when necessary, and to create gridded data sets using the Pure File Magic (PFM) format that enables editing the integrated data set within the grid as well as reading any edits made in the grid back to the GSF multibeam files. Tape backups of all processed data were made. The gridded data sets were converted to ASCII files for conversion to Arc raster grids. Map products were made as grids were created and added to the GIS product archive.

Backscatter data are logged as part of the GSF multibeam file and will be processed at PIBHMC after return to Honolulu.

In 2004, shallow-water multibeam surveying was conducted with the *AHI* during the Reef Assessment and Monitoring Program (RAMP) cruise OES0402. Those surveys resulted in complete multibeam coverage around Ofu, Olosega, and Ta'u (to depths of 250 m) with similar coverage of approximately 60% of the banks surrounding Tutuila. In addition, substantial amounts of multibeam data have been collected in American Samoan waters by academic research ships. These data were derived from the Seamount Catalog (http://earthref.org) with more recent data from the University of Hawaii ships R/V *Kilo Moana* and *Kaimi'kai O Kanaloa*. Prior to departure, these data were synthesized into grids that depicted existing coverage in all the areas which work was planned on HI-06-02. Only Swains Island had no prior multibeam surveys; all other areas had existing deepwater coverage.

In 2006, multibeam mapping coverage (sq. km.) around the American Samoa Islands totaled 1,114 sq. km: Swains Island = 256, Tutuila = 400 (214 on banks and 186 in deep water), Manu'a Group = gap fills in deep water, Rose Atoll = 269, Northeast Bank = 49, Two-Percent Bank = 80, and Vailulu'u Seamount = 60.

A.2. Oceanography & Water Quality Methods

(*Kyle Hogrefe, Ronald Hoeke, Jamison Gove, Katie Fagan, Charles Young, and Kevin Wong*)

Since 2002, the Coral Reef Ecosystem Division has been conducting multidisciplinary research around the islands and atolls of American Samoa. Considering that the oceanographic component of this research has been well established, the recovery/redeployment of instrument platforms and the continuation of oceanographic measurements represent an ongoing effort of monitoring and assessment. During HI0602, the oceanography team utilized both well established and new methods to monitor long-term trends and assess oceanographic conditions.

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

1. Coral Reef Early Warning System (CREWS) buoys: Surface buoys which measure solar radiation, air temperature, wind speed and direction, sea surface temperature, salinity, turbidity, and (on enhanced models) photosynethtically active chlorophyll. CREWS buoys telemeter a portion of their collected data in near real time.

2. Sea Surface Temperature (SST) buoys: Surface buoys which measure high resolution water temperature and telemeter their data in near real time.

3. Wave and Tide Recorders (WTR): Moored instruments which measure spectral wave energy, precision tidal elevation, and subsurface water temperature.

4. Ocean Data Platforms (ODP): Moored instruments which measure subsurface temperature, salinity, directional spectral wave energy, precision tidal elevation, and current profiles.

5. Subsurface Temperature Recorders (STR): Moored instruments which measure high resolution subsurface temperatures.

6. Surface Velocity Program (SVP) Drifters: Free floating, drogued (Lagrangian) devices which provide surface layer circulation and water temperature data. Satellite drifters telemeter their data in near real time.

7. Recruitment Plate Arrays (RPA): An arrangement of ceramic tiles embedded in a PVC framework and affixed to both CREWS buoy and ocean data platform (ODP) anchors. These arrays are deployed to support studies by Jean Kenyon and are intended to monitor the recruitment patterns of coral species.

The Oceanography Team deployed a variety of surface and subsurface oceanographic instruments and conducted near and offshore oceanographic surveys at Swains Island, Tutuila Island, Ofu-Olesega Islands, Ta'u Island, and Rose Atoll in order to quantify and assess the overall hydrographic environment affecting these coral reef systems. For Swains Island, the Oceanography Team consisted of Kyle Hogrefe, Ronald Hoeke, Jamison Gove, and Katie Fagan. For Tutuila Island, Ofu-Olesega Islands, Ta'u Island, and Rose Atoll, the Oceanography Team was comprised of Kyle Hogrefe, Katie Fagan, Charles (Chip) Young, and Kevin Wong.

Oceanographic assessments are accomplished by:

1. Shallow Water CTD casts (max 30 m), including turbidity measurements, are performed using an SBE 19+ at regularly spaced intervals around each island/atoll/shoal. These casts sample vertical water profiles of water properties providing indications for water mass movement and local seawater chemistry changes.

2. Water samples are collected during both shallow-water and deepwater (below) CTD casts. Water sample profiles are conducted as a subset of the shallow water CTD casts. Water samples are collected using a hand deployed Niskin bottle string at depths of 30 m,

20 m, 10 m and 1 m as allowed by the depth at each cast site. Water samples are collected for nutrient and chlorophyll concentration at each depth while dissolved inorganic carbon (DIC) sampling is collected from the 30-m and 1-m bins depending on the samples type(s) desired from each site.

3. Deepwater CTD casts (max 500 m) are performed at evenly spaced intervals around each island/atoll. Water samples are collected at 150 m, 125 m, 100 m, 80 m, 30 m and at the surface (~3 m). These casts sample vertical water profiles of water properties providing indications for water mass movement, local seawater chemistry changes, and chlorophyll concentration. Water samples are collected for nutrient and chlorophyll concentration at each depth while dissolved inorganic carbon (DIC) sampling is collected from the 30-m and 3-m bins depending on the samples type(s) desired from each site.

4. Acoustic Doppler current profiler (ADCP) data provide information on oceanographic current structure from the surface to 600 m. ADCP box transects were conducted in conjunction with deepwater CTDs around each island/atoll as well as during transits and most other vessel activity.

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

Protocol 1: Water Sampling Methods – ASRAMP-HI0601 (*Chip Young/ Kyle Hogrefe*)

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

Lab preparation**:**
Prepare an oil-free vacuum pump in line with a vacuum filter system for filtering the seawater grab samples. Be sure to set up a water "safety" reservoir to help ensure that sample water filtrate isn't drawn into the pump. Water in the pump will damage it. The filters used in this chlorophyll-a filtration procedure are 25-mm GFF filters from Millipore. Prepare for sample storage by placing label tape on chlorophyll tube and placing in rack. Have aluminum foil ready to wrap tubes once filters have been placed inside.

Field preparation:
Use the uniquely labeled brown rectangular 125-ml HPDE bottles for seawater sample collection. These bottles have been precisely measured for volume. Store the bottles for sample collection in the cooler marked "Water Sampling" with available "blue ice" packages. Ensure that each bottle has been thoroughly rinsed three times with deionized water (DIW). It is important to have brown bottles to limit further light exposure to the samples and use the "blue ice" to keep the samples cool and slow the metabolic activities

of organisms present within the sample. Four Niskin bottles, four messengers, and the ~35-m deployment rope are needed to take grab samples at depth. The entire setup for water sampling can be stored in the plastic red tub. Samples are recorded on the Mooring team data log sheet for CTD and Water Sample casts.

Sample collection:
Five-L Niskin bottles, deployed from a small boat, are used to collect seawater samples at various depths. The standard sampling depths are 1, 10, 20, and 30 meters deep, and the deployment line is marked as such. The seawater collected in each Niskin bottle is then subsampled and collected in the uniquely labeled brown rectangular 125-ml HPDE bottles. Ensure that each sample bottle is filled to the brim. The seawater samples are filtered/processed in the ship's laboratory later that night. The balance of the seawater in the Niskin bottle is discarded. On the data log sheet annotate the CTD cast ID, the PRR file(s), latitude and longitude, date, time, water depth and sample bottle number and sample depth. For "small boat" grab samples, sample labels are constructed as follows: (a) the first three letters of the location from which the sample was taken, (b) the CTD cast number - sequential for work site, (c) the sample bottle number, and (d) the depth at which the sample was taken. The depth notation will follow a convention of 1-m samples = "A", 10-m samples = "B", 20-m samples = "C", and 30-m samples = "D". (Example: a sample taken from Howland Island from CTD cast 003 in HPDE bottle C01 from 1 meter would be denoted HOW003C01A.) Deepwater water samples may also be taken from Niskin bottles mounted on the ship's CTD rosette with water samples being collected from 150, 125, 100, 80 and 3 meters. These "shipboard" grab sample labels are constructed as follows: (a) cruise number, (b) CTD cast number – sequential for entire cruise, (c) the sample bottle number and depth. (Example: a sample taken during HI0601 from the 21st cast of the cruise collected in HPDE bottle C16 from 125 meters would be denoted HI0601021C16_125.)

Sample processing:
Once back in the lab with the seawater samples, prepare individual labels for each sample on lab tape, identifying the sample ID, using the label convention mentioned above. Place one label on one chlorophyll tube. Prepare the vacuum system by thoroughly rinsing the filtration funnels and filter grids with deionized water (DIW). Using forceps, which are DIW rinsed and dried with Chemwipes, place one 25-mm GFF filter per filter grid and secure the filtration funnel on top of the filter/filter grid assembly. Pour the seawater sample from the 125-ml bottle into the funnel and turn on the vacuum to draw water through the filter. Rinse the 125-ml bottle with DIW, shake and pour the rinse into the filter funnel to be filtered as well. Also, rinse the sides of the funnel with DIW to ensure that the entire sample has passed through the filter. The vacuum system CRED has is an in-line 3-filter system which allows three samples to be drawn at the same time. The vacuum drawn on each funnel can be controlled with a nozzle control found at the base of each funnel. After the entire sample has been filtered, turn off the pump and disconnect the funnel. Remove the filter with DIW-rinsed forceps, fold it twice so that it fits in the tube, and place the sample filter in its appropriately labeled chlorophyll tube. Be careful not to cross contaminate the samples while folding the filters and placing them in the tube. This can be done by restricting your touch on the filter to the edges and by

not touching the middle of the filter. Once all four filters from a water sample profile (five from a deepwater "shipboard" cast) are placed in their respective tubes, close the tubes with plastic caps and wrap all tubes from the profile in a large piece of aluminum. Label the outside of the aluminum package with just the site identifier and cast number (Example from above: Shallow-water – HOW003, Deepwater – HI0601021). The purpose of the aluminum foil is to shield the filters and samples from light. Place the samples into the ship's -30˚ C freezer for storage.

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

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

Summary of oceanographic data collection and instrumentation activities:

1. A total of 1 CREWS Buoy, 5 SST buoys, 2 WTRs, 26 STRs, 7 SVP drifter buoys and 1 RPA were deployed during the cruise. In addition to these standard CRED instruments, 4 Ecological Acoustic Recorders (EARs) were deployed around Tutuila. Saving the exceptions detailed below, all deployments were replacements of existing instrumentation to assure the continuity of data for the assessment of oceanographic conditions.

2. Shallow-water CTD casts were performed at 241 sites and water samples profiles were conducted at 73 sites throughout the cruise. Water sample profiles were conducted at a subset of the CTD sites.

3. Deepwater CTD casts and water sample collections were performed along ADCP transects around each study area for a total of 11 ADCP transects, 47 CTD casts and 43 water sample profiles (Table 3). Fourteen deepwater CTD casts were performed from the vessel and 12 were conducted from the *AHI* to provide SVPs to support the mapping effort (refer to the mapping section for SVP purpose). These casts will also be analyzed as part of the Oceanography data set (Table 3).

4. ADCP data was also collected during all mapping activity and transits.

5. For the most part, the data collected by the oceanography team requires extensive post-cruise processing and analysis not allowing for an immediate summary of findings.

A.3. Rapid Ecological Assessment (REA) Methods

(*Fish: Robert Schroeder, Craig Musburger, Todd Wass, and Paula Ayotte; Corals: Bernardo Vargas Angel, Douglas Fenner, Jean Kenyon, and Jim Maragos; Algae: Megan Dailer, Nancy Daschbach, and Aline Tribollet; Macroinvertebrates: Holly Bolick)*

The survey methodology used during HI0602 is the same as previously used during REA surveys conducted in 2004, when long-term monitoring sites were selected and surveyed by the full REA team (fish, corals, algae, and other invertebrates). At each REA site, three 25-m transect lines were laid out by the fish team, separated from each other by approximately 4–5 m. At most sites, transects were laid out at 13–15 m deep. REA methods for each specific discipline are as follows.

A.3.1 Fish

Quantitative belt transects (BLT), stationary point counts (SPC), and REA surveys (species presence) were conducted at station sites following CRED's standard protocol as follows:

Fish transect stations consisted of three consecutive 25-m lines set along a single depth contour at 13–15 m. As each line was set, the observers swam about 5 m apart along either side along each side of the line, counting and recording size classes for all fishes >20 cm total length (TL) within an area 4 m wide and 4 m high. At the end of each 25-m line, the divers turned around and, while remaining on either side of the line, began counting and recording size classes of all fishes within 2 m of their side of the line and 4 m off the bottom. Four stationary point counts were made at each transect station, generally ~15 m from the transect line. SPCs consist of the diver counting and recording the size classes for all fishes >25 cm total length observed in a cylindrical volume 10 m in radius during a 5-minute period. In addition, the divers recorded the species of fishes seen outside the transect area and outside the SPC counts on an opportunistic basis. During REA surveys, the divers record all species observed during the dive. These observations of the diversity are combined with fish observed by other divers (benthic team, tow team, or mooring team) to develop an island-wide cumulative listing of all fish species seen. Monitoring stations were primarily those visited during the two previous CRED cruises to American Samoa. The benthic team (corals, algae, invertebrates) followed the fish team at all survey sites. A number of fish (listed elsewhere) with uncertain identifications, as in 2004, were photographed for subsequent species confirmation.

From February 11 to March 9, 2006, the fish census team (Robert Schroeder, Paula Ayotte, Craig Musburger, or Todd Wass) surveyed 65 total REA stations: 8 at Swains, 22 at Tutuila, 12 at Olosega/Ofu, 9 at Tau, and 14 at Rose).

A.3.2. Algae

Macroalgae were identified to genus in the field, and ranked abundance of algal genera was collected from 12 quadrats (0.18 m^2) at each site (1 being the most abundant, 2 being the next most abundant, etc., with 10 being the maximum number of genera found in a single quadrat). Six quadrats were located at random points along the first two transects (3 per transect), and 6 quadrats were located at points 3 m perpendicular from each random point in the direction of shallower water. Additionally, samples of macroalgae present within each quadrat were collected as voucher specimens (Preskitt et al., 2004). A random swim at the end of each dive augmented macroalgal collections attained from quadrats and allowed cryptic species that predominantly occurred in shaded areas to be qualitatively recorded. Because of difficulties with identification in the field, algae that fell within the functional groups of turf, cyanophytes, branched coralline algae, and crustose coralline algae were lumped into their respective categories. All ranked data were collected by the same individual to minimize the effects of observer bias.

A.3.3 Corals

Because of changes in personnel during the cruise (i.e., Jean Kenyon replaced Doug Fenner on February 25), the completeness of the coral REA protocol varied somewhat between islands. Throughout most of the cruise the first two 25-m transect lines, previously laid out by the fish team, were surveyed for number of coral colonies/genus, maximum diameter of each colony, and health. All corals whose colony center fell within 0.5 m on each side of the transect line were enumerated and assigned to one of 7 size classes: <5 cm, 6-10, 11-20, 21-40, 41-80, 81-160, and >160 cm. Raw transect data are used to estimate population abundance, density, generic richness (a proxy for biodiversity), and size class distribution. In addition, Vargas Angel used the line intercept method at 50-cm intervals along the first two of three transects laid out by the fish team to calculate the percent live cover of salient benthic components (live coral, dead coral, pavement, sand, coralline algae, macroalgae, other benthos).

At Swains, at each REA site the first two 25-m transect lines previously laid out by the fish team were videotaped by Fenner. The tapes provide a permanent record of the condition of the benthos and can be used to extract an independent estimate of coral percent cover for comparison with estimates derived from the line-intercept method used by Vargas Angel at each REA site. After videotaping, Fenner surveyed in the reverse direction along the transect lines for coral population parameters, covering 50 m^2 at each site.

On Tutuila, Fenner recorded videotransects and surveyed coral colonies along both transect lines for population parameters on February 18 and 19. No videotransects or coral population parameters were recorded between February 20 and 21. Between February 22 and 24, Vargas Angel recorded coral population parameter data. During this time, in some cases, limited bottom time only allowed for population density surveys on the first transect only. Finally, Kenyon recorded videotransects and conducted coral population parameter surveys on February 25. At all Tutuila sites, Vargas Angel used the line intercept method at 50-cm intervals along the first two transect lines to calculate the percent live cover of benthic components.

Coral survey methodology used in the Manu'a group and Rose Atoll was the same as previously used during coral REA surveys conducted in American Samoa in 2004, when long-term monitoring sites were selected and surveyed by the full REA team (fish, corals, algae, and other invertebrates). At each REA site, the first two 25-m transect lines previously laid out by the fish team were videotaped by Kenyon. After videotaping, Kenyon surveyed for coral population parameters in the reverse direction along the transect lines. Depending on colony density, the areas between 25 and 50 m^2 were surveyed at each site. Digital photographs showing an overview of site characteristics (e.g., slope, topographical relief) and the typical nature of the benthos at each site were taken as well.

At Rose Atoll, Dr. James Maragos, Coral Biologist with the U.S. Fish and Wildlife Service, conducted independent surveys along the fish transect lines at several sites and surveyed along more shallow depths at sites where he has established permanent transects during previous visits to Rose. Details on the methodology and results of this investigation are included in Section 3.2.1.

Vargas Angel also surveyed a distance of 3-4 m on each side of the transect lines to document incidence of coral bleaching and/or disease and to record additional species of corals not occurring within transects. Each diseased coral colony was identified to the lowest taxonomic level possible and the following information was recorded: (1) colony size; (2) type of affliction (bleaching, tissue loss, tumor, growth anomaly, necrosis, discoloration, parasites, predation, other); (3) area affected (percent live/dead); (4) severity of the affliction (mild, moderate, marked, severe, acute); and (5) photographic records and tissue samples were collected as needed for further disease characterization. The disease data will be used to estimate disease incidence and prevalence; samples and photographs will be used to aid in further disease characterization.

A.3.4. Macroinvertebrates

Quantitative counts for specific target marine invertebrates were conducted along two separate 2 x 25-m belt transects. This was followed by two 10 x 25-m quadrat surveys accomplished by swimming a zigzag search pattern. A quadrat survey was conducted in conjunction with both 2 x 25 transects, which were used as the reference line for the long axis. The counts from these two 10 x 25 quadrats were combined into a single 10 x 50-m 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 central and southern Pacific, and they are species that are generally visible (i.e., non-cryptic) and easily enumerated during the course of a single 50-60-minute scuba survey.
These target species were:

CNIDARIA
Zoanthids – rubber corals
Actiniaria - Anemones

ECHINODERMS
Echinoids – sea urchins
Holothuroids – sea cucumbers
Ophiuroids – brittle stars (generally cryptic but are visible in some cases)
Crinoids – feather stars

MOLLUSCA
Bivalves – ark shells, spondylid oysters, pearl oysters, tridacnid clams
Nudibranchs – sea slugs
Gastropods – snails
Cephalopods - Octopus

CRUSTACEA
hermit crabs, lobsters, large crabs and shrimp

Collections of species that cannot 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 HI-02-06 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 rapid assessment scheme, which will be included in a final species inventory at a later date.

A.4. Towed-diver Survey Methods

Shallow water habitats were surveyed using pairs of towed divers on towboards equipped with a downward-looking high resolution digital still camera with dual strobes (benthic towboard) and forward-looking digital video camera (fish towboard) to quantify habitat composition and complexity and abundance and distribution of ecologically and economically important fish and macroinvertebrate taxa. The downward-looking camera was maintained ~1 m of the bottom and was programmed to photograph benthic substrate every 15 seconds. The benthic towboard was also equipped with paired red lasers to project a 20-cm scale onto the digital imagery. The diver-observer on the benthic towboard observed and recorded habitat composition and characteristics (substrate percentages) and tallied conspicuous macroinvertebrates (crown-of-thorns, urchins, sea cucumbers, giant clams, octopus, lobster) and marine debris over 5-minute ensembles. The diver-observer on the fish towboard recorded fish greater than 50 cm total length within limits of visibility for 1 minute followed by all fish within a 10-m swath for 4 minutes. These 5-minute segments corresponded with the same 5-minute ensembles used by the benthic observer. Both towboards were instrumented with high precision temperature and depth recorders (Seabird SBE39). Global Positioning System positions,

temperature, and depth were recorded every 5 seconds along each transect. The data were downloaded and presented in an ArcView GIS and overlaid on high resolution IKONOS imagery.

A.5. Terrestrial Survey Methods

No terrestrial surveys were performed on this cruise.

Appendix B: Tutuila Island

B.1 Benthic Habitat Mapping

Multibeam operations were conducted between February 15 and 25 on the northern and western banks surrounding Tutuila. The first 3 days were *AHI*-based mapping while the ship conducted HI-06-03, the NMSP education/outreach cruise. As the ship departed Pago Pago on February 17 to resume HI-06-02, the ship's Position Orientation Sensor for Marine Vessels (POS/MV) was found to be not working. Extensive troubleshooting was conducted, but the problem could not be resolved so no night operations were conducted. The next day the problem was discussed with the manufacturer's technical representative while the *AHI* conducted daytime mapping. That evening (February 18) the *AHI*'s rack mounted POS controller system (PCS) was temporarily removed from the launch and installed onboard ship, where it was used to conduct shipboard mapping operations. The next day the PCS was returned to the *AHI* for more daytime mapping. Swapping the unit between the *AHI* and the ship was relatively straight forward so the PCS was moved between the vessels on a daily basis, which prevented the malfunction from affecting the mapping mission. In summary, daytime mapping was conducted from the *AHI* on February 15-21 and February 23-24, while nighttime mapping was conducted from the *Hi'ialakai* on February 18-21 and February 23-24.

Tutuila is a highly eroded, volcanic structure bounded by a bank (Fig. G-2) that extends 3 km or more from the shore in most locations. Around the perimeter of the bank is a feature that appears to be a relict atoll ranging from 10 m down to 50 m. Immediately outside the atoll-like structure the bank drops off sharply. Late stage volcanic eruptions formed the island of Aunu'u and the large flat Tafuna plain. The Tafuna plain eruption evidently buried a large portion of the southern bank and reef inside the atoll. The lava flows appear to have been bounded by the atoll-like structure and where the plain exists there are no banks -- just a steep drop to depth. Inside the outer atoll-like structure there are complex features including what may be a less well-defined inner atoll-like structure. One of the important characteristics of this complex bank structure is profusion of hard, probably carbonate structures that may contain live coral. Many of these are well over a kilometer off the island.

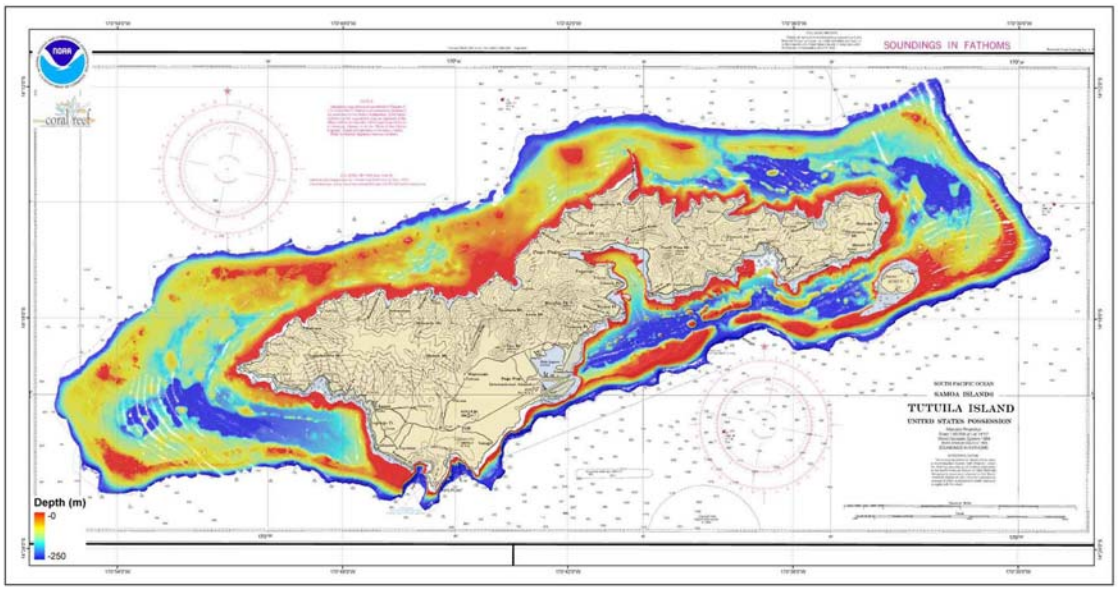

Figure B.1-1: Multibeam bathymetry surrounding Tutuila.

B.2. Oceanography & Water Quality

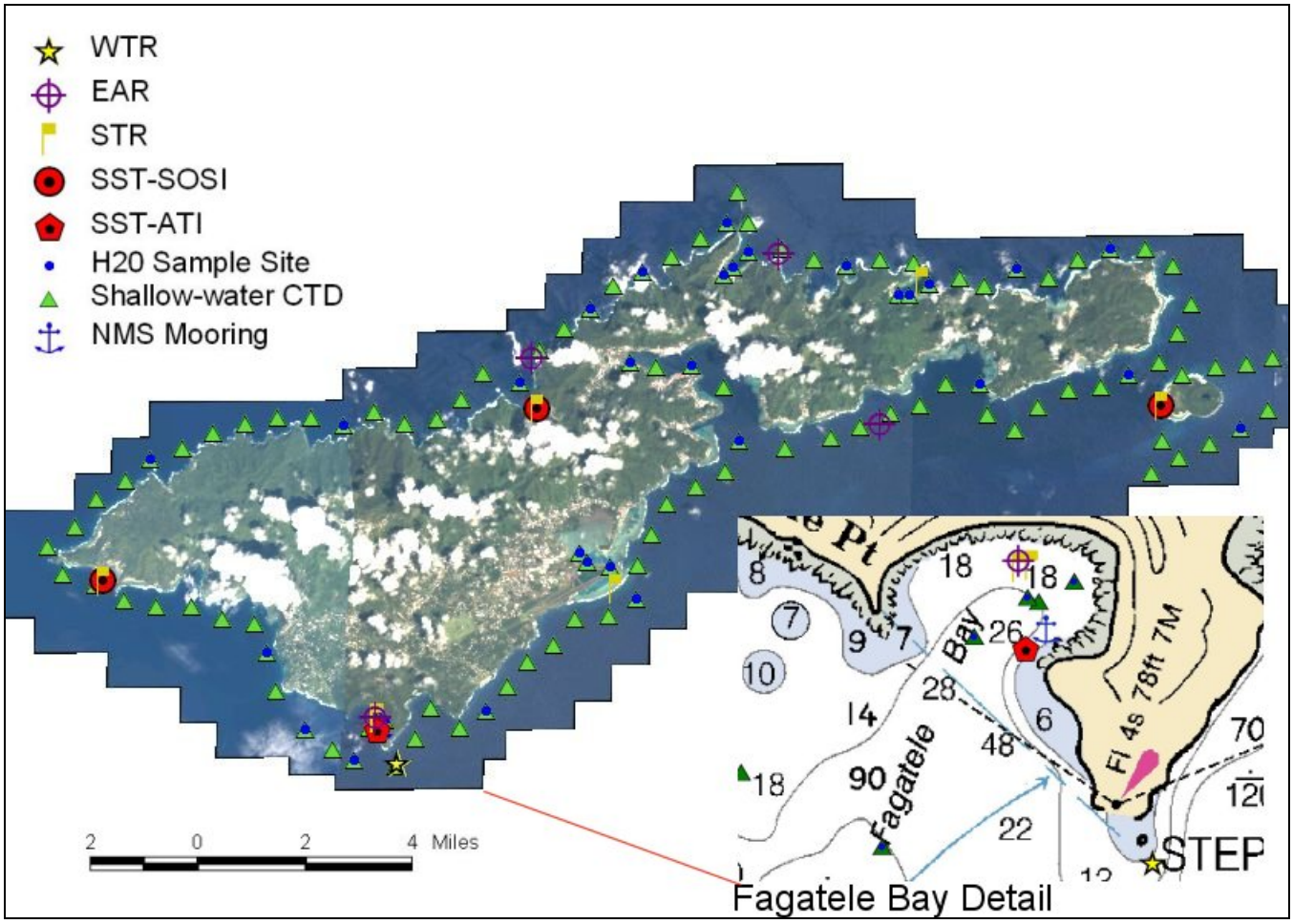

Figure B.2-1: Oceanographic instrumentation and sampling activities – Island of Tutuila.

B.2.1. CTD Casts

One hundred thirteen shallow water conductivity-temperature-depths (CTDs) were conducted around the periphery of the island in as close to 33 meters of depth as possible considering the slope of the island and surf conditions. Water sample profiles were conducted at 33 of these sites with a total of 110 chlorophyll, 110 nutrient and 26 DIC samples being collected. Deepwater CTD/water sample profile casts were conducted at 14 sites along acoustic Doppler current profiler (ADCP) transects. Four of these sites were on the north, east, south, and west corners of a box transect around the island; five were along a line transect to the north of Fagasa Bay; and five were along a line transect to the south-southwest of Fagatele Bay. A total of 44 chlorophyll, 44 nutrient, and 20 DIC samples were collected. In support of the mapping effort, 7 CTD casts were conducted from the ship and 11 CTD casts were conducted from the *AHI*. The completed shipboard sampling plans are included below.

B.2.2. Oceanographic Instrumentation Deployments

A total of four Sea Surface Temperature (SST) buoys, one Wave and Tide Recorder (WTR), and seven Subsurface Temperature Recorders (STR) were deployed in the vicinity of Tutuila and Aunuu. Three of the STRs were deployed on the anchors of SST buoys to increase our capacity for temperature profiling. One of the SSTs was a new deployment in Fagatele Bay and is a new model ATI-SST (developed due to concerns of the instrument's buoyancy) which deployed the new rigging system. The SST is tethered to a large primary float shackled to the mooring line. In addition to this standard instrumentation, four Ecological Acoustic Recorders (EARS) were deployed around the island to assess their value for recording vessel noise to determine traffic levels, whale song to study the movement of cetacean species, and the vocalizations of various reef species to gauge general reef health. Upon request of the National Marine Sanctuaries Program, a subsurface mooring was installed on a preexisting mooring pin.

Shipboard CTD, ADCP and Water Sampling Plan

Tutuila - HI0602

Transect 1: 02/19/06 (CTD/Water Sampling/ADCP)

This will be a line transect starting 2 km to the N of the mouth of Fagasa Bay (point "CTD001") and proceeding for 15 km to the N with a cast every 4 km. It will be a continuation of a daytime transect started in the Zodiac. The first four casts only need to be sent to 50 meters with water samples being collected at 30 meters and the surface. The fifth cast should be sent to 500 meters with all sampling conducted according to CRED protocols.

ID	LAT_DEG	LAT_MIN	LAT_H	LONG_DEG	LONG_MIN	LONG_H
DIC001	14	13.72160	S	170	36.81790	W
DIC002	14	12.54580	S	170	36.81130	W
DIC003	14	11.45880	S	170	36.83090	W
DIC004	14	10.37170	S	170	36.82440	W
DIC005	14	9.27820	S	170	36.82440	W

Transect 2: 02/22/06 (CTD/Water Sampling/ADCP)

This will be a very large (~170 km total length) box transect around the island that will hit all of CRED's historical CTD stations. It is understood that this is a very ambitious plan for one night, but whatever is accomplished will be good science and thought has been put in to finishing the operation to setup for day-ops on 2/23. Begin at pt "ctd001" (the southernmost point) proceeding around the transect in a clockwise direction with CTD casts being conducted at each corner of the box which are oriented in the cardinal directions. This is a departure from how we've conducted transects so far, but the change was made to reduce run time. The closest that the transect comes to the island is 5 km at its closest approach so that proximity to the island should be within vessel safety protocols. All casts will be to 500 meters presuming seafloor depth is greater than 600 m, if not, cast depth will be reduced (though this should not be an issue). Water samples will be collected according to CRED protocols on all casts.

ID	LAT_DEG	LAT_MIN	LAT_H	LONG_DEG	LONG_MIN	LONG_H
CTD001	14	31.19950	S	170	42.53790	W
CTD002	14	18.90740	S	170	57.98530	W
CTD003	14	5.41112	S	170	41.12030	W
CTD004	14	17.47740	S	170	25.86840	W

Transect 3: 02/25/06 (CTD/Water Sampling/ADCP)

This will be a line transect starting 2 km to the S-SW of the mouth of Fagatele Bay (point "CTD001") and proceeding for 15 km to the S-SW with a cast every 4 km. It will be a continuation of a daytime transect started in the Zodiac. The first four casts only need to be sent to 50 meters with water samples being collected at 30 meters and the surface. The fifth cast should be sent to 500 meters with all sampling conducted according to CRED protocols.

Cast Positions:

CTD001	14	22.99650	S	170	46.15490	W
CTD002	14	24.74450	S	170	46.59540	W
CTD003	14	26.46040	S	170	47.02220	W
CTD004	14	28.15860	S	170	47.46680	W
CTD005	14	29.89140	S	170	47.91140	W

B.3. Benthic Environment

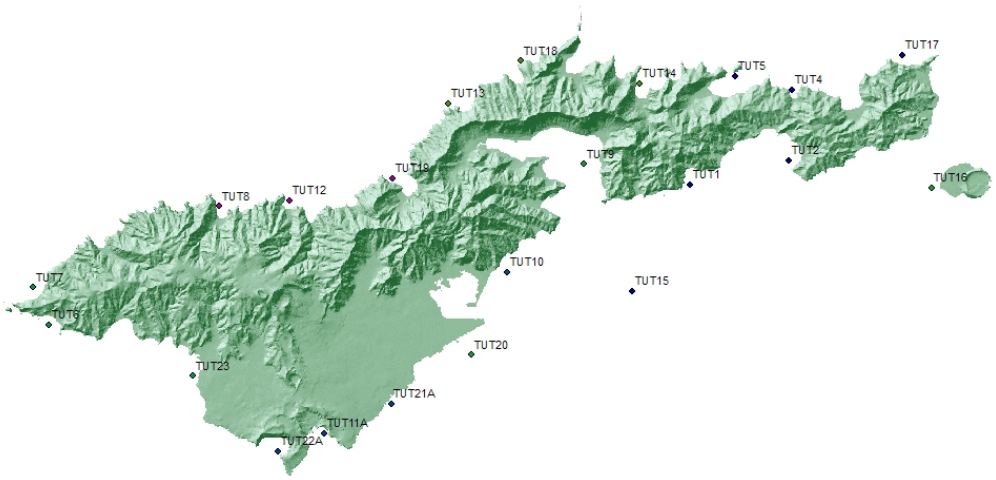

Figure B.3-1. Tutuila REA Site Locations.

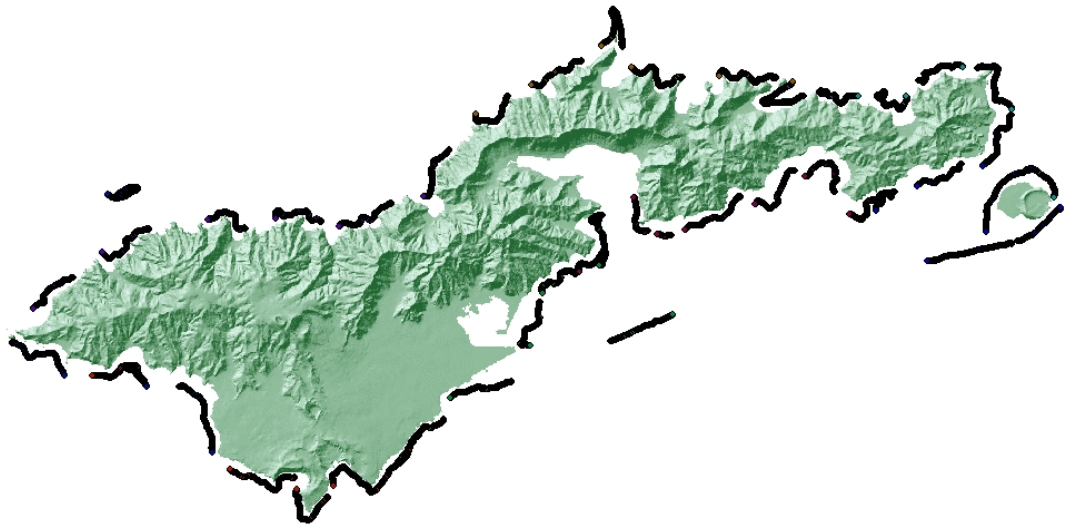

Figure B.3-2. Tutuila Towed-Diver Survey Tracks.

B.3.1. Algae

During 2006, a total of 22 sites were visited around Tutuila, American Samoa . At two of the 22 sites, only a qualitative study of macroalgal diversity was carried out due to the environmental conditions. At the other sites, both qualitative and quantitative (RAM) studies were realized. A total of 240 photoquadrat pictures have been taken. Forty different genera of macroalgae were observed across all sites.
The most common algae observed around Tutuila were: turf algae (93% of occurrence in the photoquadrats), crustose algae (82%), *Peyssonellia (43%)*, *Amphiroa* (50%) and *Halimeda (39%)*. However, other algae were also relatively abundant: *Actinotrichia, Champia, Cheilosporum, Gelid, Gelidiopsis, Jania* and *Dictyota*. Blue-green algae were present around Tutuila but represented less than 15% of occurrence per photoquadrat at the island scale. Locally, blue-green algae could be abundant.

Site Description

TUT05: 02-18-2006
The reef was located at the northeast side of the island. It looks like a canyon with sandy areas separating reef slopes. Visibility was good (around 30 m). The coral cover was not very impressive and algal diversity was relatively poor. The main algae observed were turf, crustose coralline algae, *Halimeda,* and *Peyssonellia*.

TUT04: 02-18-2006
The site was located at the northeast side of Tutuila. The studied reef was situated on a sharp slope. The site showed important water surge because its location close to the rocky shore. Visibility was about 20 m. The coral cover was similar to the one found at Tutuila 5. The algal diversity and abundance of macroalgae were more important than at Tutuila 5. A lot of algae have been collected at this site, especially rhodophytes. The main algae were: *Halimeda, Actinotricha, Amphiroa, Peyssonellia,* crustose, and turf algae.

TUT17: 02-18-2006
The site was located at the northeast side of Tutuila, west of the first two sites. The studied reef looked like a canyon. Water surge was important. Visibility was relatively low (<20 m). The coral cover was relatively low like at the other sites. Algal abundance and biodiversity were similar than at the other two sites. The dominant algae in the photoquadrats were: *Dictyosphearia, Peyssonellia, Gelid,* crustose coralline, and turf algae.

TUT14: 02-19-2006
The site was located at the northern side of Tutuila inside a little bay. There was some water surge and the visibility was good (>30 m). The bottom floor was covered mostly by turf algae, *Halimeda* , *Peyssonellia*, *Ventricaria*, *Amphiroa,* and *Dictyota*.

TUT18: 02-19-2006

The reef was located at the northern side of Tutuila, near the shore break. Water surge was important and visibility was less than 30 m. The reef looked dead. Bioerosion processes were very important. Many sponges including boring sponges were observed. Algal biodiversity was relatively low. The bottom floor was mostly composed by turf algae, crustose algae, *Gelid, Gelidiopsis*, *Jania,* and *Dyctiota*. Some blue-green algae were also observed.

TUT13: 02-19-2006

The reef was located at the northern side of Tutuila Island, near the shore break. Water surge was important and visibility was less than 20 m. The reef looked like a dead reef canyon. Bioerosion processes were very important. The coral cover was very low although a lot of coral recruits were observed. Algae were dominated by turf, encrusting coralline algae, *Ventricaria, Actinotricha*, *Gelidiopsis*, *Jania*, as well as by *Dyctiota*. Blue-green algae and *Valonia* were also observed in the photoquadrats. Outside the photoquadrats, few young *Halimeda* were observed. Blue-green algae were not very abundant but were observed in the photoquadrats.

TUT19: 02-20-2006

The reef was located at the northwest side of the island. It looked like a canyon, showed a low visibility (around 15 m), and experienced water motion. Because of its proximity to the rocky shore, which is densely colonized by a tropical forest, the reef was impacted by terrigenous inputs. It should be also noted that recently the island experienced a tropical storm dredging terrigenous organic matter to the ocean. A lot of organic matter in decomposition (e.g., leaves) was observed. The coral cover was very poor at this reef. Algae were very abundant and the diversity was relatively high. The main algae found in photoquadrats were: turf algae, coralline algae, *Halimeda, Actinotrichia, Amphiroa, Galaxaura,* and *Peyssonellia*. Surprisingly, blue-green algae were rarely observed.

TUT12: 02-20-2006

The reef was located at the northwest side of the island; west of site 19. Water motion was important and visibility was poor (<15 m). The reef was mostly 'dead' and showed lots of coral rubbles. Organic matter in decomposition was seen everywhere along both transects. Cyanobacteria were very abundant. Turf, crustose corallines, *Halimeda, Amphiroa, Gelid,* and *Peyssonellia* were very abundant.

TUT08: 02-20-2006

The site was located at the northwest side of the island; west of site 12. A low water motion was noticed. Visibility was maybe about 15 m. Patch reefs were separated by sandy channels. The coral cover was much better at this site than at the two other sites. A lot of 'plateaux' of *Acroporids* and *Porites* were observed. Algae were dominated by crustose algae and turf algae. Additionally, *Chlorodesmis*, *Halimeda*, *Amphiroa and Peyssonellia* were also observed in abundance.

TUT07 : 2-21-2006
The site was located northwest of the island. The reef showed only coral rubbles and rocks. It forms a plateau; no slope. The visibility was lower than 8 m. There was a bit of water surge. The cover coral was almost zero. Algae were dominated by turf algae. Some *Gelid, Tricleocarpa, Haloplegma,* and *Dictyota* were also observed along transects as well as crustose algae.

TUT06 : 2-21-2006
The reef was located on the west side of the island on the reef break. Surge was very important and the visibility was lower than 3 m. A lot of debris such as tires and plastic bags were observed. The coral cover was relatively low. Lots of coralline algae were seen. Additionally, *Neomeris, Amphiroa, Lobophora, Peyssonelia,* and *Haloplegma* were found among a lot of tiny red algae to be determined in the lab. Only a qualitative study was carried out at this site.

TUT23 : 2-21-2006
The site was located southwest of the island. The visibility was relatively low and water surge was low. Algae were dominated by: crustose algae, turf algae, *Amphiroa, Cheilosporum, Gelid,* and *Peyssonelia*.

TUT02: 2-22-2006
This site was located on the southeast side of the island in a protected area inside a bay. The reef slope dropped rapidly and showed a good coral cover. Weather that day was rainy and windy making the visibility at 15 m depth relatively poor. No water surge was noticed. Algae were dominated by turf, crustose algae, *Halimeda, Amphiroa, Gelid Peyssonellia,* and *Dictyota*. A lot of blue-green algae were also seen. New algae since the start of the survey around Tutuila were collected at this site during the random swim. Two different species of *Caulerpa,* at least, were collected at this site.

TUT01: 2-22-2006
This reef was located in the southeast side of Tutuila. Visibility was poor (< 5 m) due to high water motion and runoffs. The coral cover was relatively low. Large colonies of massive *Porites* were abundant at this site. Soft corals also dominated the reef. Algae were mostly dominated by crustose corallines, *Halimeda, Amphiroa,* and *Peyssonellia*.

TUT15: 2-22-2006
This site was located in the south of Tutuila and offshore (reef bank). The visibility was much higher (around 20 m) although a strong current was present in this area. It was impossible to use the photoquadrat because of the surge. A qualitative survey was therefore carried out at this site. The reef was covered by different species of corals and algae. A lot of soft corals were observed. Algae were mostly dominated by crustose corallines and *Amphiroa*.

TUT16 : 2-23-2006
This reef was located offshore around a small island situated at the south of Tutuila. The swell was important but the visibility was good (>20 m). An important current was

present at this site at 13 to 17 m deep. The reef was a reef slope going down slowly. The coral cover was important with a lot of branched corals as well as massive corals. Algae were dominated by crustose and turf algae. However, *Halimeda*, *Amphiroa,* and *Jania* were relatively abundant.

TUT20 : 2-23-2006

This reef was located south of Tutuila in the Pago Pago Harbor. Visibility was poor (<10 m) and no surge was noticed. The reef was a fringing reef forming a vertical wall. The coral cover was almost equal to zero. Algae were dominated by *Peyssonellia,* turf and crustose corallines. Blue-green algae were also abundant outside the photoquadrats.

TUT09: 2-23-2006

This reef was a bank reef located offshore in front of the airport, south of Tutuila. A strong current was present down to 15 m deep. Visibility was good (>25 m). The coral cover was important and the dominant corals were mostly encrusting forms such as *Astreoporids*, *Galaxea,* and some *Favidea*. Algae were not very diverse and were dominated by turf, crustose algae, *Peyssonellia*, *Halimeda*, *Dictyosphaeria*, *Gelid*, *Gelidiopsis,* and *Jania*.

TUT10: 2-24-2006

This reef was located at the south of Tutuila between the airport and Pago Pago Harbor. A lot of dredging was carried out in this area to consolidate the road before 2002. The weather was perfect (clear, sunny) and visibility was high (>30 m). Water surge was moderate. The reef was a plateau with a slope dropping rapidly around 15 m deep. Coral cover was important especially along the second transect. Algae were dominated by turf, crustose coralline, *Amphiroa* and *Cheilosporum* along the first transect while *Peyssonellia* and *Amphiroa* were the main algae along the second transect. *Gelid* and *Jania* were also observed in abundance.

TUT22: 2-25-2006

The studied reef was located inside the marine sanctuary of Tutuila, on the southeast side of the sanctuary. Reef slope was gentle and formed like a peninsula. Weather conditions were perfect as well as visibility (around 30 m). Coral cover was important. Lots of branched corals were observed. Algae were dominated by crustose corallines. Diversity of algae was high. Because the reef was located inside a marine protected area, only pictures were taken with the photoquadrat to quantify the relative abundance of macroalgae RAM. No collection of specimens was carried out. *Amphiroa, Actinotricha, Champia, Cheilosporum, Gelid, Jania, Peyssonellia,* crustose corallines, *Halimeda,* and turf algae were observed in abundance.

TUT11: 2-25-2006

The studied reef was located inside a bay, southwest of Tutuila. Weather conditions were very good and visibility was around 25 m. The reef was a slope going down slowly. Zones of high coral cover were separated by zones of coral rubbles or/and sand forming a canyon. Coral cover was very important including a lot of branched corals such as *Acropora*, *Turbinaria,* and *Pocillopora*. Algae were abundant and highly diverse. They

were, however, dominated by calcareous algae (encrusting and branched ones) and turf algae. Some blue-green algae were found while the reef looked oligotrophic and healthy. Additionally, *Dictyosphearia, Cheilosporum, Galaxaura, Gelid,* and *Peyssonellia* were observed.

TUT21: 2-25-2006

This reef was located southwest of Tutuila. The reef was composed mostly of limestone colonized by small coral colonies of encrusting corals and tiny macroalgae such as *Champia, Dictyosphearia, Gelid, Gelidiopsis, Jania, Peyssonellia and Dictyota.* Visibility was relatively low (10 m) and water motion was important.

Table 3.1-1: Macroalgae of Tutuila, bold numbers represent island averages, the numbers below represent average island ranks.

	% Occurrence in PQ Stdev	Average rank Stdev	Found during random swim
GREEN ALGAE			
Boodlea	16.7 NA	4.8 NA	
Bryopsis	6.3 4.2	5.0 2.5	
Caulerpa	0.8 2.6	4.3 0.7	
Cladophoropsis			*
Chlorodesmis	10.0 11.1	3.9 0.9	
Dictyosphaeria	10.8 12.1	3.7 1.5	
Halimeda	38.8 36.9	3.7 1.5	
Neomeris	8.3 0.0	4.0 0.8	
Valonia			*
Ventricaria	5.4 11.6	4.3 1.5	
RED ALGAE			
Actinotrichia	25.0 14.1	5.3 1.4	
Amphiroa	50.0 31.0	3.8 1.3	
Botryocladia	8.3 NA	2.0 NA	
Champia	18.8 9.7	6.1 1.1	
Cheilosporum	25.8 29.3	3.0 0.7	
Chondrophycus	2.4	3.7	

	% Occurrence in PQ Stdev	Average rank Stdev	Found during random swim
	4.1	0.7	
Chrysymenia	0.8 2.6	4.3 2.1	
Dasya	8.3 6.8	3.5 1.2	
Galaxaura	13.7 16.5	4.6 2.4	
Gelid	35.9 24.3	4.4 1.4	
Gelidiopsis	15.7 17.6	4.2 1.5	
Gibsmithia			*
Grateloupia	16.7 NA	3.8 NA	
Griffithsia			*
Haloplegma			*
Halymenia			*
Jania	27.1 24.2	4.8 1.5	
Liagora	8.3 NA	2.5 NA	
Lithanophora	16.7 9.6	2.1 0.8	
Martensia	4.2 NA	4.5 NA	
Peyssonnelia	43.0 27.5	3.7 0.8	
Portieria			*
Predaea	2.8 NA	1.5 NA	
Titanophora			*
Tricleocarpa	13.1 15.1	2.8 0.9	
Branched upright coralline	1.3 4.1	2.3 2.1	
Crustose coralline	82.1 28.1	1.8 0.7	
BROWN ALGAE			
Dictyota	22.0 23.7	4.1 2.0	
Encrusting brown	6.3 10.8	3.0 1.2	
Turbinaria			*

	% Occurrence in PQ Stdev	Average rank Stdev	Found during random swim
CYANOPHYTES	12.5 14.7	4.3 1.4	
TURF	92.5 16.2	1.7 0.8	

B.3.1.1 Benthic Towed-diver Survey—Algae

Macroalgal cover, on average made up less then 20% of the benthic habitat.

B.3.2. Corals

General observations on coral community composition and health assessment.

Full rapid ecological assessment (REA) surveys were conducted at 22 sites around the Island of Tutuila by the benthic team between February 18, 2006 and February 25, 2006. Relatively good weather conditions allowed the REA team to survey a variety of the reef slopes around the main cardinal points of the island.

Dive depths ranged from 11 to 16 m. Coral REA surveys indicated that the mean percent of live coral cover on reefs around the island of Tutuila was 24% and dead coral accounted for nearly 13%. Mean coral cover was the highest at Aunu'u Island (TUT16), TUT06, and TUT09, ranging between 30 and 66%. Lowest mean coral cover (range 0.0–9.8%) was observed at stations TUT18, TUT13, TUT19, TUT07 on the north side of the island, as well as site TUT20 at the entrance of Pago Pago Harbor. Highest coral generic diversity was observed at stations TUT09, TUT02, TUT17, TUT4, and TUT13; not necessarily associated with highest percent coral cover. Dominant coral genera in descending order included: *Montipora*, Porites, *Pocillopora Montastrea*, *Leptastrea*, *and Acropora.* In addition, colony densities ranged between 3.1 and 11.2 col/m^2 for all sites combined. The largest colonies observed were of the coral *Lobophyllia*, as station TUT10. Crustose coralline algae were an important component of the benthic biota (range 50–86%) particularly as stations, TUT17 and TUT04 on the NE corner of the Island, as well as at the Taiema Bank on the South. A summary of benthic parameters is presented in Table 1. Disease assessment: Abundance of coral diseases and syndromes was low overall. Out of a total of 23 stations visited, 17 cases of growth anomalies were detected for all stations combined. Corals of the genus *Astreopora* exhibited the greatest number of cases for this type of affliction. Five cases of mild bleaching, as well as three cases of tissue loss in *Acropora cytherea* were observed. In addition, one case of cyanobacteria infestation (black band) on *Porties* cf. *lobata* was detected. Aside from coral diseases, pathogenic afflictions were also detected on crustose coralline algae, particularly the coralline lethal orange disease (CLOD) the black fungal disease (BFD), and the ring syndrome (RS); a total of 169 cases were reported for these two diseases combined. A summary graph of disease prevalence is presented below. Predation marks, clearly attributable to the gastropod *Drupella* were observed on *Acropora abrontanoides*, *Acropora nobilis*, and *Montipora* cf. *nodosa*. In addition multiple blemishes as well as irritations probably caused by predation and allelopathic interactions surrounding tightly

adherent zones, respectively, were repeatedly observed on corals such as: *Montipora*, *Porites*, *Astreopora*, and *Leptoria*.

Table 3.2-1. Summary of benthic cover parameters at Tutuila (other includes, fleshy and turf macroalgae, rubble, and non-scleractinian sessile invertebrates).

	Coral cover	dead	pavement	sand	cca	other
TUT05	30.4	12.7	16.7	0.0	20.6	19.6
TUT04	15.7	0.0	1.0	0.0	57.8	25.5
TUT17	15.7	1.0	1.0	0.0	73.5	8.8
TUT14	14.7	2.9	3.9	7.8	14.7	55.9
TUT18	9.8	0.0	71.6	2.0	14.7	2.0
TUT13	9.8	0.0	61.8	0.0	23.5	4.9
TUT19	7.8	2.0	15.7	29.4	25.5	19.6
TUT12	14.7	44.1	2.9	3.9	12.7	21.6
TUT08	17.6	0.0	14.7	12.7	33.3	21.6
TUT07	0.0	0.0	0.0	0.0	0.0	100.0
TUT06	49.0	0.0	2.9	16.7	27.5	3.9
TUT23	34.3	1.0	2.0	13.7	41.2	7.8
TUT02	36.3	15.7	14.7	0.0	9.8	23.5
TUT01	14.7	0.0	2.0	0.0	40.2	43.1
TUT15	19.6	0.0	0.0	0.0	79.4	1.0
TUT16	63.7	9.8	10.8	0.0	13.7	2.0
TUT20	9.8	0.0	2.9	4.9	60.8	21.6
TUT09	59.8	0.0	14.7	0.0	14.7	10.8
TUT10	20.6	0.0	2.9	0.0	31.4	45.1
TUT22	26.5	3.9	2.0	1.0	52.9	13.7
TUT11	39.2	1.0	10.8	0.0	39.2	9.8
TUT21	19.6	1.0	24.5	0.0	45.1	9.8
Gran Mean	24.1	4.3	12.7	4.2	33.3	21.4
Std dev	18.0	13.2	19.3	10.2	22.0	23.4

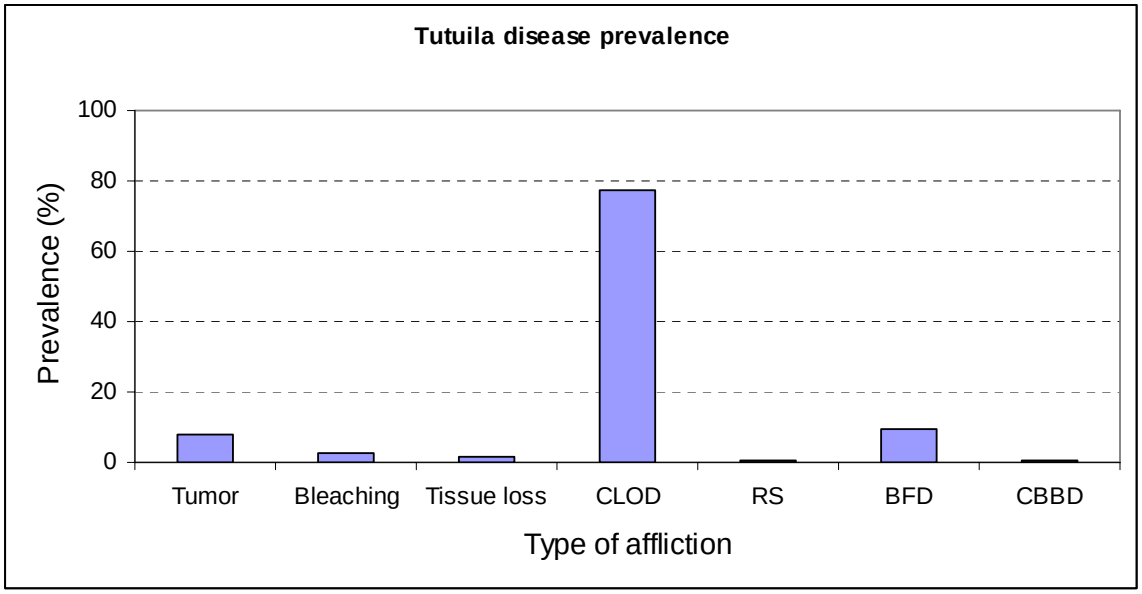

Figure 3.2-1. Disease prevalence at Tutuila (CLOD coralline lethal orange disease, RS= ring syndrome, BFD = coralline black fungal disease, and CBBD = coral black band disease)

Site Descriptions

February 18, 2006

TUT05

GPS: 14°15.119 S; 170°37.409 W

Northwest, ocean fringing reef slope; 60° slope. Depth range: 12 to 14 m. Mean coral cover was 30%. Low diversity dominated by *Porites rus* and *Porites cilindrica*. Crustose coralline algae contributed 20% of the total bottom cover. Colony density averaged 5.3 col/m^2. Disease assessment: No diseases observed. *Drupella* predation marks observed on *Acropora hyacinthus*.

TUT04

GPS: 14°15.366 S; 170°36.367 W

Northwest, ocean fringing reef slope; 60° slope. Depth range: 12 to 13 m. Mean coral cover was 15%. Low diversity dominated by *Porites rus* and *Porites cilindrica*. Crustose coralline algae contributed over 57% of the total bottom cover. Colony density averaged 3.8 col/m^2. Disease assessment: No coral diseases observed. Three cases of coralline orange lethal disease observed; no samples collected.

TUT17

GPS: 14°15.366 S; 170°36.367 W

Northwest, ocean fringing fore reef-slope; depth range: 9 to 13 m. Mean coral cover was 15%. Mean colony density was 4.2 col m/^{2}. Low coral diversity dominated by *Montipora* cf. *nodosa*, *Leptoria* cf *phrygia*, and *Favia* sp. Crustose coralline algae contributed over 73% to the benthic cover. Disease assessment: Within the survey area, four colonies of *Leptoria* exhibited patchy paling. One case of tissue loss on *Leptoria* was observed outside the survey area.

February 19, 2006

TUT 14

GPS: 14°15.212 S; 170°39.150 W

45˚ angle slope covered with *Halimeda* and only a few corals. Slope smooth and rounded with some sand channels. Mean coral cover was 14%. Disease assessment: No coral diseases detected.

TUT 18

GPS: 14°14.480 S; 170°41.346 W

Very bare smooth substrate with very few corals. Mean coral cover was 9.8%. Disease assessment: No coral diseases detected.

TUT 13

GPS: 14°15.596 S; 170°44.704 W

Very bare smooth substrate with very few corals. Mean coral cover was 9.8%. Disease assessment: No coral diseases detected.

February 20, 2006
TUT19
GPS: 14°16.978 S; 170°43.676 W
North shore; fringing reef slope. Depth range: 11 to 14 m. Mean coral cover was 7.8%. No data for mean colony density. Dominant corals in order of importance: *Montipora* and *Pocillopora*. Other corals present included: *Porites lobata, Fungia,* and *Favia stelligera*. Disease assessment: Five cases of growth anomalies were detected on *Astreopora*.

TUT12
GPS: 14°17.393 S; 170°45.567 W
Massacre Bay. Fringing reef slope. Depth range: 12 to 13 m. Mean coral cover was 17.6%; no data collected for colony size class distribution. Dominant corals in order of importance included: *Montipora*, *Pocillopora,* and *Porites rus*. Other species present in the area included: *Pavona explanulata, Turbinaria* sp., *Fungia sp.*, and *Pavona varians*. Few *Porites* sp. bommies were also observed in the general vicinity of the survey transects. Disease assessment: four cases of coralline lethal orange disease (CLOD), one case of tissue loss on *Acropora cytherea*, one case of *Phormidium coralliticum* infestation (black band disease) in *Porites* cf. *lobata*, four cases of discoloration on *Montipora* spp., and one case of discoloration in crustose coralline algae.

TUT08
GPS: 14°17.483 S; 170°46.848 W
Northwest side of Island. Fringing reef slope. Depth range: 9 to 12 m. Mean coral cover was 17.6%; no data collected for colony size class distribution. Dominant corals in order of importance included: *Montipora, Porites rus*, and *Pavona varians*. Other corals present in the general area included: *Acropora cytherea*, *A. hyacynthus*, *A. digitata, A. cf. valida, A. abrontanoides, A. nobilis, P. eydouxi, P. verrucosa, Turbinaria, Platygyra, Hydnophora, Galaxea, Fungia, Favia, Favites, Leptastrea, Echinopora, Astreopora, Montastrea, Porites cilindrica*, *Leptoria*, *Sandalolitha,* and *Fungia*. Disease assessment: 7 colonies of *Acropora abrontanoides* showed growth anomalies, one of which exhibited 56 tumors, 1 case of growth anomalies in *A. hyacinthus*, 1 case of tissue loss in *A. cytherea*, and 1 case of CLOD.

February 21, 2006
TUT07
GPS: 14°18.980 S; 170°50.221 W
Northwest tip of island. Rubble plain, very few scleractinian corals. Mean coral cover based on point count method was 0%; no data collected for colony size class distribution. Corals present in the general area included *Montastrea* sp. and *Leptastrea* sp. Disease assessment: No diseases observed.

TUT 06
GPS: 14°19.657 S; 170°49.960 W
Southwest tip of island. Spur and groove system and patch reefs. Mean depth: 14 m. Mean coral cover was 49%; no data collected for colony size class distribution High generic diversity; dominant corals in order of importance included: *Montipora*, tabular

acroporids, *Porites* cf. *lobata*, and *Porites rus.* Other coral genera present in the area included: *Leptastrea*, *Galaxea*, *Favia*, *Favites*, *Pavona*, *Pocillopora*, *Fungia*, and *Hydnophora*. *Acropora* tables dominant in shallow substrata (5 to 8 m), *Porites* cf. *lobata* bommies in deeper waters. Overall reduced visibility of approximately 12 m. Disease assessment: Overall infrequent, but two cases of patchy bleaching in small *Porites* cf. *lobata* colonies were detected.

TUT23
GPS: 14°20.586 S; 170°47.325 W
Southwest portion of island. Fringing reef spur and groove system. Depth range: 11 to 14 m. Mean coral cover was 34.4%; no data collected for colony size class distribution. Crustose coralline algae contributed importantly to the benthic cover (41%). *Montipora* and *Acropora* were the dominant genera along the transect lines. Other coral genera present in the area included: *Pocillopora, Fungia, Leptastrea, Porties, Astreopora, Alveopora, Favites, Lobophyllia, Pavona, Hydnophora, Galaxea, Merulina*, and *Leptoria*. Disease assessment: one case of tissue loss in *Acropora clathrata*, and four cases of CLODS, and one case of crustose coralline algae fungal disease.

February 22, 2006
TUT02
GPS: 14°16.646 S; 170°31.360 W
Southwest corner of island. Fringing reef slope; average depth 12 m. Low underwater visibility probably due to overnight showers. Also, some debris and garbage (plastic bags and cans) present at this site. Mean coral cover was 36%, and mean colony density was 4.8 col/m^2. A total of 18 coral general were detected along the survey area; dominant corals in order of importance: *Montipora, Pavona*, *Fungia*, and *Porties*. Disease assessment: No diseases detected.

TUT01
GPS: 14°17.066 S; 170°38.276 W
Southwest side of island. Fringing reef slope; 60-70 degree slope. Average depth: 16 m. Mean coral cover was 14.7%, and mean colony density was 5.7 col/m^2. Dominant corals in order of importance: *Montipora*, *Pavona*, *Fungia*, and *Turbinaria*. *Crustose coralline* algae and *Halimeda* accounted for over 80% of the benthic cover. Disease assessment: seven cases of CLOD and one case of coralline algae fungal disease.

TUT15
GPS: 14°17.066 S; 170°38.276 W
Taiema Bank, south of Pago Pago Harbor. Strong surge current. Depth range: 11 to 15 m. Mean coral cover was close to 20%, and mean colony density was 6.0 col/m^2. Dominant corals in order of importance: *Montipora*, *Montastrea*, *Pocillopora*, *Acropora*, *Leptastrea*, *Favites*, and *Astreopora*. Soft corals of the genus *Cladiella* were also abundant. Other coral genera present included: *Acropora*, *Leptastrea*, *Favia*, *Favites*, and *Porties*. Disease assessment: three cases of CLOD, as well as one case of growth anomalies in *Acropora abrontanoides* were detected.

February 23, 2006
TUT16
GPS: 14°17.145 S; 170°33.858 W
East side of island, Aunu'u Island. Reef slope. Depth range: 14 to 15 m. High diversity and high coral cover. Mean coral cover was close to 64%, and mean colony density was 10.4 col/m^2 (only one transect line surveyed for coral size class distribution). Dominant corals in order of importance included: *Montipora, Pocillopora, Acropora, Pavona, Montastrea,* and *Leptastrea*. Disease assessment: No evidence of disease.

TUT20
GPS: 14°16.721 S; 170°40.169 W
Entrance of Pago Pago Harbor; east side. Reef slope ~60 degree slope. Depth range: 13 to 14 m. Low coral cover and diversity. Mean coral cover accounted for less than 10%, and mean colony density was 1.5 col/m^2. Crustose coralline algae was an important component of the benthic community accounting for over 60% of the live cover. Total number of genera on transect: 11. Disease assessment: No evidence of disease.

TUT09
GPS: 14°17.145 S; 170°33.858 W
South, off the airport. Reef slope environment. Depth range: 12 to 16 m. High coral cover and generic diversity; mean accounted for close to 60% and mean colony density was 11.5 col/m^2. Dominant corals in order of importance: *Monitpora, Montastrea, Pocillopora,* and *Porites*. Soft corals of the genus *Cladiella* were also quite abundant along the survey area. Other coral genera present included *Favites, Pavona*. *Psammocora, Favia,* and *Coscinaraea*. Disease assessment: one case of growth anomaly on *Astreopora*.

February 24, 2006
TUT09
GPS: 14°18.682 S; 170°41.573 W
South side of island, between airport and Pago Pago Harbor. Sixty degree wall on first transect; 30–40 degree slope on second transect. Depth range: 9 to 14 m. Mean coral cover was 20%, and mean colony density was 10.7 col/m^2. Dominant corals were *Pavona varians, Montipora, Porites rus, Lobophyllia,* and *Pocillopora*. Other corals present along the transect lines included: *Fungia, Echinophyllia, Galaxea* and *Echinopora*. The soft coral *Cladiella* was particularly abundant. In addition, the red alga *Cheliosporum* and *Halimeda* accounted for nearly 70% of the benthic live cover. Disease assessment: 2 cases of CLOD and 10 cases of coralline algae fungal disease. Outside the transect lines, in 5 m of water nine cases of coralline algae fungal disease were observed.

February 25, 2006
TUT22
GPS: 14°21.924 S; 170°45.771W
Fagatele Bay. Mean percent coral cover was 26.5 Disease assessment: No coral diseases detected. However, 78 cases of CLOD observed.

TUT11
GPS: 14°21.624 S; 170°44.919
Larsen's Bay. High coral cover and species diversity. Mean coral cover was 39%. Disease assessment: One case of mild bleaching on *Montastrea*, one case of growth anomaly on *Favites*, and seven cases of CLOD.

TUT21
GPS: 14°21.078 S; 170°43.713W
Coral cover was 19%. Disease assessment: No coral diseases observed, instead, 30 cases of CLOD were detected.

B.3.2.1 Towed-diver Survey – Corals

We surveyed along the forereef slope which we found to consist of continuous reef. Large swells made surveying at the 15-m isobath difficult, leading to deeper and less consistent sampling then in previous years. For the 44 towed-diver habitat surveys, we found the overall habitat to have fairly consistent levels of hard coral cover, with average levels between 5 and 20%. We found the highest average hard coral cover was observed along the south coast from Pago Pago Harbor to the SW corner of the island, although the hard coral cover was never observed to be more then 40% in any area. Soft corals were found to make up generally 1-10% of the reef, with some areas having slightly higher cover.

B.3.3. Invertebrates

In the Tutuila portion of the study, a total of 22 sites were surveyed. Noteworthy observations include the presence of the giant clam (*Tridacnid* sp.) at 13 of the 22 sites with variable densities (highest densities from sites 18, 2, and 16), 5 species of sponge seen throughout the island (with the exception of site 7), and an abundance soft corals at 19 of the 22 sites (primarily *Sarcophyton*, *Lobophyton*, and *Cladiella*).

In addition, the most common mobile macroinvertebrates in this island were hermit crabs and gastropods (present at all sites). The most common non-mobile species were sponges, zoanthids, hydroids, and didemnum, and colonial tunicates. Also commonly seen and collected were trapezid guard crabs and alpheid shrimp in *Pocilloporid* and *Acroporid* coral heads. The only commonly seen echinoderm was the urchin *Echinostrephus*, although brittle stars, sea stars, and sea cucumbers were seen at a few sites with patchy distribution.

Also noteworthy was the species diversity at site 7 (substrate mostly sand and rubble), which was high in mobile inverts, but did not include the commonly seen encrusting animals (non-mobile species).

Figure B.3.3-1. Total Sites Surveyed: 22

Date	Island	Site #	habitat type	wind/lee ward	min depth	max depth	Latitude	longitude
2/18/2006	Tutuila	5	forereef	wind	10.3	13.1	14°15.119	170°37.409
2/18/2006	Tutuila	4	forereef	wind	11.0	15.2	14°15.361	170°36.377
2/18/2006	Tutuila	17	forereef	wind	10.0	13.7	14°14.771	170°34.313
2/19/2006	Tutuila	14	forereef	wind	11.9	14.0	14°15.212	170°39.150
2/19/2006	Tutuila	18	forereef	wind	12.5	14.0	14°14.805	170°41.347
2/19/2006	Tutuila	13	forereef	wind	14.0	16.8	14°15.596	170°42.704
2/20/2006	Tutuila	19	forereef	wind	12.2	14.6	14°16.978	170°43.676
2/20/2006	Tutuila	12	forereef	wind	13.1	14.6	14°17.393	170°45.567
2/20/2006	Tutuila	8	forereef	wind	8.8	13.1	14°17.483	170°46.848
2/21/2006	Tutuila	7	forereef	wind	13.4	14.3	14°18.980	170°50.221
2/21/2006	Tutuila	6	forereef	wind	12.2	13.7	14°19.657	170°49.960
2/21/2006	Tutuila	23	forereef	wind	11.6	14.9	14°20.584	170°47.324
2/22/2006	Tutuila	2	backreef	lee	12.2	14.3	14°16.646	170°36.458
2/22/2006	Tutuila	1	backreef	lee	13.4	16.5	14°17.072	170°38.258
2/22/2006	Tutuila	15	backreef	lee	11.6	13.7	14°19.070	170°39.304
2/23/2006	Tutuila	16	backreef	lee	14.0	16.5	14°17.144	170°33.858
2/23/2006	Tutuila	20	backreef	lee	12.5	16.5	14°16.739	170°40.187
2/23/2006	Tutuila	9	backreef	lee	15.2	16.5	14°20.181	170°42.250
2/24/2006	Tutuila	10	backreef	lee	13.1	15.2	14°18.682	170°41.570
2/25/2006	Tutuila	22	backreef	lee	12.2	16.5	14°21.937	170°45.779
2/25/2006	Tutuila	11	backreef	lee	14.3	16.8	14°21.624	170°44.920
2/25/2006	Tutuila	21	backreef	lee	12.8	16.2	14°21.077	170°43.713

B.3.3.1. Benthic Towed-diver Survey – Macroinvertebrates

We observed only one crown-of-thorns starfish, *Acanthaster planci* on the surveys which was located in Larsen's Bay. Nineteen Holothurids were recorded at the island, 18 of which were found on the southeast end of the island. Sixty-six total giant clams (*Tridacna sp.)* were found throughout the surveys with 36% observed on the reefs adjacent to Cock's Comb.

B.4. Fish

From February 18 to February 25, 2006, the fish census team (Robert Schroeder, Paula Ayotte, and Todd Wass) surveyed 22 total stations in the vicinity of Tutuila, including 1 at Taiema Bank (just S of Pago Pago Harbor), 1 at Aunuu, and 20 around the large Island of Tutuila. Habitats included reefs within bays and exposed outer reef slopes. All sites were resurveys ("monitoring") of sites established by CRED in February of 2002 or 2004. The same quantitative methods (BLT, SPC, REA) were conducted at each of these sites.

Overall, fish assemblages around this most populated Samoan Island did not appear to be greatly different in 2006 than seen during our previous visits. A minimum of 242 coral reef fish species were seen around Tutuila (number expected to rise upon full analysis of data). Some of the Island's highest relative abundance and species richness were found at Larson's Bay, followed by Fagatele Bay, along the southwest. Medium-large fish density still appeared to be rather low and quite possibly (pending statistical confirmation) lower than the other Islands of American Samoa. For example, sharks remained extremely rare

with only two individuals (a white-tip off the airport, and a gray reef off the seaward end of Cock's Comb) seen by the fish team during its entire time underwater (22 dives sites around the Island of Tutuila; 66 man-dives, each > 1 hr observation time).

Target species commonly seen included parrotfish (e.g., *Scarus japanensis*), surgeonfish, grouper (*Cephalopholis* spp.), and snapper (*Macolor* spp.). *Lujanus bohar* were rare. A few dogtooth tuna were seen along the north. Several humphead wrasse were seen, but no bumphead parrotfish. Rabbitfish (*Siganus* [*punctatissimus*?]) were relatively common in shallow water (less than 5 m).

No major or heavy recruitment pulses were noted for any species, but low levels of recruitment were occurring for species such as *Ctenochaetus striatus*, *Zebrasoma scopas*, *Cheilinus* sp., and *Parupeneus multifasciatus*.

Low visibility hampered visual methods (mostly SPC) at station 23 (6 m), along the southwest, and at station 6 (3 to 6 m) on the west side due to rain and large swells. Quantitative data from station 15 (Taiema Bank) may also be in question due to strong surge hampering complete counts. Station TUT-18 may have been mislocated and surveyed on the exposed NE shoreline, while in 2004 it was inside a shallow nearby cove.

Typically, more rare species seen at least once included: *Exallias brevis*, *Xanthichthys auromarginatus*, *Fistularia* sp., *Apolemichthys trimaculatus, Epinephelus melanostigma, E. merra, Cephalopholis spiloparaea, Grammistis sexlineatus, Oxymonocanthus longirostris, Lepidozygus tapeinosoma, Amphiprion chrysopterus, A. melanopus, Chaetodon bennetti, Plectorhinchus picus, Pseudanthias cooperi,* and *Cirrhilabrus katherinae*.

Fish Family Summaries:

Twenty-five species of surgeonfishes (Acanthuridae) were observed around Tutuila. The most frequently observed species was the striped bristletooth, *Ctenochaetus striatus*. The brown surgeonfish (*Acanthurus nigroris*) and whitecheek surgeonfish (*A. nigricans*) were also rather common. Because of lighting conditions (e.g., cloudy, overcasted) some identification of the "brown surgeonfishes" were questionable (e.g., *A. nigrofuscus*?). In contrast to 2004, the mimic surgeonfish (*Acanthurus pyroferus*) was rare as were *Naso* spp. (a few *N. hexacanthus*, *N. lituratus*, and *N. unicornis* were seen).

A preliminary minimum of 38 species of wrasses (Labridae) were observed. Most common were the checkerboard wrasse (*Halichoeres hortulanus*), followed by the cleaner wrasses (*Labroides dimidiatus*), and the six-line wrasse (*Pseudocheilinus hexataenia*). Seen in lesser abundance were the cleaner wrasse (*Labroides bicolor*), the bird wrasse (*Gomphosus varius*), and the sling-jaw wrasse (*Epibulus insidiator*). Even less abundant were the ornate wrasse (*Halichores ornatissimus*), the ringtail wrasse (*Oxycheilinus unifasciatus*), the redribbon wrasse (*Thalassoma quinquevittatum*), and

Thallasoma lutescens. Rare were the humphead wrasse, *Cheilinus undulatus, Anampses twistii,* and *Labropsis xanthonota*.

Twelve species of groupers (Serranidae: Epinephelinae and Anthiinae) were observed. Most commonly seen were small flagtail grouper (*Cephalopholis urodeta*), followed by small-medium size peacock grouper (*Cephalopholis argus*). Species of *Epinephelus* were rare (e.g., *E. melanostigma, E. merra*). Coral trout (e.g., *Plectropomus laevis*), and the slenderspine grouper (*Gracila albomarginata*) were also rare. Fairy basslets (e.g., *Pseudanthias pascalus, P. cooperi*) were not at all common.

Eight species of snappers (Lutjanidae) were observed. Most common, but not abundant, were *Aphareus furca,* the onespot snapper (*Lutjanus monostigma*), and the blacktail snapper (*L. fulvus*). Less abundant were *Macolor* spp., the humpback snapper (*L. gibbus*), and *L. kasmira*. In contrast to 2004, the twinspot snapper (*Lutjanus bohar*) were rather rare, and represented by mostly juveniles.

Fourteen species of parrotfishes (Scaridae) were preliminarily recorded. The most frequently occurring was the redtail parrotfish *Scarus japanensis*, while bullethead parrotfish (*Chlorurus sordidus*) were typically more numerous, including juveniles.

Less common species seen included the whitespot parrotfish (*Scarus forsteni*), the dark-capped parrotfish (*Scarus oviceps*), the redlip parrotfish (*Scarus rubroviolaceus*), *Calotomus carolinus*, and *Cetoscarus bicolor*.

Jacks (Carangidae) were rather rare in 2006. The few seen were mostly the bluefin trevally (*Caranx melampygus*). Several leatherjacket (*Scomberoides lysan*) were also seen. A school of pompano (*Trachinotus* [*bailloni*?]) was seen near the surge zone at the north tip of Cock's Comb. *C. ignobilis* were rare.

Twenty-three species of butterflyfishes (Chaetodontidae) were seen, while none were very common. The most frequently occurring species, as in 2004, was the reticulated butterflyfish (*Chaetodon reticulatus*), followed by (in no particular order): *C. pelewensis, C. unimaculatus, C. quadrimaculatus*, the chevron butterflyfish (*C. trifascialis*), the forceps butterflyfish (*Forcipiger flavissimus*), the longnose butterflyfish (*F. longirostris*), the pennant bannerfish (*Heniochus chrysostomus*), and the humphead bannerfish (*H. varius*), and *H. acuminatus*. Species rarely seen were the dotted butterflyfish (*C. semeion*), the black-backed butterflyfish (*C. melannotus*), and *C. bennetti*.

Twenty-nine species of damselfishes (Pomacentridae) were observed around Tutuila. Most common were the midget chromis (*Chromis acares*), the bicolor chromis (*C. margaritifer*), the half and half chromis (*C. iomelas*), the charcoal damsel (*Pomacentrus brachialis*), Dick's damsel (*Plectroglyphidodon dickii*), and the Johnston Island damsel (*P. johnstonianus*). More rare were the black damsel (*Chromis xanthura*), the neon damsel (*Pomacentrus coelestis*), *Dascyllus auripinnis* and *D. reticulatus*. Clownfishes (*Amphiprion chrysopterus* and *A. melanopus*) were seen occasionally in association with anemones.

Twelve species of triggerfishes (Balistidae) were seen. While nowhere abundant, the pinktail triggerfish (*Melichthys vidua*) had the highest frequency of occurrence, followed by the black triggerfish (*M. niger*), and the orange-striped triggerfish (*Balistapus undulatus*). Less common species were the scythe triggerfish (*Sufflamen bursa*), *S. chrysopterum, Xanthichthys auromarginatus, Pseudobalistes flavimarginatus*, and *Balistoides viridescens*.

The most commonly observed fish over 50 cm total length (TL) was the big eye jack (*Caranx sexfasciatus*) with 248 observations (the majority observed in 2 schools) and the blackfin barracuda (*Sphyraena qenie)* with 75 observations (the majority observed in 1 school). Parrotfish were the third most commonly observed fish with 61 observations for the entire family including 21 sightings of the pacific steep head parrotfish (*Chlorurus microrhinos*) and 28 sightings of the redlip parrotfish (*Scarus rubroviolaceus*). The most commonly observed shark for this survey period was the benthic feeding reef whitetip shark (*Triaenodon obesus*) with three observations; both the reef blacktip shark (*Carcharhinus melanopterus*) and the Galapagos shark (*Carcharhinus galapagensis*) had one observation each. Other notable observations included 9 sightings of the Napoleon wrasse (*Cheilinus undulatus*) and 1 sighting of the bumphead parrotfish (*Bolbometopon muricatum*) during this survey period (44 tow surveys covering 80 km of habitat).

Appendix C: Manua Islands (Ofu, Olosega, and Ta'u)

C.1. Benthic Habitat Mapping

Because of the multibeam mapping performed in 2004, no shallow-water multibeam surveying was conducted with the *AHI* during this cruise. Instead, the *AHI* was used to conduct towed camera operations along nearshore areas. Fifteen towed camera tracks were conducted during 5 days of operations. Figure G-3 and Table G-1 summarize the data collected during that time.

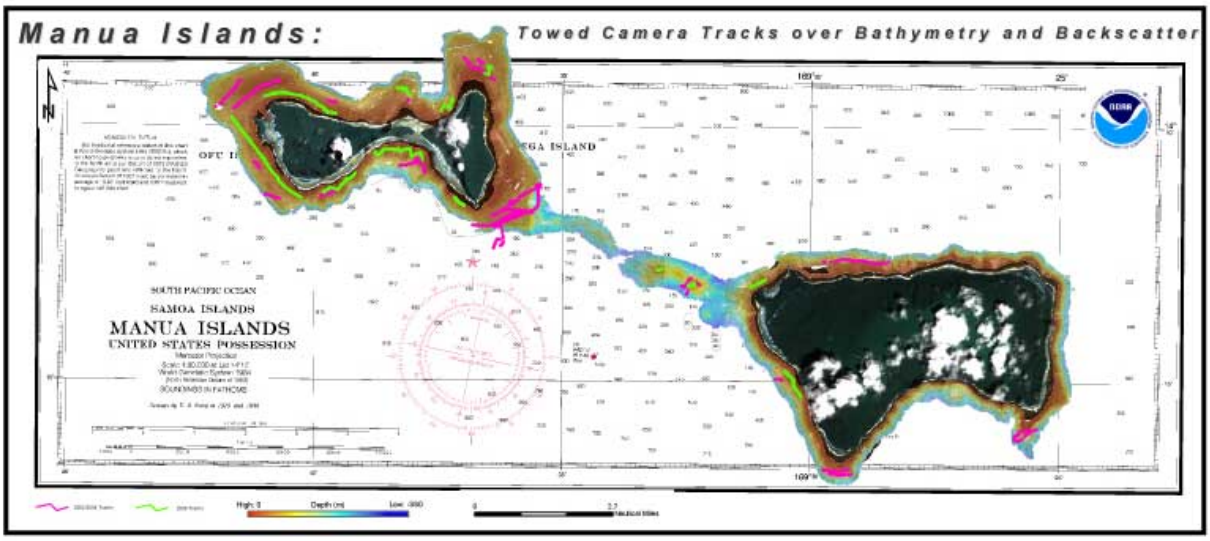

Figure C.1-1: Towed camera tracks around the Manu'a Group.

Table C.1-1: Towed camera trackline summary.

Date	Total tows	Tow ID	Bottom time	Min depth, m	Max depth, m	Tow length, km	Notes
Ofu & Olosega	**10**		**11:20**	**15**	**68**	**15.1**	
26-Feb-06		OFU06001	01:51	25	60	2.7	Times in Hypack Raw file were UTC-10; they were corrected to UTC in the CSV file using Excel
26-Feb-06		OFU06002	01:23	24	47	0.6	
27-Feb-06		OFU06003	01:05	28	58	0.6	
27-Feb-06		OFU06004	00:56	15	49	1.7	
27-Feb-06		OFU06005	01:34	22	66	4.0	
28-Feb-06		OFU06006	00:19	31	43	0.9	Aborted when generator stopped
1-Mar-06		OFU06007	01:02	26	48	0.6	
1-Mar-06		OFU06008	00:19	31	67	0.3	
1-Mar-06		OFU06009	00:56	58	68	0.9	
1-Mar-06		OFU06010	01:52	18	41	2.8	
Tau	**5**		**03:00**	**21**	**93**	**2.7**	
2-Mar-06		TAU06011	01:55	21	48	1.3	
2-Mar-06		TAU06012	00:21	27	73	0.7	
2-Mar-06		TAU06013	00:19	47	86	0.3	
2-Mar-06		TAU06014	00:16	47	92	0.3	
3-Mar-06		TAU06015	00:07	49	93	0.2	Aborted when leak alarm went off
Cruise total	**15**		**14:20**	**15**	**93**	**17.8**	

On the fourth day of towed camera operations work was cut short when the leak sensor alarm in the towfish went off. We recovered the towfish and returned to the ship where the towfish bottle was disassembled. There was no sign of a leak, and the sponge on the leak sensor was dry. We reassembled the unit and tested it on deck; no alarm was sounded. On the fifth day we attempted to perform more towed camera deployments but on the first deployment the leak alarm sounded immediately after the unit was put in the water. After a couple of hours of debugging and an extended conversation with Deep Ocean Engineering, we determined that the alarm was probably false and began to start tows again. At that time, however, we found there was no video feed. After brief troubleshooting on the boat, we returned to the ship and checked things out. It appears that the DSPL camera had failed; this was diagnosed by powering the camera with 12VDC and feeding the output to a monitor using alligator clips. There was no indication why the camera failed and at this point it appears to be independent of the leak alarm. Because no backup camera was available, the towed camera deployments were secured.

Some potential problems were observed during some tows. Usually the heading sensor appeared to work well but at other times the heading data were very noisy; for instance, the heading would jumping from 1 to 160 degrees about once per second while the camera image showed the towfish moving steadily over the bottom. The pressure sensor depth (lower left corner) was also jumping around by several meters. Sometimes the towfish depth sensor appeared to be working fine but at other times it was in error by as much as 20 m. During the last day's troubleshooting we noticed that the leak alarm, pressure depth, and towfish heading are all handled by the same card within the towfish. Perhaps all these problems stem from a faulty card. Finally, while the altimeter worked

well in all deployments it appeared to be reporting height off the bottom in feet rather than meters. The documentation indicates the units should be in meters but during a tow retrieving a meter of cable resulted in several units of change in the altimeter reading. The towfish was hanging almost directly below the vessel and we could see it occasionally in the multibeam return. The amount of cable out almost always equaled the water depth so we are relatively confident of how the fish is behaving.

Even though the camera deployments were curtailed the tows we did perform were very successful. Our last three tows characterized two previously unknown deeper coral reef ecosystems (47 to 60 meters) that are lush and relatively pristine. The camera deployment on the *AHI* was also successful. Controlling the cable out with the bidirectional pot hauler worked quite well and cable management was not a real problem. Navigation data and bathymetry were derived from the POS/MV and RESON and provided Hypack via the ISS2000 multibeam survey control system. If the equipment were to be deployed on the *AHI* for a long period of time we could improve the arrangement of the electronics equipment, but for a first deployment the operation went very smoothly.

Shipboard benthic habitat mapping was performed to fill gaps in existing multibeam coverage near the Manu'a Islands. Surveys were performed on the nights of February 26, March 1-2, and March 4.

C.2. Oceanography & Water Quality

Ofu and Olosega

A total of seven STRs were deployed in the vicinity of Ofu and Olesega Islands. Three of the STRs were replacements at locations established near REA sites while four of them represent new deployments. One of the new deployments was inside Ofu Lagoon and three of them were along a profile at depths of 6, 17, and 31 m just outside of the lagoon placement to enhance the capacity for temperature profiling.

Thirty-three shallow-water CTDs were conducted around the periphery of the islands in as close to 33 meters of depth as possible considering the slope of the island and surf conditions. Water sample profiles were conducted at 17 of these sites with a total of 58 chlorophyll, 58 nutrient, and 35 DIC samples being collected. In addition to this typical sampling methodology, an extended "horizontal cast" was conducted within Ofu Lagoon by lashing floatation to the CTD and swimming it through the lagoon just inshore of the surf zone and along the beach while tracking the cast with a GPS. Three chlorophyll and three nutrient samples were collected along the route of this cast.

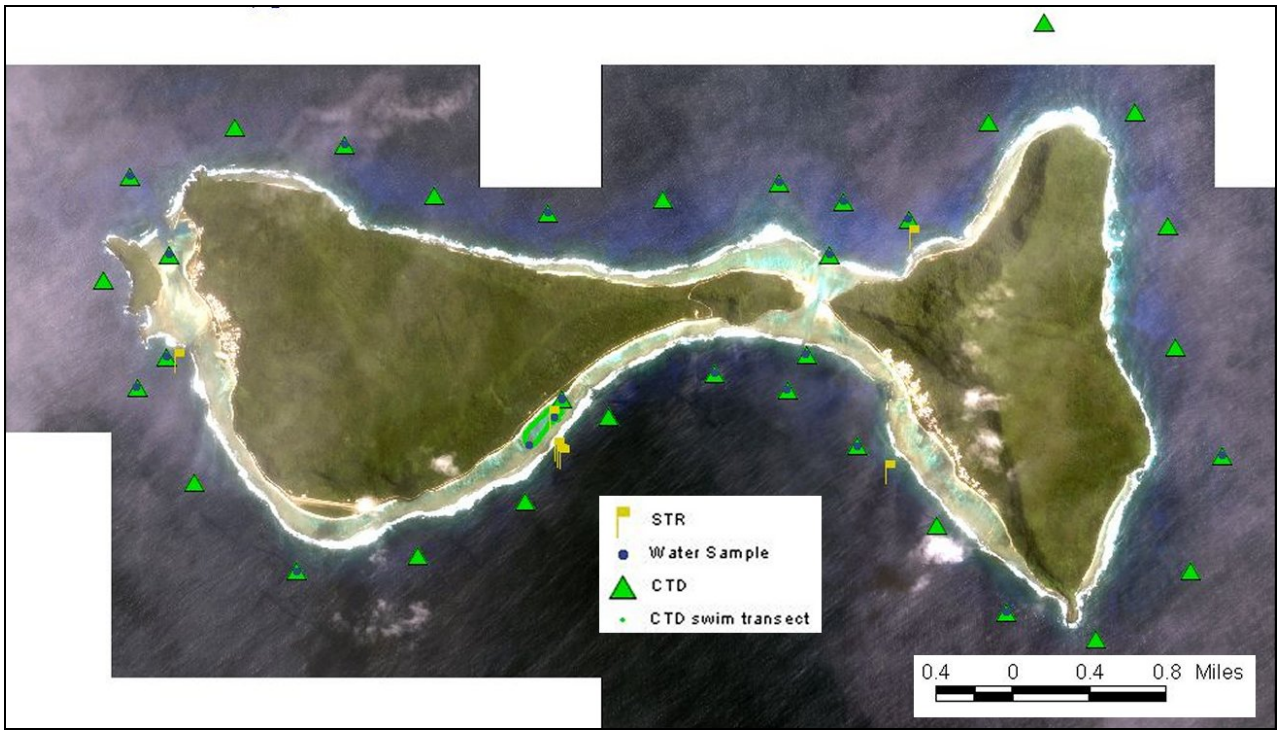

Figure C.2-1: Oceanographic instrumentation and sampling activities – Islands of Ofu and Olesega.

Tau Island:

One SST was deployed at the established site south of Tau Village. The ATI-SST previously deployed at the site was no longer there so it was not recovered. Transmissions from the buoy indicate that it detached from its mooring shortly after it was deployed. Inspection of the mooring line and the disposition of the anchor indicate that it was hit by a vessel, dragged for a distance with the line around the prop and then cut free. The anchor was found ~100 meters from its deployment location which even a very strong current or weather event most likely would not have moved it so it was probably dragged by a vessel. In addition to being severed some distance below the splice, the line had several strands of its braid cut or damaged at varying distances from the severance point indicating damage by a prop. A total of three STRs were deployed in the vicinity of Tau Island. All of the STRs were replacements with two at locations previously established near REA sites and one on the anchor of the SST buoy to enhance the capacity for temperature profiling. One SVP drifter buoy was deployed in the vicinity of Tau.

Thirty-five shallow water CTDs were conducted around the periphery of the islands in as close to 33 meters of depth as possible considering the slope of the island and surf conditions. Water sample profiles were conducted at 7 of these sites with a total of 28 chlorophyll, 28 nutrient, and 18 DIC samples being collected.

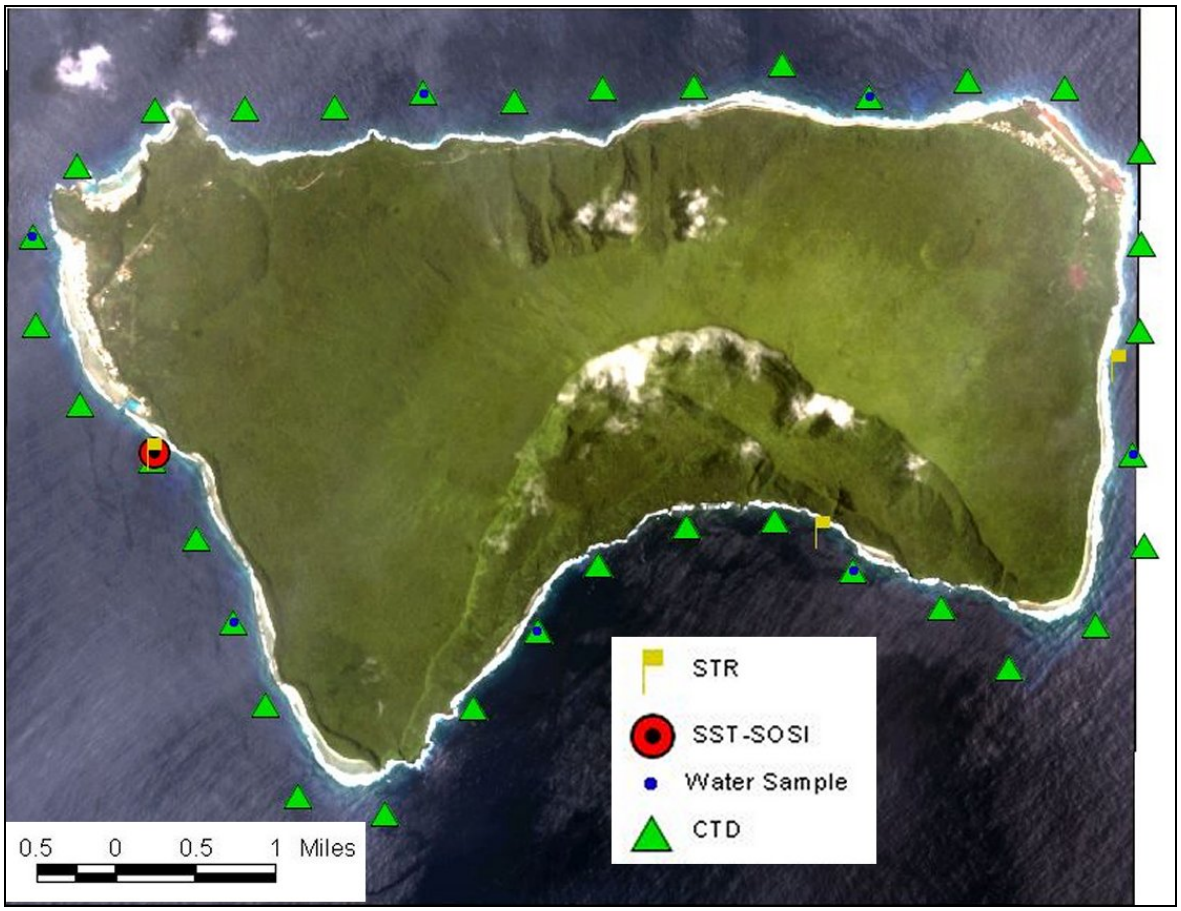

Figure C.2-1: Oceanographic instrumentation and sampling activities – Island of Tau.

Manua Island Group – Shipboard Oceanography:

As on previous cruises, shipboard oceanographic sampling activity encompassed the Manua Island Group (Ofu, Olesega, and Tau Islands) as a whole. Deepwater CTD/water sample profile casts were conducted at six sites along the same 115-km ADCP transect on 2 separate nights adding two new sites to the four traditionally sampled on RAMP cruises. On the first night (2/27/06), water sampling occurred at all six CTD sites with water samples being collected at each depth usually sampled (150, 125, 100, 80, 30 – added for DIC sampling, and 3 meters) and DIC samples collected only at the north, east, south, and west positions. On the second night (3/03/06), due to concerns about supplies lasting for the rest of the cruise, it was intended that water samples would only be collected at 30 and 3 meters at the north, east, south, and west CTD sites to support the DIC sampling effort. However, the re-pipetter used to dispense Mercuric Chloride malfunctioned after the first cast site and DIC sampling was discontinued. Thereafter, chlorophyll and nutrient samples were collected at 150 and 3 meters at the intended CTD sites to more effectively sample for the variability of these factors. A total of 12 CTD casts and 10 water sample profiles were conducted with 44 chlorophyll, 44 nutrient, and 8

DIC samples being collected. In support of the mapping effort, five CTD casts were conducted from the ship. The completed shipboard sampling plans are included below.

Shipboard CTD, ADCP and Water Sampling Plan

Manua Group - HI0602

Transect 1: 02/27/06 (CTD/Water Sampling/ADCP)

This will be a large transect around Ofu-Olesega and Tau that will hit all of CRED's historical CTD stations around the Manua group and two new ones. Begin at pt "ctd001" (the southeastern point) proceeding around the transect in a clockwise direction with CTD casts being conducted in sequence. All casts will be to 500 meters presuming seafloor depth is > 600; if not, cast depth will be reduced (though this should not be an issue). Water samples will be collected according to CRED protocols on all casts with the addition of DIC samples being collected at 30 m and the surface.

CTD Positions:

ID	LAT_DEG	LAT_MIN	LAT_H	LONG_DEG	LONG_MIN	LONG_H
CTD001	14	13.19740	S	169	42.77940	W
CTDnew1	14	6.80100	S	169	42.19540	W
CTD002	14	7.98305	S	169	32.67210	W
CTD003	14	12.96350	S	169	21.74550	W
CTDnew2	14	19.15910	S	169	23.75110	W
CTD004	14	18.08460	S	169	32.55350	W

Transect 2: 03/03/06 (CTD/Water Sampling/ADCP)

This will be a large transect around Ofu-Olesega and Tau that will hit all of the same sites as on 02/27/06. Begin at the most convenient point and proceed around the transect in a clockwise direction with CTD casts being conducted in sequence. All casts will be to 500 meters presuming seafloor depth is > 600; if not, cast depth will be reduced (though this should not be an issue). Water samples will be collected only at the south, west, north, and east sites (CTD001, CTD002, CTD003 and CTD004) at 30 and 3 meters in support of DIC sampling.

Note (after sampling complete): DIC sampling was discontinued due to a malfunctioning re-pipetter that would not accurately dispense Mercuric Chloride. Water samples were collected at the planned sites but at 150 and 3 meters to better sample for chlorophyll and nutrients.

A.6. Benthic Environment

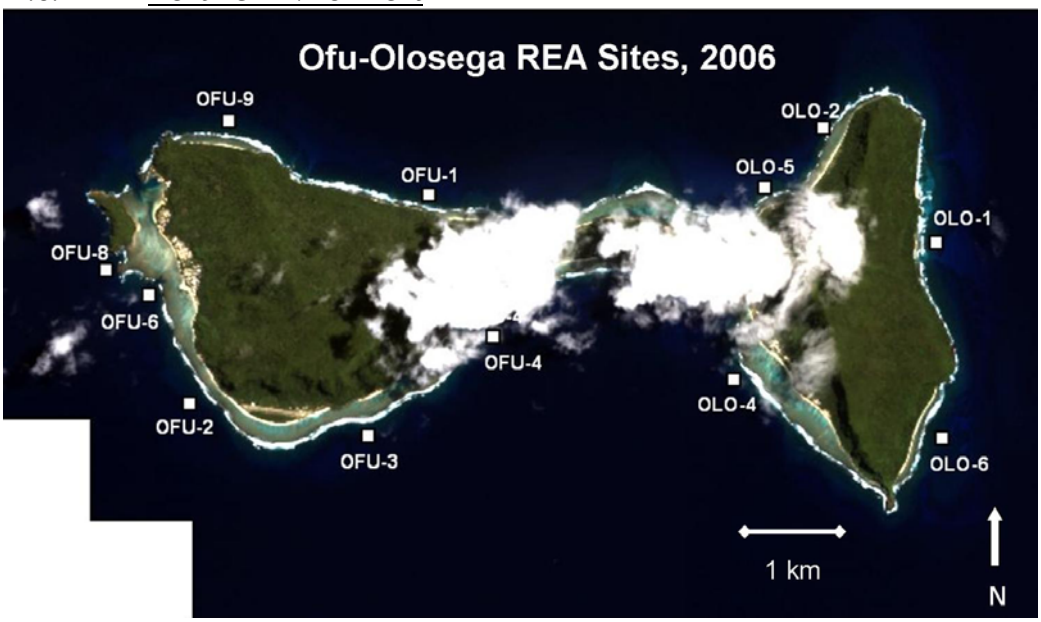

Figure C.3-1. REA site locations at Ofu and Olosega Islands.

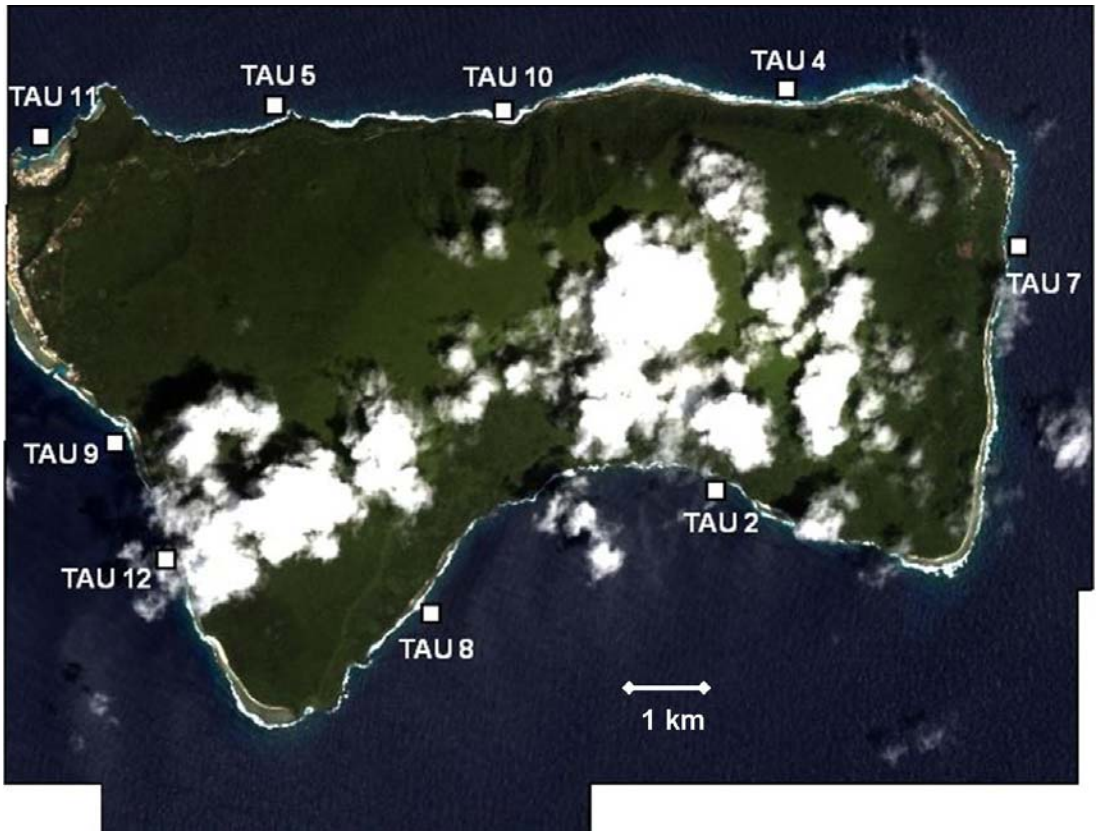

Figure C.3-2. REA site locations at Ta'u Island.

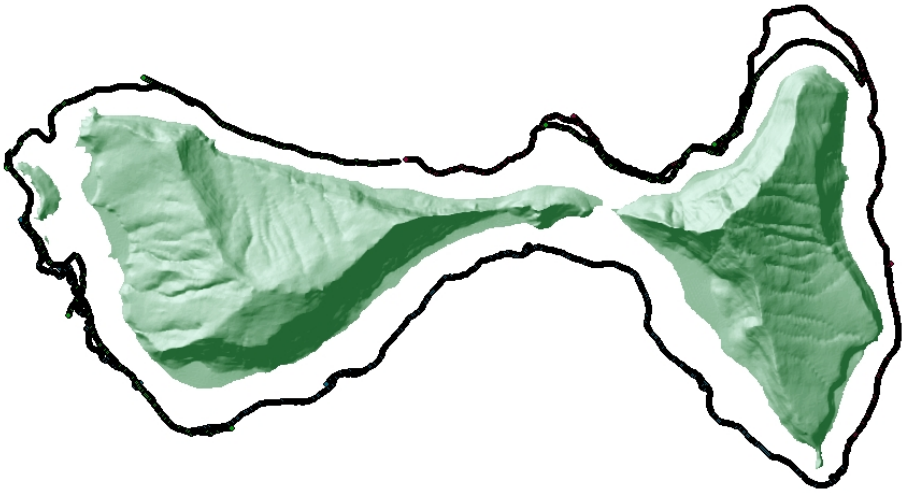

Figure C.3-3. Towed-diver Survey Tracks at Ofu and Olosega Islands.

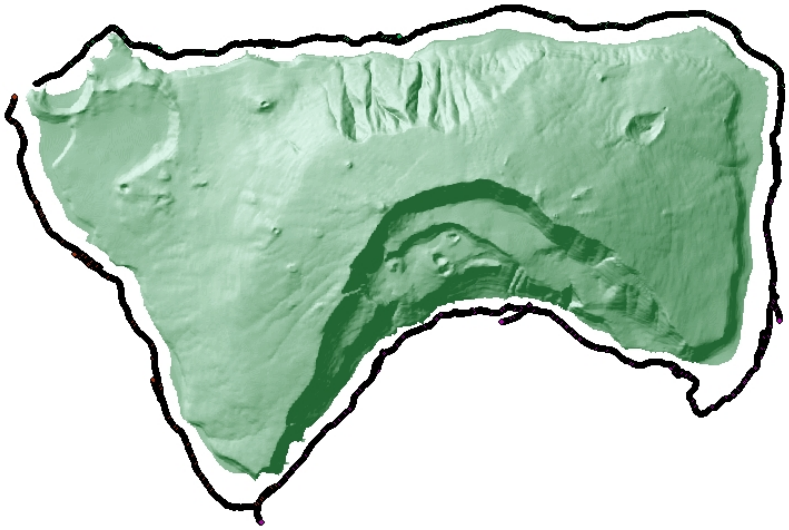

Figure C.3-4. Towed-diver Survey Tracks at Ta'u Island.

GPS coordinates, transect depth range, and water temperature recorded during 2006 surveys at long-term monitoring sites are presented in the table below. Site locations are shown in the graphics above.

Table C.3-1. Sites surveyed by REA team in Manu'a group and Rose Atoll, HI-06-02, February/March 2006. Depths and temperatures are from Kenyon dive gauges.

Site #	Date	Latitude (S)		Longitude (W)		Transect depth, m	Temp, °C
Ofu-Olosega							
OLO-6	2/26/2006	14	11.184	169	36.462	13.1	28.9
OLO-1	2/26/2006	14	10.113	169	36.497	14.5 - 15.2	28.9
OLO-2	2/26/2006	14	9.498	169	37.142	12.5 - 14.3	28.9
OLO-4	2/27/2006	14	10.873	169	37.624	13.1 - 13.7	28.9
OFU-4	2/27/2006	14	10.642	169	38.974	13.7 - 15.2	28.9
OFU-3	2/27/2006	14	11.192	169	39.669	12.8 - 13.7	28.9
OLO-5	2/28/2006	14	9.824	169	37.461	8.5 - 13.7	28.9
OFU-1	2/28/2006	14	9.878	169	39.341	12.2 - 15.2	28.9
OFU-9	2/28/2006	14	9.471	169	40.465	30 - 36	28.9
OFU-2	3/1/2006	14	11.019	169	40.675	12.2 - 14.6	28.9
OFU-6	3/1/2006	14	10.428	169	40.909	7.9 - 14.6	28.9
OFU-8	3/1/2006	14	10.297	169	41.150	12.2 - 14.3	28.9
Ta'u							
TAU-5	3/2/2006	14	12.859	169	29.421	12.8 - 14.0	28.3
TAU-10	3/2/2006	14	12.882	169	28.091	13.7 - 15.2	28.3
TAU-4	3/2/2006	14	12.744	169	26.440	12.8 - 14.0	28.3
TAU-7	3/3/2006	14	13.637	169	25.075	13.7	28.9
TAU-2	3/3/2006	14	15.043	169	26.840	13.7 - 14.3	28.9
TAU-8	3/3/2006	14	15.754	169	28.495	12.8 - 14.3	28.9
TAU-12	3/4/2006	14	15.453	169	30.041	12.2 - 14.3	28.3
TAU-9	3/4/2006	14	14.796	169	30.346	12.2 - 15.2	28.3
TAU-11	3/4/2006	14	13.043	169	30.785	12.8 - 13.7	28.3

C.3.1. Algae

- Thirty-two sites have been visited between the Manua Group of islands and Rose Atoll.
- More than 40 genera and 4 functional groups of macroalgae were determined
- Macroalgal communities were globally dominated by crustose corallines, turf algae, and *Peyssonellia*. However, some differences were highlighted between islands. For example, Rose Atoll was the only location showing *Microdyction* in abundance.
- *Halimeda*, *Jania*, *Dictyosphaeria* and *Gelid* were common algae encountered in the different reefs of the Manua Group and at Rose Atoll.
- Algal diversity was amazingly important at site 5 in the northern side of Tau.

• Algal diversity and algal abundance were relatively homogenous around Rose Atoll with crustose algae, turf algae and *Microdictyon* being the dominant macroalgae. One exception, however, has to be noticed in the south of the atoll. Where the wreck was located (south of the atoll) and around it, blue-green algae are still dominant. They are also the major photosynthetic organisms covering the reef floor in the lagoon. This is probably due to the water circulation in the lagoon (influence of the swell and tides).

Sites description

Olosega

OLO6 : 2-26-2006
GPS: 14°11.184S, 169°36.466W
This reef slope was located on the east side of Olosega. Weather conditions consisted of a southeast wind, water surge, and current. Visibility was relatively good (around 25 m). Coral cover was moderate but included large colonies of *Porites lobata*. Algae were mostly dominated by turf and coralline algae as well as *Peyssonellia*. *Gelid* and *Laurencia* were also very abundant. Additionally, blue-green algae were observed.

OLO1 : 2-26-2006
GPS: 14°10.104S, 169°36.489W
This site was located on the east side of Olosega. It was sunny when we started the dive and raining when we came up. Visibility was higher than 30 m. The reef looked like a canyon bordered in depth by a sandy area. Coral cover was amazing with large colonies of *Porites, Turbinaria, Pocillopora,* and other branching and encrusting corals. Soft corals were also abundant. Algae diversity was relatively low, mainly dominated by turf and coralline algae. *Peyssonellia* and *Gelid* were also abundant. *Halimeda* was found in few places during the random swim. Additionally, blue-green algae were observed in relative abundance.

OLO2 : 2-26-2006
GPS: 14°9.500S, 169°37.122
This reef was located north of Olosega in a more protected area than the two previous sites; the wind blowing southeast. Visibility was higher than 30 m. Weather was again sunny. The first transect was located on a vertical wall mostly dominated by algae. The second transect was located above the limestone forming a gentle slope, mostly covered by turf. Coral cover was moderate. Algae were dominated by a lot of small red algae, turf and coralline algae as well as *Peyssonellia*, *Gelid,* and *Jania*. *Tydemania* was found on both transects. *Chlorodesmis* was also reported as well as *Dictyota* and blue-green algae.

OLO4: 2-27-2006
GPS: 14°10.873S, 169°37.627W
This reef slope was located south of Olosega. Weather conditions were good (sunny) but there was some water surge. Visibility was more than 30 m. The reef was mostly dead with intense bioerosion going on (lots of holes have been observed and which can be attributed to boring sponges, bivalves, and worms). Grazing was intense (lots of grazer

scars). Coral cover was poor. Only small colonies of massive or encrusting corals have been observed. Algae were abundant and dominated by crustose algae as well as turf algae. *Valonia* was also found as well as small rhodophytes such as *Haloplegma*; most of them will be determined in the lab.

OLO5: 2-28-2006
GPS: 14°9.824S, 169°37.461W
This reef showed canyons separated by sandy channels. It was located north of Olosega. The weather conditions were good. Visibility was higher than 40 m. Coral cover was important. Algae were dominated by crustose corallines, *Peyssonellia,* and turf algae. However, algae such as *Gelid, Gelidiopsis, Jania,* and *Halimeda* were also observed and were relatively abundant across transects.

Ofu

OFU4: 2-27-2006
GPS: 14°10.642S, 169°38.974W
This site was located southeast of Ofu. Weather conditions were good (sunny) but some water surge was noticed. Visibility was higher than 35 m. Coral cover was important with small and large colonies of branched and massive corals. A lot of *Porites, Pavona, Pocillopora,* and *Astreopora* have been observed for example. Algae covered a large surface area along transects. Crustose algae and the chlorophyte *Halimeda,* mainly dominated there. Algal diversity looked poorer at this site in comparison to previous sites.

OFU3: 2-27-2006
GPS: 14°11.192S, 169°39.669W
This reef slope was located south of Ofu. Visibility was high (around 30 m). Weather conditions were deteriorating at the start of the dive (rain, wind, important water surge). Because of an important current under water, it was not possible to use the photoquadrat and therefore, to carry out the quantitative study of RAM at this location. A qualitative study was realized. Coral cover was important. A lot of tiny colonies of coral were observed all along both transects. Those colonies were essentially colonies of massive and encrusting corals. Algae also had a high cover and were dominated mostly by crustose algae, turf, *Peyssonellia,* and *Halimeda*. Some branched calcareous algae were also observed as well as *Chlorodesmis*. As usual, a repens *Laurencia* sp. was present (ubiquitous alga) on top of encrusting corallines.

OFU1: 2-28-2006
GPS: 14°9.878S, 169°39.341W
This reef slope showed canyons separated by sandy channels. It was located on the north of OFU. Weather conditions were good. Visibility was higher than 40 m. Coral cover was important. Corals were dominated by encrusting and massive forms, as well as by small colonies. Algae were dominated by crustose corallines, turf and *Halimeda*. *Peyssonellia* and *Dictyosphaeria verslusii* were also abundant. Additionally, other algae such as *Chlorodesmis, Tydemania, Jania,* and *Gelid* were observed in abundance.

OFU9: 2-28-2006
GPS: 14° 9.496S, 169°40.477
This site is new. It was located on the north side of OFU and was a reef slope composed mainly by grazed limestone. The roughness was very low (flat reef slope). Coral cover was very low. Few colonies of encrusting and massive corals were seen. *Porites lobata/lutea* was one of the most abundant corals. Algae were dominated by cynaobacteria, turf algae, and *Peyssonellia*. However, *Halimeda, Haloplegma, Chlorodesmis, Gelid, Tydemania, and Gelidiopsis* were observed during the random swim.

OFU2: 3-1-2006
GPS: 14° 11.019S, 169°40.675
This reef slope was located south of OFU. Weather conditions were good but water surge was important. Visibility was higher than 20 m. Coral cover was relatively low; the reef looked intensively bioeroded. The dominant algae were crustose and turf algae as well as *Peyssonellia.* Additionally, *Gelid, Jania, Laurencia,* and *Halimeda* were observed in relative abundance.

OFU6: 3-1-2006
GPS: 14°10.428S, 169°40.909W
This reef was located southwest of OFU. Weather conditions were good but water motion was important. Visibility was important. The reef looked alike a canyon bordered by a sandy area around 25 m. Algae were dominated by crustose and turf algae as well as by *Peyssonellia.* A lot of *Gelid* and *Galaxaura* were also observed as well as blue-green algae.

OFU8: 3-1-2006
GPS: 14°10.297S, 169°41.150W
This reef was located on the western side of OFU. Weather conditions were good but water motion was high. Visibility was higher than 20 m. Coral cover was low. Algae were dominated by crustose and turf algae as well as by *Peyssonellia.* Study of RAM at this reef was not possible because of the camera was not in use (the battery went down).

Tau

TAU5: 3-2-2006
GPS: 14°12.859S, 169°29.421W
This site was located north of TAU. Weather conditions were good although there was a strong wind. Visibility was lower than 25 m. The reef was mostly flat and intensively bioeroded. Coral cover was low. The floor was mostly limestone. Only encrusting and massive colonies of coral were seen. They were all small. Algal biodiversity was amazing. Algae were dominated by turf, crustose algae, but also by *Peyssonellia*. Two different species of *Caulerpa* were collected during the random swim as were many species of red algae. Species identification will be determined during laboratory analyses. Also, *Bornetella* and *Boodlea* were collected. *Boodlea* was very abundant. A lot of Diatoms covered the reef floor. They were disc shaped.

TAU10: 3-2-2006
GPS: 14°12.882S, 169°28.091W
This reef was located northeast of Tau. It was made by large rocks forming canyons, each separated from the other by black sand. Weather conditions were rainy and windy. Water surge was moderate. Visibility was lower than 15 m. Coral cover was moderate and included a lot of colonies of *Porites lobata* and *lutea*. Algal diversity was low. Algae were dominated by crustose and turf algae as well as by *Peyssonellia*. *Actinotrichia, Gelid,* and *Dictyota* were also seen in abundance. A lot of star-shaped Diatoms were observed on the floor. Sedimentation was high at this site.

TAU4: 3-2-2006
GPS: 14°12.744S, 169°26.440W
This reef was located northeast of Tau. It was flat and mainly composed of limestone. Visibility at this site was around 20 m. Weather conditions were rainy and surgy. Water motion was moderate. Coral cover was low. Coral colonies were small, and all from encrusting or massive corals. Lots of *Porites, Astreoides,* and *Galaxea* were observed. Algal diversity was low. Algae were dominated by turf algae and *Dictyosphaeria verslusii*. Crustose algae, *Peyssonellia, Jania, Gelid,* and *Dictyota* were also abundant. Very short and small *Halimeda* were observed. *Haloplegma* was collected during the random swim. Lots of star-shaped Diatoms were observed on the reef floor.

TAU7: 3-3-2006
GPS: 14°13.637S, 169°25.081W
This site was located on the east side of Tau. Weather conditions were good but water motion was important. The reef was flat and intensively bioeroded. Visibility was around 25 m. Coral cover was moderate. Algal diversity was low. Macroalgal communities were dominated by crustose corallines, turf algae, and *Peyssonellia*. *Halimeda, Jania,* and *Gelid* were observed as well as cyanobacteria.

TAU2: 3-3-2006
GPS: 14°15.043S, 169°26.839W
This reef was located southeast of Tau. Weather conditions were good and visibility was higher than 30 m. Water motion was moderate. The reef was a reef slope with a vertical drop-off (reef wall) at around 15 m. Coral cover was important as well as coral diversity. Algal diversity was relatively low. Algal communities were dominated by turf algae, *Peyssonellia,* crustose corallines, and *Halimeda*. Other algae such as *Chlorodesmis* and *Dyctiosphaeria verslusii* were also recorded.

TAU8: 3-3-2006
GPS: 14°15.754S, 169°28.495W
This reef was located southwest of Tau. Weather conditions were good but a strong current was noticed along transects. Therefore, it was not possible to use the photoquadrat. A qualitative survey of macroalgae was carried out at this site. The reef was flat (gentle slope) and intensively bioeroded. Coral cover was very low. Small colonies of encrusting and massive corals were dominant. Small colonies of soft corals as well as branching corals such as *Pocillopora* and *Acropora* were observed. Algal

diversity was low. Macroalgae were dominated by turf algae, *Peyssonellia,* and *Boodlea*. Boodlea was extremely abundant along the second transect. Crustose corallines were also abundant. Additionally *Halimeda* was noticed as well as *Dictyosphaeria verslusii*. Blue-green were very abundant.

TAU12: 3-4-2006
GPS: 14°15.453S, 169°30.041W
This reef was located on the west side of Tau. Weather conditions were good. There was no wind and no swell. No water surge underwater. Visibility was higher than 30 m. The reef looked like a canyon with pinnacles formed by very large colonies of massive *Porites*. Coral cover was important. Algae were abundant, mostly dominated by crustose and turf algae. *Peyssonellia* was also abundant as well as *Halimeda*, *Gelid, Jania, Actinotrichia,* and *Dictyosphaeria.* Blue-green algae were observed and were abundant.

TAU9: 3-4-2006
GPS: 14°13.013S, 169°30.772W
This reef was located on the west side of Tau. Weather conditions were excellent. No wind, no surge, and no swell were noticed. Visibility was higher than 30 m. The reef slope was formed by large rocks and colonies of *Porites*. Coral cover was moderate. Algal diversity was moderate. Algal communities were dominated by crustose and turf algae as well as by *Peyssonellia, Halimeda, Jania, Gelid, and Dictyosphaeria*. *Haloplegma* was recorded during the random swim. Blue-green algae were often observed.

TAU11: 3-4-2006
GPS: 14°14.796S, 169°30.346W
This site was located northwest of Tau. Water surge was important (strong current in the bottom). Weather conditions were good. The reef was a gentle slope mostly composed by limestone. Coral cover was moderate. Corals were dominated by encrusting forms. Massive forms were also observed and rarely, branching corals such as *Pocillopora*. Algae were not very diverse. Algal communities were dominated by turf, blue-green algae and crustose corallines. *Peyssonellia* was abundant as well. *Tydemania* and lots of *Gelid* as well as *Amphiroa* were seen during the random swim.

Table C.3.1-1. RAM for the Manua group.

	OLO6	OLO1	OLO2	OLO4	OLO5	OFU4	OFU3	OFU1	OFU9	OFU2	OFU6	OFU8	TAU5	TAU10	TAU4	TAU7	TAU2	TAU8	TAU12	TAU9	TAU11
GREEN ALGAE																					
Boodlea	**8.3** 5.0												**41.7** 5.4					*			
Bornetella								*					**8.3** 7.0								
Bryopsis	**8.3** 6.0		**8.3** 7.0		**8.3** 4.0		*	**16.7** 6.0				*									
Caulerpa													**25.0** 4.7								
Cladophor-opsis																				**8.3** 8.0	
Chloro-desmis	*		**8.3** 4.0		**8.3** 54.0	**16.7** 6.0	*	**16.7** 3.5	*			*	**16.7** 4.0	*	*	**8.3** 9.0	**33.3** 6.5	*	*	**8.3** 7.0	**41.7** 5.8
Dictyo-sphaeria				**8.3** 6.0				**25.0** 4.7		**8.3** 7.0			**33.3** 6.0		**83.3** 4.0	**8.3** 6.0	**8.3** 7.0	*	**25.0** 6.3	**25.0** 7.0	**41.7** 4.2
Halimeda		**16.7** 3.0	**8.3** 6.0	**16.7** 4.5	**8.3** 4.0	**100** 2.8	*	**25.0** 4.7	*	**41.7** 4.4		*	**8.3** 3.0		**25.0** 6.7	**8.3** 7.0	**66.7** 4.6	*	**25.0** 6.3	**25.0** 5.0	*
Neomeris		**8.3** 5.0					*							*	**16.7** 5.5					**8.3** 9.0	
Tydemania								*	*				*		*					*	
Udotea			**8.3** 5.0					*	*												*
Valonia				*									**25.0** 5.7				*				**16.7** 3.5

	OLO6	OLO1	OLO2	OLO4	OLO5	OFU4	OFU3	OFU1	OFU9	OFU2	OFU6	OFU8	TAU5	TAU10	TAU4	TAU7	TAU2	TAU8	TAU12	TAU9	TAU11
RED ALGAE																					
Actinotrichia			**8.3** 8.0			*	**8.3** 8.0	**16.7** 6.0				*	**8.3** 8.0	**25.0** 4.7		**8.3** 8.0		*	**25.0** 7.3	**8.3** 6.0	*
Amansia													*								*
Amphiroa			**8.3** 5.0																		**25.0** 5.7
Carpopeltis								*					*								
Champia					**8.3** 7.0			**8.3** 7.0					**8.3** 7.0	**16.7** 6.0				*	**8.3** 8.0		
Cheilo-sporum								*													
Chondro-phycus				*				*													
Chrysymenia													*			**8.3** 11.0				*	
Dasya													**8.3** 6.0								
Galaxaura							**8.3** 7.0				**16.7** 6.0			**8.3** 4.0	**16.7** 6.5	**8.3** 7.0				**16.7** 6.0	
Gelid	**58.3** 4.9	**41.7** 3.4	**58.3** 3.7	**33.3** 5.3	**33.3** 6.0	*	**100** 4.3	**66.7** 5.1	**75.0** 4.3	**91.7** 5.5	**91.7** 4.5	*	**100** 2.3	**33.3** 5.5	**83.3** 5.4	**41.7** 5.0	**66.7** 5.6	*	**50.0** 5.3	**83.3** 4.7	**66.7** 4.6
Gelidiopsis			**16.7** 7.0				**25.0** 5.3	**8.3** 3.0			**8.3** 6.0	*	**16.7** 5.5					*		**8.3** 6.0	*
Gibsmithia						*													*		*
Grateloupia																	*		*		
Haloplegma				*			*	*	*		*		*	*	*				*	**16.7**	*

	OLO6	OLO1	OLO2	OLO4	OLO5	OFU4	OFU3	OFU1	OFU9	OFU2	OFU6	OFU8	TAU5	TAU10	TAU4	TAU7	TAU2	TAU8	TAU12	TAU9	TAU11
																				5.0	
Halychrysis								**8.3** 8.0			**8.3** 5.0										
Hypo-glossum														*							
Jania	**16.7** 6.0		**41.7** 5.4	**83.3** 5.1	**41.7** 6.8	*	**91.7** 5.5	**50.0** 6.3	**66.7** 5.4	**100** 6.8		*	**58.3** 6.4	**58.3** 4.0	**91.7** 5.6	**75.0** 5.3	**75.0** 6.4	*	**66.7** 4.9	83.3 6.0	66.7 6.4
Laurencia	**50.0** 3.2			8.3 7.0		*				66.7 5.8											
Martensia													**16.7** 7.0								
Meristotheca								*													
Nitophyllum											**8.3** 5.0	*									
Peysson-nelia	**41.7** 2.8	**58.3** 3.7	**41.7** 3.2	**66.7** 3.3	**91.7** 4.4	*	**83.3** 2.9	**83.3** 2.8	**58.3** 3.1	**83.3** 2.6	**100** 2.8	*	**75.0** 3.7	**75.0** 2.4	**100** 2.3	**83.3** 2.7	**83.3** 2.6	*	**100** 3.3	**83.3** 2.5	**33.3** 3.5
Portieria	**8.3** 3.0								*				*								
Titanophora				**8.3** 3.0								*									
Wrangelia											*		8.3 7.0								
branched upright coralline					**8.3** 5.0	*	*														
crustose coralline	**100** 1.5	**83.3** 1.6	**83.3** 1.4	**100** 1.1	**100** 1.1		**100** 1.3	**91.7** 1.2	**83.3** 1.8	**100** 1.2	**100** 1.1		**75.0** 3.0	**41.7** 2.0	**100** 1.8	**100** 2.4	**100** 1.3		**100** 1.3	**100** 1.9	**91.7** 2.4
BROWN ALGAE																					

	OLO6	OLO1	OLO2	OLO4	OLO5	OFU4	OFU3	OFU1	OFU9	OFU2	OFU6	OFU8	TAU5	TAU10	TAU4	TAU7	TAU2	TAU8	TAU12	TAU9	TAU11
Dictyota			**33.3** 5.5			*				**8.3** 10.0		*	**41.7** 6.2	**25.0** 6.3	**25.0** 7.0	**41.7** 7.2	**58.3** 6.0		**16.7** 7.5	**16.7** 9.0	
Lobophora												*				8.3 4.0	16.7 5.0	*			*
CYANO-PHYTES	**66.7** 4.1	**33.3** 3.5	**41.7** 3.4	**75.0** 3.8	**100** 3.5	*	**58.3** 5.7	**83.3** 4.1	**100** 2.6	**91.7** 3.7	**58.3** 4.3	*		**33.3** 1.3	**33.3** 6.5	**66.7** 3.8	**91.7** 4.8	*	**91.7** 3.9	**66.7** 4.1	**83.3** 3.4
TURF	**100** 1.7	**91.7** 1.4	**100** 1.5	**100** 2.2	**83.3** 2.6	*	**100** 2.0	**100** 2.2	**100** 2.2	**100** 2.4	**100** 2.3	*	**100** 1.1	**66.7** 1.5	**100** 1.9	**100** 1.3	**100** 2.4	*	**100** 1.8	**100** 1.8	**100** 1.0

C.3.1.1. Benthic Towed-diver Survey – Algae

Macroalgae was present on all sides at low levels, the highest averages (5–10%) found on the east and south sides, while at all areas surveyed coralline algae was found to be a dominant benthic cover, averaging between 10 and 40%. Turf algae was observed on steep walls at multiple south and west forereef sites.

Macroalgae levels were recorded at an average of less then or equal to about 5% all around the island with the exception of the southern shore of Ofu which had an average of around 15%.

C.3.2. Corals

Ta'u

Nine sites were surveyed by the coral team, shown in the figure above. All nine sites were previously surveyed by CRED in 2004.

Colonies belonging to at least 28 cnidarian genera were observed by Kenyon and counted within belt transects during quantitative surveys (see table below). Members of the genera M*ontipora* and *Astreopora* dominated the coral fauna in terms of number of colonies, with each genus contributing more than 10% of the total number of colonies. A total of 3436 coral colonies (of which 3352 were scleractinians) were counted within a total survey area of 400 m^2, for an average colony density of 8.6 coral colonies/m^2. Density values at individual sites ranged from 3.5/m^2 at site TAU-10 to 12.4/m^2 at both TAU-2 and TAU-4. The highest generic diversity (23 genera) along the transect belt was observed at TAU-12. Inspection of a histogram showing the size class distribution of cnidarian colonies counted and classified within belt transects shows that the majority (79.1%) of colonies measure less than 20 cm in maximum diameter, with the greatest number of colonies occurring within the 10–20–cm size class.

Ofu and Olosega

Five sites were surveyed by the REA team at Olosega and seven sites at Ofu, for a total of 12 sites. Site locations are shown in the figure above.

Colonies belonging to at least 33 cnidarian genera were observed by Kenyon and counted within belt transects during quantitative surveys (see table above). Members of the genera M*ontipora, Goniastrea,* and *Pocillopora* dominated the coral fauna in terms of number of colonies, with each genus contributing more than 10% of the total number of colonies. A total of 4185 cnidarian colonies (of which 4111 were scleractinians) were counted within a total survey area of 495 m^2, for an average colony density of 9.8 cnidarian colonies/m^2. Density values at individual sites ranged from 4.0/m^2 at OFU-1 to 19.8/m^2 at OFU-3. The highest generic diversity (28 genera) along the transect belts was found at OFU-4. Inspection of a histogram showing the size class distribution of cnidarian colonies counted and classified within belt transects (see below) shows that the majority (85.2%) of colonies measure less than 20 cm in maximum diameter, with the greatest number of colonies occurring within the 5–10–cm size class.

Table 3.2-1. Number of corals, by genus, enumerated along belt transects by Kenyon during 2006 coral REA surveys. Genera contributing more than 10% of the total number of colonies at each location are highlighted in bold.

	Ofu-Olosega		Ta'u		Rose Atoll	
Coral Genera	# cnidarians	% of total	# cnidarians	% of total	# cnidarians	% of total
Acanthastrea	10	0.2%	12	0.3%	16	0.4%
Acropora	98	2.3%	207	6.0%	178	4.2%
Astreopora	162	3.9%	489	14.2%	206	4.8%
Coscinaraea	3	0.1%	3	0.1%	20	0.5%
Cyphastrea	16	0.4%	22	0.6%	40	0.9%
Diploastrea	4	0.1%	0	0.0%	0	0.0%
Echinophyllia	5	0.1%	4	0.1%	4	0.1%
Echinopora	14	0.3%	5	0.1%	1	0.0%
Favia	108	2.6%	76	2.2%	306	7.2%
Favites	190	4.5%	304	8.8%	1	0.0%
Fungia	63	1.5%	22	0.6%	30	0.7%
Galaxea	215	5.1%	112	3.3%	1	0.0%
Gardineroseris	3	0.1%	0	0.0%	0	0.0%
Goniastrea	581	13.9%	320	9.3%	3	0.1%
Goniopora	2	0.0%	0	0.0%	2	0.0%
Heliopora	3	0.1%	0	0.0%	0	0.0%
Hydnophora	16	0.4%	5	0.1%	6	0.1%
Leptastrea	188	4.5%	292	8.5%	63	1.5%
Leptoseris/ Pachyseris	7	0.2%	1	0.0%	15	0.4%
Lobophyllia/ Symphyllia	10	0.2%	8	0.2%	2	0.0%
Merulina/ Scapophyllia	0	0.0%	0	0.0%	0	0.0%
Millepora	7	0.2%	2	0.1%	0	0.0%
Montastrea	289	6.9%	218	6.3%	520	12.2%
Montipora	1026	24.5%	547	15.9%	430	10.1%
Mycedium	5	0.1%	0	0.0%	0	0.0%
Oulophyllia	3	0.1%	8	0.2%	0	0.0%
Palythoa/ Zoanthus	4	0.1%	26	0.8%	0	0.0%
Pavona	190	4.5%	116	3.4%	125	2.9%
Platygyra/ Leptoria	186	4.4%	108	3.1%	1	0.0%
Pocillopora	451	10.8%	203	5.9%	1376	32.2%
Porites	208	5.0%	258	7.5%	566	13.3%
Psammocora	9	0.2%	6	0.2%	24	0.6%
Sandalolitha	5	0.1%	2	0.1%	0	0.0%
Seriatopora	0	0.0%	0	0.0%	0	0.0%
Sinularia/ Lobophytum/ Sarcophyton	60	1.4%	56	1.6%	312	7.3%
Stylaster/ Distichopora	0	0.0%	0	0.0%	5	0.1%
Stylocoeniella	0	0.0%	0	0.0%	14	0.3%
Stylophora	0	0.0%	0	0.0%	0	0.0%
Turbinaria	44	1.1%	4	0.1%	0	0.0%
TOTAL	4185	100.0 %	3436	100.0%	4267	100.0%

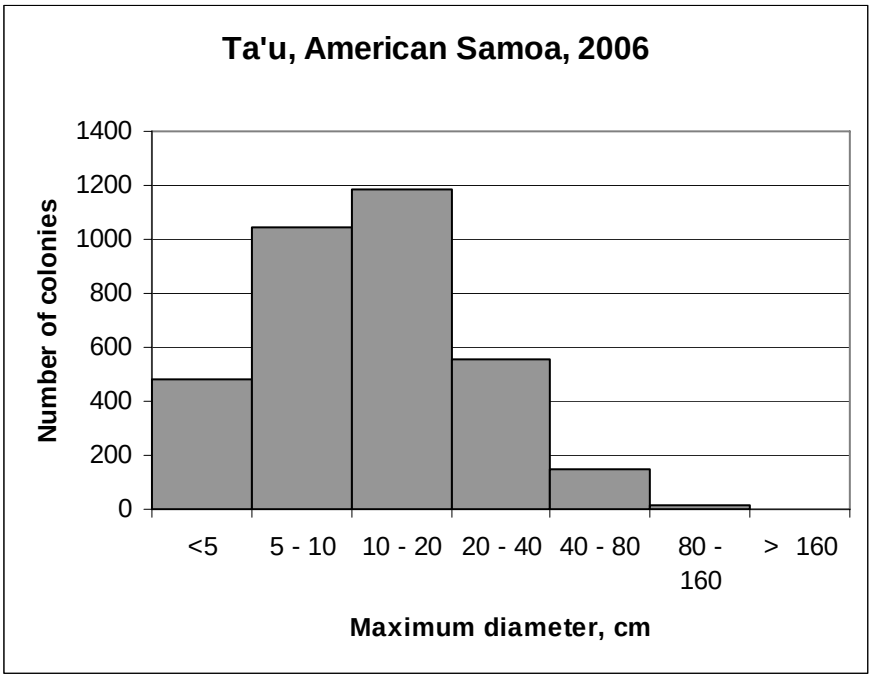

Fig 3.2-1. Coral size distribution, Ta'u Island.

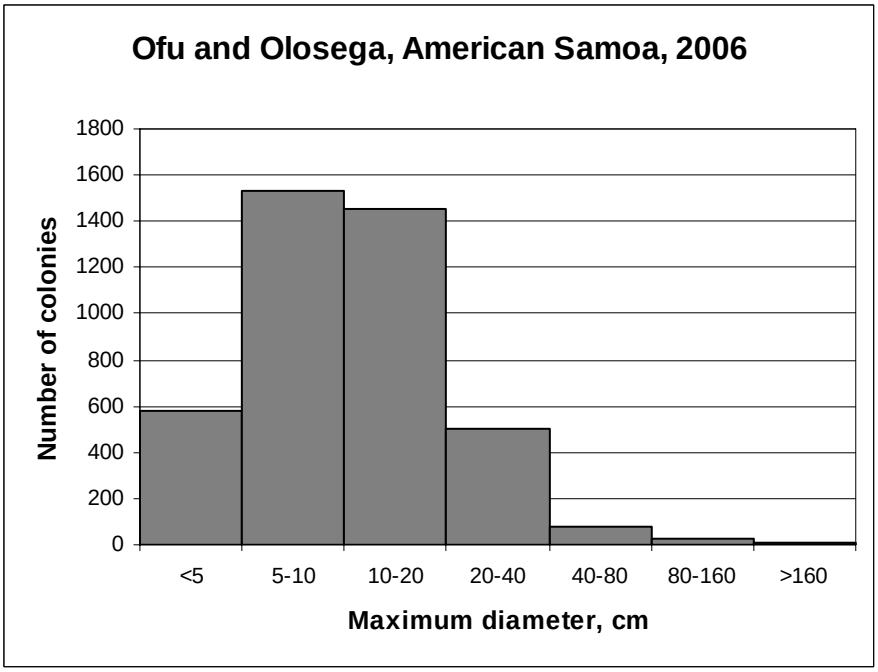

Figure 3.2-2. Coral size distribution, Ofu and Olosega Islands.

General observations on coral community composition and health assessment:
Full REA surveys were conducted at 33 sites around the Islands of Ofu-Olosega, Ta'u, and Rose Atoll by the benthic team between February 26, 2006 and March 8, 2006. Relatively good weather conditions allowed the REA team to survey a variety of the reef slopes around the main cardinal points of the islands. Dive depths ranged from 5.8 to 17.0 m. Coral REA surveys indicated that the mean percent live coral cover on reefs around the Islands of Ofu-Olosega was close to 30%, 20% at Ta'u, and 15% at Rose Atoll. Percent cover of crustose coralline algae and fleshy macroalgae was the highest at Rose Atoll (70%) and lowest at Ta'u (20%).

Coral disease and health assessment: The average abundance of coral and coralline algae diseases and syndromes at Ofu-Olosega was moderately high: 40.2 cases/1000m^2. In contrast, coral diseases were much lower at Ta'u and Rose Atoll (11.1 cases/1000m^2 and 3.2 cases/1000m^2, respectively). The main types of diseases and syndromes detected included: (1) patchy paling/mild bleaching (25 cases) affecting species in the following genera: *Porites*, *Pavona*, *Pocillopora*, *Coscinaraea*, *Platygyra*., and *Leptoria*; (2) skeletal growth anomalies (18 cases) mainly affecting colonies of *Monitpora* spp., *Astreopora*, and *Acropora*; (3) discoloration/dark spots (2 cases) affecting colonies of *Coscinaraea*. Afflictions to coralline algae were also observed. These were more abundant than coral diseases. A total of 213 cases of coralline algae diseases were detected including coralline lethal orange disease (CLODS) and the ring syndrome. The Islands of Ofu-Olosega exhibited the highest number of cases of coralline algae diseases (193 cases); Rose Atoll, the lowest (9 cases). Many cases of irritation and partial mortality because of filamentous algal overgrowth were also observed, particularly at Rose Atoll, affecting corals of the genera *Pocillopora*, *Favia*, *Montastrea*, *Montipora*, *Porites*, and *Pavona*. The abundance of this condition was relatively high; nearly 67 cases/m^2. This condition affected corals mainly 5 cm and above, and the severity was variable ranging from subtle to severe.

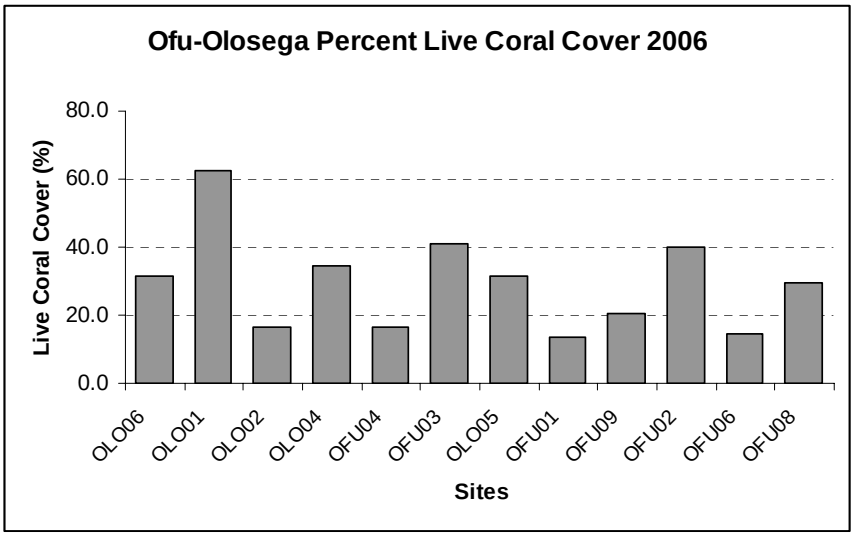

Figure 3.2-3. Coral cover, Ofu and Olosega Islands.

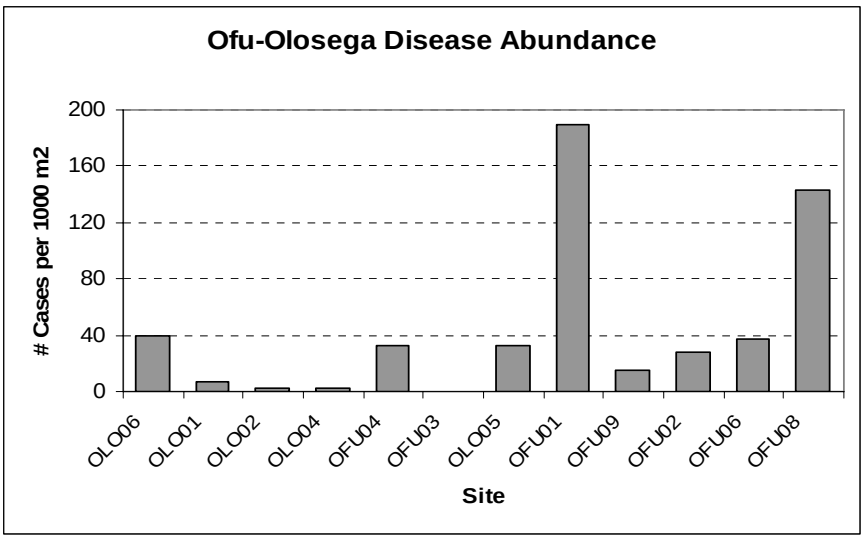

Figure 3.2-4. Coral disease abundance, Ofu and Olosega Islands.

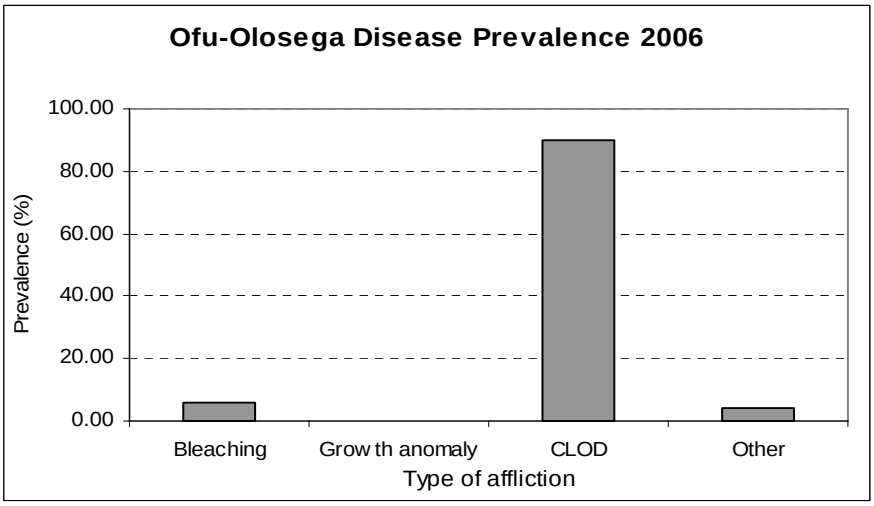

Figure 3.2-5. Disease prevalence, Ofu and Olosega Islands. BL: bleaching, GA: growth anomaly; DS: discoloration (dark spots); CLOD: coralline lethal orange disease; OT: other coralline algae disease, mainly ring syndrome.

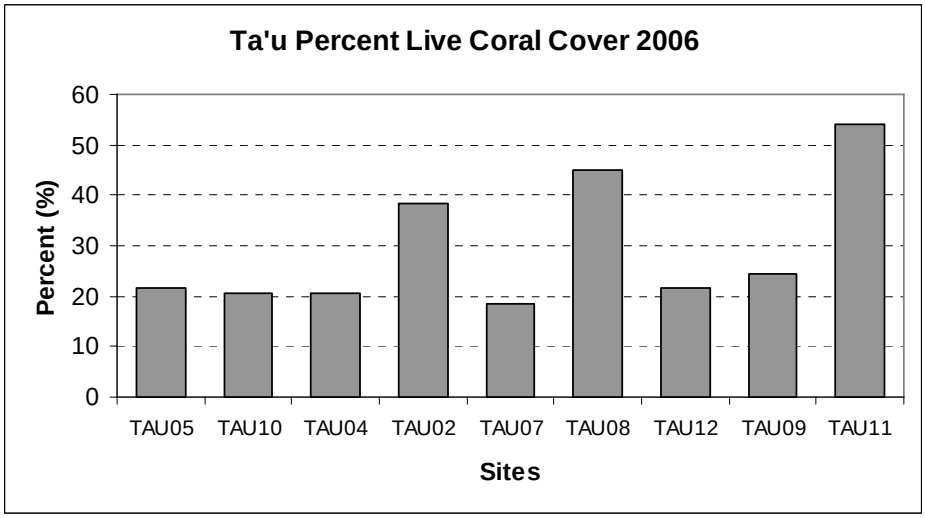

Figure 3.2-6. Coral cover, Ta’u Island.

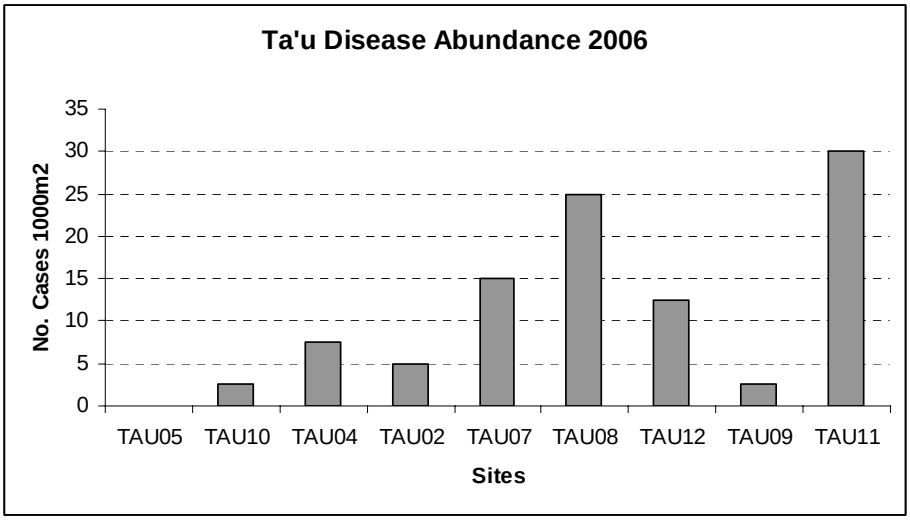

Figure 3.2-7. Coral disease abundance, Ta’u Island.

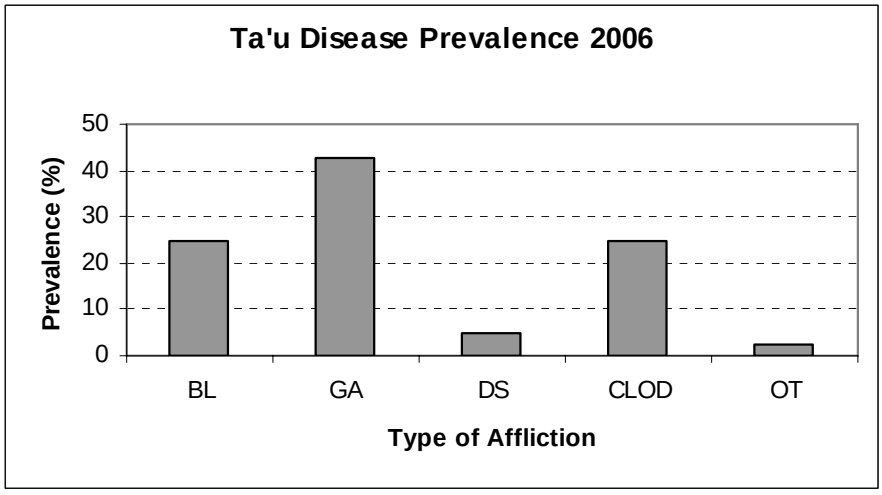

Figure 3.2-8. Coral disease prevalence, Ta'u Island. BL: bleaching, GA: growth anomaly; DS: discoloration (dark spots); CLOD: coralline lethal orange disease; OT: other coralline algae disease, mainly ring syndrome.

C.3.2.1. Benthic Towed-diver Survey – Corals

The habitat along the forereef slopes of Ta'u were observed to consist of an average of 10–20% hard coral cover. The north and west sides fell on the lower end of this average and the east and south sides had the higher averages. Soft corals were observed only occasionally throughout the island, with the exception of the south side where they were found with slightly more regularity (1–5%).

The dominant habitats observed along the forereef slopes of Ofu and Olosega Islands consist of between 5 and 30% hard coral cover. On all sides of the island an average of 1–5% of the hard coral was observed to be stressed. Soft corals were observed only occasionally on the north and west sides, and were recorded more regularly (1–10% cover) on the south and east sides.

C.3.3. Invertebrates

The Islands of Tau, Olosega, and Ofu, which make up the Manua Islands are more isolated and less populated than Tutuila. This should make the pressure from reef gleaning in the shallow nearshore areas much less. There are many areas in this island group that are rarely visited by local inhabitants due to difficulties in accessing them. The sites surveyed from February 26 through March 4 at the Manua Islands were represented by mostly reef slopes that led to dropoffs (some vertical dropoffs like Site 2) with medium to high rugosity with a depth range between 12 and 21 m.

The condition of all sites appeared to be good, although at some sites there were few invertebrates besides hermits, gastropods, and small amounts of other encrusting species. Two unknown sponge species were commonly seen at all sites. All other sites surveyed had a typical balanced compliment of species. Tridacnid clam densities were variable and gastropods and sponges were the most common species at all sites.

Molluscs

The giant clams *Tridacna maxima* and *Tridacna squamosa* were both observed during surveys at all but 2 of the 21 sites surveyed during this study. Giant clams were rare to common at all sites where present. Gastropod populations were made up of Trochidae, Turbinidae, Thaididae, Conidae, Vasidae, Fasciolaridae, Cypraeidae, and Veneridae. Cone shells (Conidae) were common at all sites.

Echinoderms

Echinoderms were not abundant or diverse at any of the sites surveyed on the reef slope. The echinoderm seen regularly at most of the sites on this island was the echinoid (urchin) *Echinostrephus,* which was variable in its abundance between sites. Asteroids (sea stars) were a rare occurrence at all sites at this depth and the only two recorded at the 12 and 21 m depth range were *Linckia multifora* and *Culcita novaeguineae* although *Acanthaster planci* had been cited during previous cruises. Only three different types of holothuroid (sea cucumber) were seen throughout the islands, which were *Bohadschia argus*, *Holothuria whitmaei*, and *Thelenota ananas*. There were also a few species of ophiuroids (brittle stars) and crinoids (sea fans) present at some of the sites as well.

Crustacea

The crustacean fauna was dominated by an abundant and diverse population of diogenid hermit crabs at all sites. The two species *Calcinus minutus* and *Clibinarius virescens* were by far the most common throughout all sites. Other species such as *Dardanus guttatus*, *Dardanus lagopodes*, *Calcinus gaimardii*, and *Ciliopagurus strigatus* were variable in their presence and abundance throughout all sites.

Other groups

The remainder of the groups were encrusting species represented by sponges (two species were commonly seen at all sites), hydrozoa (hydroids and the gorgonian *Distichopora*), a few species of zoanthids, and a variety of tunicates with the most common being *Didemnum*. There was also one common polychaete, *Spirobranchus giganteus,* throughout all sites in Tau.

Figure C.3.3-1. Total Sites Surveyed: 21

Date	Island	Site #	Habitat type	Wind/lee ward	Min depth	Max depth	Latitude	Longitude
2/26/2006	Olosega	6	backreef	wind	12.8	14.9	14°`11.184	169°36.466
2/26/2006	Olosega	1	forereef	wind	14.6	16.5	14°`10.109	169°36.492
2/26/2006	Olosega	2	forereef	wind	11.9	14.0	14°`09.500	169°37.122
2/27/2006	Olosega	4	forereef	wind	13.4	14.9	14°`10.873	169°37.627
2/27/2006	Ofu	4	forereef	wind	14.0	16.8	14°`10.642	169°38.974
2/27/2006	Ofu	3	forereef	wind	14.6	16.5	14°`11.192	169°39.669
2/28/2006	Olosega	5	forereef	wind	13.1	15.2	14°`09.823	169°37.463
2/28/2006	Ofu	1	forereef	wind	9.7	14.3	14°`09.876	169°39.338
2/28/2006	Ofu	9	forereef	wind	11.3	14.0	14°`09.496	169°29.421
3/1/2006	Ofu	2	forereef	wind	13.7	15.9	14°`11.019	169°40.675
3/1/2006	Ofu	6	forereef	wind	11.0	15.5	14°`10.428	169°40.909
3/1/2006	Ofu	8	forereef	wind	13.7	15.2	14°`10.302	169°41.133
3/2/2006	Tau	5	forereef	wind	13.1	14.9	14°`12.059	169°29.421

Date	Island	Site #	Habitat type	Wind/lee ward	Min depth	Max depth	Latitude	Longitude
3/2/2006	Tau	10	forereef	wind	12.8	15.9	14°`12.877	169°28.096
3/2/2006	Tau	4	forereef	wind	12.8	16.8	14°`12.744	169°26.440
3/3/2006	Tau	7	forereef	wind	12.8	15.2	14°`13.637	169°25.081
3/3/2006	Tau	2	forereef	wind	14.3	15.2	14°`15.043	169°26.839
3/3/2006	Tau	8	forereef	wind	13.7	16.8	14°`15.754	169°28.495
3/4/2006	Tau	12	forereef	wind	13.1	15.2	14°`15.453	169°30.041
3/4/2006	Tau	9	forereef	wind	14.0	15.9	14°`14.785	169°30.344
3/4/2006	Tau	11	forereef	wind	13.4	14.9	14°`13.037	169°30.772

C.3.3.1. Benthic Towed-diver Survey – Macroinvertebrates

On Ta'u, a total of ~272 giant clams (*Tridacna sp.*) were observed for an average of ~8 per linear kilometer of survey. While no crown-of-thorns starfish (*Acanthaster sp*.) were observed, potential signs of *Acanthaster sp.* predation were noted along the western forereef slopes. Over ~25,000 boring urchins (most believed to be *Echinostrephus sp*.) were observed; the majority of these were found on the north and west sides of the island.

At Ofu and Olosega, a total of ~108 giant clams were observed for an average of ~3 per linear kilometer of survey. No crown-of-thorns starfish (*Acanthaster sp*.) were observed. Multiple fresh water seeps were noted on the Ofu western forereef. Numerous sightings of a gray sponge were recorded along the northern Ofu forereef.

C.4. Fish

Ofu/Olosega

From February 26 to March 1, 2006, the fish REA team surveyed 12 stations around Ofu/Olosega. Survey conditions were suitable-good at all sites. A minimum of 171 coral reef fish species were recorded.

Of all fishes, surgeonfish and wrasses were the most abundant and diverse groups. In general, medium-large fish (e.g., typical fishery targets) appeared to be more numerous here than around Tutuila on both belt-transects and SPC surveys. These fish also appeared to be somewhat larger and more abundant around Olosega than Ofu. Sharks were very rare, with only one white-tip (*Triaenodon obesus*) and one black-tip (*Carcharhinus melanopterus*) seen in 2006, continuing an apparent downward trend since 2002 (pending statistical confirmation). No bumphead parrotfish (*Bolbometopon muricatum*) were sighted, but a few humphead wrasse (*Cheilinus undulatus*) were observed of various sizes. Common target fish families were parrotfish, snapper, and grouper. Parrotfish were diverse (at least 12 species), including large individuals (e.g., *Chlororus microrhinos*). Common snappers were *Lutjanus bohar* and *Macolor* spp. Others were *Plectorhinchus* spp., *Caranx melampygus*, *Naso tonganus*, *Lethrinus* spp. and barracuda (*Sphyraena* spp).

A heavy recruitment pulse was detected at only one spot—a very dense aggregation of *Ctenochaetus striatus* in a major reef groove (OLO-5), being preyed upon by a number of jacks (mostly *Caranx melampygus*). Very few *C. striatus* juveniles were seen elsewhere

around these two connected islands. Other species counted with relatively higher juvenile numbers included *Gomphosus varius*, *Acanthurus nigroris*, and, in low relief habitats, *Halichoeres margaritaceus*.

Fish Family Summaries:

Angelfish (Pomacanthidae; six species) occasionally seen were mainly *Centropyge flavissima*, followed by *C. bispinnosa*, and fewer *Pomacanthus imperator, Pygoplites diacanthus*, and *Apolemichthys trimaculatus*. *C. loricula* was very rare.

The most common butterflyfish (Chaetodontidae; 18 species) seen was *Chaetodon reticulatus*, then *C. vagabundus*. Overall, butterfyfish appeared less common here than around Tutuila.

Damselfish (Pomacentridae; 15 species) were again the most abundant family by numbers, dominated by the midget chromis (*Chromis acares*). *C margaritifer* and *C. iomelas* were also common. Less abundant but in frequent occurrence were *Pomacentrus vaiuli, Plectroglyphidodon lacrymatus, P. johnstonianus*, and *Pomacentrus coelestis*. Other species recorded included *Chromis xanthura, Pomacentrus brachialis*, and *Stegastes fasciolatus*.

The most common goatfish (Mullidae; four species) was *Parupeneus cyclostomus*, many rather large (>25 cm TL). Large *P. insularis* and smaller *P. multifasciatus* were also present.

Grouper (Serranidae; six species) were dominated by *Cephalopholis urodeta* and lesser, but larger, *C. argus*. Other occasionally seen included *E. hexagonatus, Gracila albomarginata*, and a few *Variola louti*. Anthiids (*Psuedanthias pascalus*) were present at only a few sites and not abundant.

Hawkfish (Cirrhitidae; three species) were present in low numbers, with *Paracirrhites arcatus* sighted most frequently, which included many juveniles. Others included *P. fosteri, P. hemistictus*, and rarely *Cirrhitichthys falco*.

The most common parrotfish (Scaridae; 12 species) around these two islands were *Chlororus sordidus, Scarus fosteni*, and *S. oviceps*. Other species seen were *S. rubroviolaceus, C. microrhinos, S. schlegeli, Calatomus spp., C. japanenis, S. niger*, and *S. altipinnis*.

Snapper (Lutjanidae; seven species) were represented mainly by medium-sized *Lutjanus kasmiri*. *Aphareus furca* occurred regularly but in low numbers. *L. bohar* were few and mostly small.

Emperors (Lethrinidae) were represented by three species, with *Monotaxis grandoculis* being most frequent in occurrence. A few *Lethrinus* spp. and *Plectorhinchus gibbosus* were also counted.

Surgeonfish (Acanthuridae; 22 species), one of the most common families, was dominated by *Acanthurus nigroris, A. nigricans, Ctenochaetus striatus*, and *C. cyanocheilus*. (But note, there was some difficulty identifying closely similar species that appeared uniformly dark brown, in less than optimal light conditions). Others included *A. lineatus, A. nigricauda, A. achilles, A. pyropherus, A. thompsoni*, and, mainly juveniles of *Zebrasoma scopas. Naso* spp. were mostly *N. lituratus*, with occasional sightings of *N. tonganus*, and *N. brevirostris*.

Of the triggerfish (Balistidae; six species), *Melichthys vidua* occurred most frequently, but was not common, followed by *Balistapus undulatus*. A few *Sufflamen bursa, S. chrysopterum,* and large titan triggers (*Balistoides viridescens*) were also spotted.

Wrasses (Labridae; 33 species) were one of the most diverse and abundant groups as a whole, but no species dominated overall. Those species with relatively higher frequency of occurrence were *Labroides dimidiatus, Gomphosus varius, Halichoreres hortulanus, Pseudocheilinus octotania*, and *P. tetratania*. In low relief habitats, *H. maragitaceus* was more common. Other species more than rarely encountered were *Hemigymnus fasciatus, H. melapterus, L. rubrolabiatus, L. bicolor, Labropsis xanthonota, Oxycheilinus unifasciatus, Cheilinus trilobatus, Macropharyngodon melegaris,* and large *Epibulus insidiator*.

Among other fishes seen were jacks (e.g., a few *Caranx melampygus* and one large *C. ignobilis*), a few moray eels (*Gymnothorax melagaris, G. javanicus*), puffers (*Arothron nigropunctatus* and *A. hispidus*), a large boxfish (*Ostracion cubicus*), and a spotted eagle ray (*Aetobatus narinari*).

Ta'u

From March 2 to 4, 2006, the fish REA team surveyed nine monitoring stations around the Manua Island of Ta'u. Visibility was greater than 30 m at most sites. A preliminary minimum of 164 species were recorded.

In general, overall species richness and abundance, for small and large fish, was similar to that of Ofu/Olosega. During this year's survey, no sharks were seen by the fish REA team. Considering medium-large fishes, species richness and abundance was relatively good, except in the few areas of flat or low-relief habitat. More common were parrotfishes (e.g., *Scarus fosteni, S. oviceps*), the grouper *Cephalopholis argus*, the goatfish *Parupeneus cyclostomus* and *Mulloidichthys vanicolensis*, snappers (*Aphareus furca, Lutjanus kasmira, L. monostigma, L. gibbus*, and surgeonfish (*Naso* spp., *Acanthurus nigricauda, Odonus niger*), and a school of ~200 barracuda (*Sphyraena helleri*). Several Maori wrasse (*Cheilinus undulatus*, 50-120 cm TL) were seen, including seven at one site. One unique sighting was a deep, long crevasse in the reef at the top of a vertical drop-off (site TAU-2) where several large fish (*Plectorhinchus picus, Diodon hystrix, Macolor macularis, Sargocentron spiniferum*) were seeking shelter.

No species stood out in having heavy recruitment pulses at this time. Small juveniles were observed in low abundances for *Pomacentrus vaiuli, P. coelestis, Sufflamen bursa, Parrachirrhites arcatus, Ctenochaetus striatus,* and *Valenciennea strigata*.

Fish Family Summaries:

Of the angelfishes (four species) *Centropyge flavissima* was moderately common, followed by *C. bispinnosa, Pomacanthus imperator,* and *Pygoplites diacanthus*.

Butterflyfishes appeared relatively uncommon around Tau, but included *Chaetodon reticulatus, C. pelewensis,* and *Forcipiger flavissumus*.

The most common damselfish species was again *Chromis acares* (by numbers). Others that were also relatively common were *Chromis margaritifer, Pomacentrus vaiuli, C. iomelas*, and fewer *C. vanderbilti, C. xanthura, P. coelestis, Pomachromis exilis. C. agilis,* and *Plectroglyphidodon johnstonianus*.

Goatfish (four species) were rare around Tau; the few seen were *Parupeneus cyclostomus, P. insularis, Mulloidichthys vanicolensis,* and *P. multifasciatus*.

Five species of grouper were recorded. Anthias (e.g., *Pseudanthias pascalus*) were rare, except along deeper drop-offs/walls. *Cephalopholis urodeta* appeared to be the most common grouper, followed by *C. argus*. Other grouper were rare (e.g., *Epinephelus fasciatus, Gracila albomarginata*).

Hawkfish (four species) were relatively less common around Tau, with *Paracirrhites arcatus* mostly seen and even fewer *P. fosteri, P. hemistictus,* and *Cirrhitichthys falco*.

Parrotfish (seven species) were in lower abundance around Tau, compared to Ofu/Olosega, and represented mainly by *Scarus oviceps, S. fosteni*, and *Chlorurus microrhinus*.

Snapper (six species) were represented by *Lutjanus kasmira, Aphareus furca, L. bohar,* and fewer *L. monostigma, L. fulvus,* and *Macolor macularis*.

No emperors were seen on the belt transects, but REA counts recorded a few *Monotaxis grandoculis* and a school of *Gnathodentex aureolineatus*.

Surgeonfishes (23 species) were one of the most diverse families and abundant. Most common were *Acanthurus nigroris, A. nigricans, Ctenochaetus striatus,* and *C. cyanocheilus*.

Triggerfish were not common but represented by *Sufflamen bursa,* followed by *Melichthys vidua* and *M. niger*. A few clown triggers (*Balistoides conspicillum*) were seen.

Wrasses were relatively abundant and diverse (28 species). *Thalassoma quinquevittatum* appeared most common, followed by *Halichoeres margaritaceus, Labroides dimidiatus, L. bicolor, L. rubrolabiatus,* and *Halichores ornatissimus*.

Appendix D. Swains Island

D.1. Benthic Habitat Mapping

Multibeam surveys were conducted around Swains Island from the *AHI* on February 11. Two circuits of the island resulted in coverage from less than 20 m to depths in excess of 300 m. Shipboard mapping at night was conducted with the EM300 sonar on the nights of February 11 and 12 and during daylight on February 13. The first night's mapping started after the CTD failed and oceanography work had to be halted. Mapping was started by circling the island 1.6 km from the surf zone and then working deeper out to 3000 m. The CTD was repaired on the February 12 and mapping continued that night by conducting seabed mapping in concert with the ADCP transects. Those data were not contiguous with the earlier data, resulting in a rectangle of coverage in depths as deep as 4000 m. On February 13 the ship mapped near the island with the EM300 and overlapped with the shallow data collected by the *AHI*.

Swains Island is a steeply sloped, conical seamount (Fig. G-1) with rift zones that extend from each corner of the reef down to at least 3000 m. Otherwise the sides are smooth and exhibit no signs of mass wasting. The bathymetry immediately adjacent to the exposed reef is very steep and shows no evidence of spur and groove structures; however, spur and groove features are evident at some locations on the reef crest.

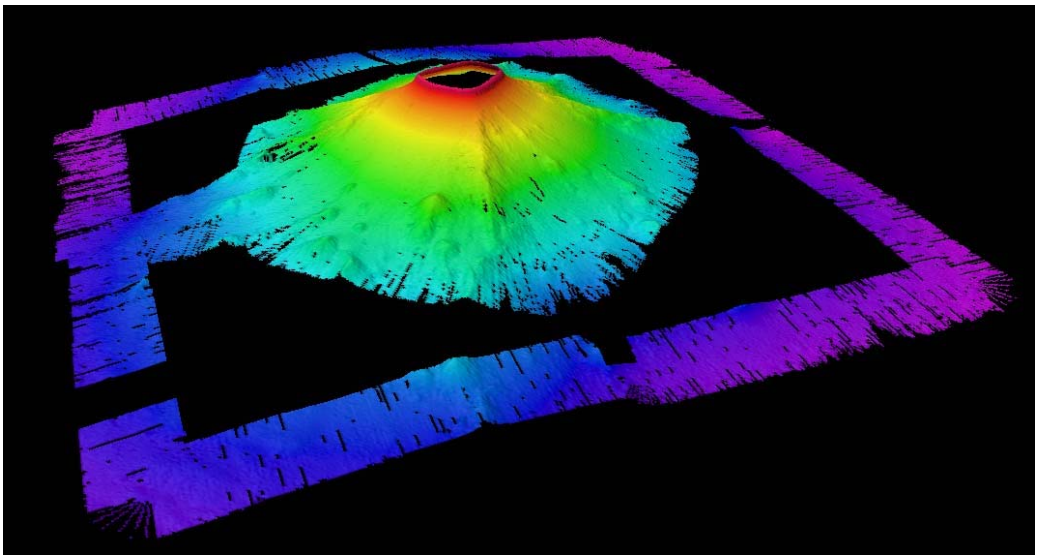

Figure D.1-1: Multibeam bathymetry surrounding Swains Island.

D.2. Oceanography and Water Quality

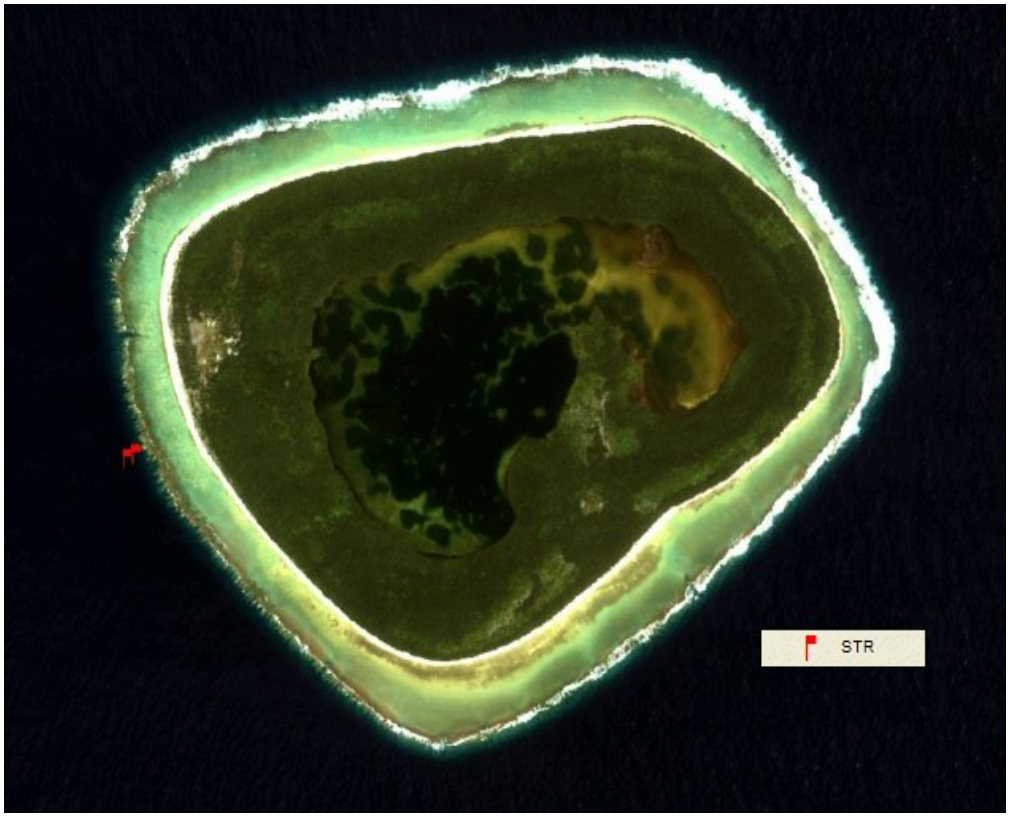

Figure D.2-1. Oceanographic instrumentation at Swains Island.

One STR was recovered and replaced at the established site in 14 m of water and two additional STRs were deployed adjacent to the same site, one shallower (6.7 m) and one deeper (28 m), to provide a temperature profile time series along the slope on the west side of the island. This modified deployment style is intended to provide data for temperature profiling to enhance oceanographic monitoring and modeling.
Eighteen shallow water CTDs were conducted around the periphery of the island in as close to 33 meters of depth as possible considering the slope of the island and surf conditions. Water sample profiles were conducted at 4 of these sites with a total of 16 chlorophyll, 16 nutrient, and 8 DIC samples being collected. Eight deepwater CTD/water sample profile casts were conducted along two ADCP box transects around the atoll during night operations with casts conducted at the midpoint of each side of the box for a total of 48 chlorophyll, 48 nutrient, and 4 DIC samples (taken only at eastern CTD positions) collected. In support of the mapping effort (for the primary purpose of surface velocity profiles) one CTD cast was conducted from the *AHI* to 200 m. The completed Deepwater CTD sampling plan is included below:

Shipboard CTD, ADCP and Water Sampling Plan
Swains Island - HI0602

Transect 1: 02/11/06 (CTD/Water Sampling/ADCP)
This will be a small (~28 km total length) box transect around the island beginning at pt "ctd1" proceeding around the transect in a clockwise direction with CTD casts being conducted at the midpoint of each side. Each side of the box is 3 km from the island at its closest point so that proximity to the island should be within vessel safety protocols. The first three casts will be to 500 meters presuming seafloor depth is > 600; if not, cast depth will be reduced (though this should not be an issue). Water samples will be collected according to CRED protocols on all casts.

After this transect is complete, the remainder of the evening will be dedicated to the mapping effort. The last cast should be made to 1500 meters (or as deep as the mapping team would like it) as long as the water is deep enough.

CTD cast positions/Transect corners:

ID	LAT_DEG	LAT_MIN	LAT_H	LONG_DEG	LONG_MIN	LONG_H
ctd1	11	3.40944	S	171	7.05791	W
cnr1	11	1.20037	S	171	7.04816	W
ctd2	11	1.20990	S	171	4.67014	W
cnr2	11	1.20159	S	171	2.31872	W
ctd3	11	3.41066	S	171	2.31901	W
cnr3	11	5.60220	S	171	2.31930	W
ctd4	11	5.61050	S	171	4.69792	W
cnr4	11	5.60097	S	171	7.05879	W

Transect 2: 02/12/06 (CTD/Water Sampling/ADCP)
This will be a large (~104 km total length) box transect around the island beginning at pt "ctd1" proceeding around the transect in a clockwise direction with CTD casts being conducted at the midpoint of each side of the transect. Each side of the box is greater than 12 km from the island so neither proximity to the island nor water depth should be an issue. The first three casts will be to 500 meters and the fourth to 1500 meters to provide another deep SVP for mapping activities. Water samples will be collected according to CRED protocols.

CTD cast positions/Transect corners:

ID	LAT_DEG	LAT_MIN	LAT_H	LONG_DEG	LONG_MIN	LONG_H
CTD1	11	3.39684	S	171	12.15500	W
Cnr1	10	57.21710	S	171	12.17780	W
Ctd2	10	57.22050	S	171	4.67865	W
Cnr2	10	57.22090	S	170	57.15240	W
Ctd3	11	3.40069	S	170	57.15140	W
Cnr3	11	10.49000	S	170	57.15020	W
Ctd4	11	10.48960	S	171	4.70925	W
Cnr4	11	10.51280	S	171	12.18700	W

Note: When conducting a CTD cast please make every effort to hold position and keep the wire angle straight up and down. This leads to improved geo-referenced data water sampling technique.

A.7. Benthic Environment

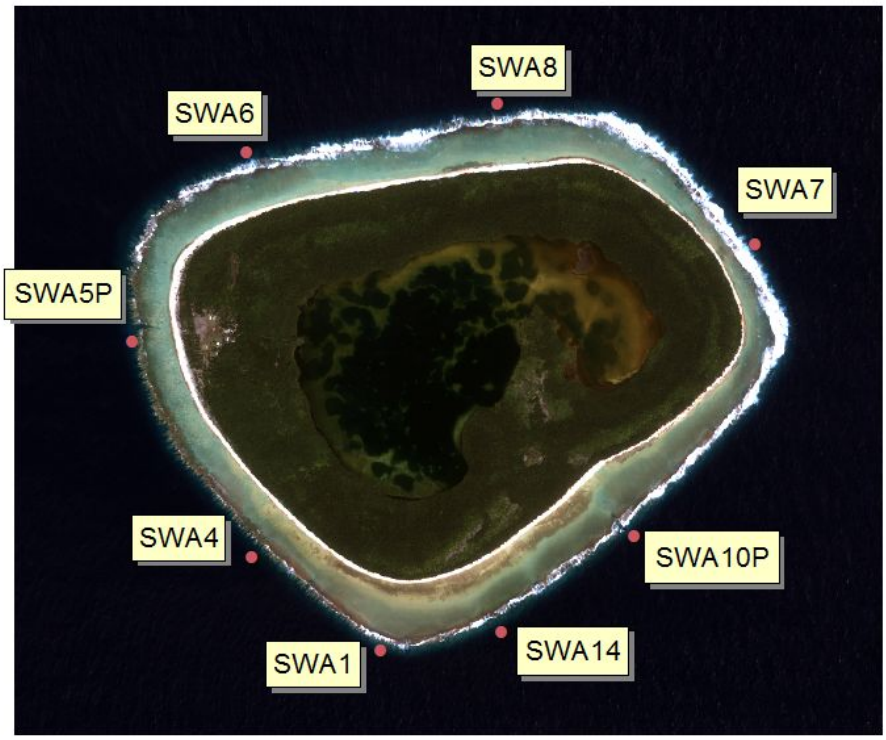

Figure D.3-1. Swains Island REA Sites.

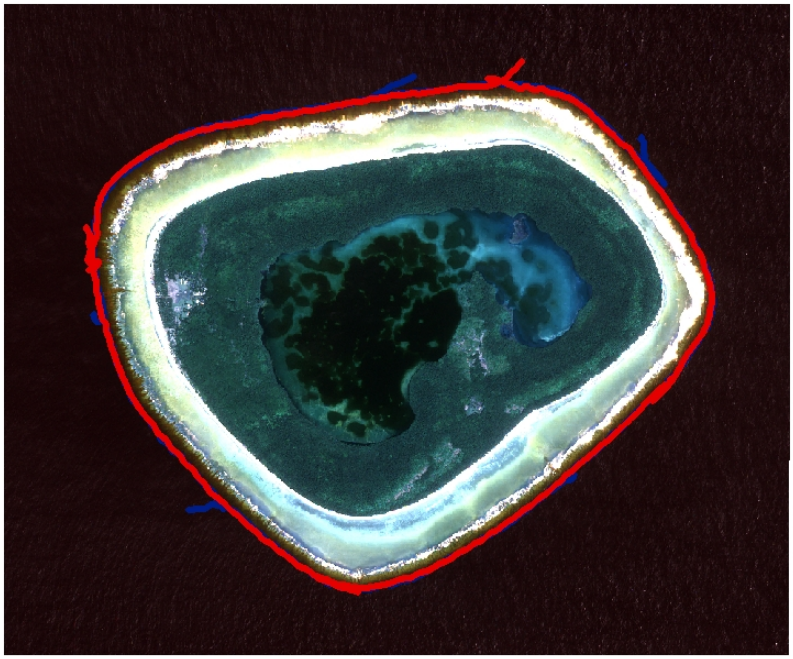

Figure D.3-2. Towed-diver Survey Tracks at Swains Island.

D.3.1. Algae

- The majority of the sites around Swains Island are dominated by the combination of *Ripilia orentalis* and *Microdictyon.*
- The remaining sites seem to have more coral rubble which is encrusted with crustose coralline and turf algae.
- We documented two new records of *Codium* and *Chaetomorpha* at sites SWA5P and SWA8, respectively.

Site Descriptions

SWA 10P and 14
The benthic substrate at these sites was primarily dominated by *Montipora* coral, *Microdictyon,* and *Ripilia*. These sites had few dead coral heads and low fish abundance. Transects were located in about 14 m, and surveys were conducted between 12.5 and 16.2 m. Other macroalgal components were *Dictyosphaeria verslyusii* and *Halimeda sp*. *Halimeda sp*. was only found at SWA 14. Both sites also had tufts of bright pink blue-green algae (cyanobacteria).

SWA 6, 7, 8, and 1
The benthic substrate at these sites was primarily dominated by *Montipora* coral, *Ripilia orientalis*, and a green encrusting tunicate. *Microdictyon*, *Dictyosphaeria verslyusii*, and bright pink tufts of cyanobacteria were also found at all three sites. At SWA 7, *Chaetomorpha* (new record for Swains Island) and *Halimeda* were found in about 8 m of water. The transects were positioned in approximately 12 to 14 m of water, and sampling depths ranged from 8 to 15 m.

SWA 4 and 5P
The benthic substrate at these sites was dominated by coral rubble covered with crustose coralline and turf algae. Numerous live *Poccillpora* colonies were also present. *Galaxura, Caulerpa, Ripilia orentalis,* and *Dictyota* were the most common macroalgae found at these sites. *Codium* was also found at SWA 5P in about 9 m of water, which is a new record for Swains Island. The transects were positioned in approximately 14 m of water, and samples were collected from 9 to 15 m of water.

	SWA 10P	SWA 14	SWA 7	SWA 8	SWA 6	SWA 1	SWA 4	SWA 5P	Island average
Green Algae									
Caulerpa							**8.3** 4.0	**58.3** 2.6	**8.3 (20.4)** 3.3 (1.0)
Chaetomorpha				*					
Codium								*	
Dictyosphaeria		**33.3** 3.0	**25.0** 2.7	**66.7** 2.3	**8.3** 1	**25.0** 4.0	*	*	**19.8 (23.1)** 2.6 (1.1)
Halimeda		*		*	*	*	*		
Microdictyon	**66.7** 1.6	**100** 1.5	**58.3** 1.6	**58.3** 2.6	25.0 2.5	**66.7** 1.5			**51.6 (34.4)** 1.8 (0.4)
Ripilia orentalis	**83.3** 2.2	**75.0** 2.1	**91.7** 2.0	**91.7** 1.5	**91.7** 1.3	**75.0** 2.6	**50.0** 3.0	**33.3** 3.3	**74.0 (21.6)** 2.2 (0.7)
Red Algae									
Galaxaura							**66.7** 1.6		NA
Peyssonnelia		**8.3** 3.0	**41.7** 4.2	**8.3** 3.0		**25.0** 5.0			**20.8 (16.0)** 3.8 (1.0)
Brown Algae									
Dictyota								**41.7** 3.0	NA
encrusting brown							**66.7** 2.1		NA
Cyannophytes	**33.3** 4.0	**16.7** 2.5	**25.0** 3.0	**16.7** 4.5		**41.7** 4.4		**8.3** 6.0	**17.7 (15.1)** 4.1 (1.2)
TURF	**50.0** 2.0	**50.0** 3.0	**41.7** 2.4	**16.7** 3.5	**8.3** 2	**83.3** 2.4	**91.7** 2.0	**100** 1.9	**55.2 (33.9)** 2.4 (0.6)
Crustose coralline	**91.7** 2.2	**83.3** 2.8	**83.3** 2.5	**100** 2.5	**41.7** 2.0	**91.7** 2.6	**91.7** 1.8	**25.0** 2.3	**76.0 (27.3)** 2.3 (0.3)

Figure D.3.1-1. Macroalgae of Swains Island.

D.3.1.1. Benthic Towed-diver Survey – Algae

Macroalgal cover was relatively high throughout the island, commonly making up between 30% of the benthic cover and up to 60% in some areas.

D.3.2. Corals

General observations on coral community composition and health assessment

Full REA surveys were conducted at eight sites (SWA01, 5P–08, and 10P) around Swains Island by the benthic team between February 11, 2006 and February 13, 2006. Relatively good weather conditions allowed the REA team to survey a variety of the reef slopes around the main cardinal points of the island. Dive depths ranged from 12 to 15 m. Coral REA surveys indicated that the mean percent live coral cover on reefs around Swains Island was close to 43%, and dead coral accounted for nearly 13%. Coral cover was the highest on the east sites, ranging from 50 to 80%, and lowest on the south sites

(21-40%; Table 1). The fleshy macroalga *Microdyction* exhibited elevated abundance (40%) particularly at sites SWA14 and SWA 10P. Colony densities ranged between 3.6 and 11.4 col/m^2 for all sites combined. Dominant corals in descending order included: *Montipora* cf . *effusa*/*grisea*, and *Pocillpora verrucosa*. *Porites rus* and *Porites* cf. *lobata*/*lutea* were particularly abundant at site SWA05P. Other scleractinians present at the survey sites included: *Pocillopora eydouxi*, *Stylophora pistillata*, *Pavona maldivensis*, *Pavona varians*, *Montipora* cf. *nodosa*, *Leptoseris mycetoceroides*, *Fungia scutaria*, as well as the octocoral *Helipora coerulea*. Disease assessment: Two cases of growth anomalies were detected on *Porites rus* and *Porites* cf. *lobata*/*lutea*; both at site SWA05P. These cases were observed in deeper water (17 to 18 m) outside the 3–m corridor surveyed on either side of the transect line. Tissue samples and photographic records were collected for further disease characterization. Finally, predation marks probably attributable to the gastropod *Drupella* and the echinoderm *Acanthaster planci* were widely observed, particularly on the platy *Montipora*, as well as *Pocillopora*. A total of seven specimens of *Acanthaster planci* were observed outside the survey transect lines, at sites SWA01, SWA04, SWA05P, and SWA06.

Site description

February 11, 2006
SWA10P
GPS: 11°03.807S; 171°04.241W
South, ocean fringing reef slope. Depth range: 12.5 to 15.2 m. Mean coral cover was 41%. The fleshy green algae, particularly *Macrodyction* and *Ripilia* exhibited elevated abundance (40%), overgrowing dead colonies of *Pocillopora*. Crustose coralline algae were also important, accounting for over 17% of the total bottom cover and also overgrowing dead colonies of *Pocillopora*. Colony density averaged 6.6 col/m^2. Dominant coral species in descending order were *Montipora (effusa; grisea)* and *Pocillpora verrucosa*. Other scleractinians present included: *Stylophora pistillata*, *Pavona maldivensis*, *Porites*, and *Fungia*. Additionally, scattered colonies of the octocoral *Heliopora coerulea* were also observed. Disease assessment: scattered blemishes on *Montipora*, were observed; these mostly attributable to predation (*Drupella*?).

SWA14
GPS: 11°04.047 S; 171°04.536 W
South, ocean fringing reef slope. Depth range: 13.4 to 14.6 m. Mean coral cover was 43%. The fleshy green algae, particularly *Macrodyction* and *Ripilia* exhibited elevated abundance (35%). Crustose coralline algae were also an important component of the benthos (17%). These types of algae exhibited profuse overgrowth mainly dead colonies of *Pocillopora* of the total bottom cover and also overgrowing dead colonies of *Pocillopora*. Colony density averaged 6.8 col/m^2. Dominant coral species in descending order were *Montipora (effusa, grisea)* and *Pocillpora verrucosa*. Other scleractinians present included: *Stylophora pistillata*, *Pavona maldivensis*, *Porites*, and *Fungia*. Additionally, scattered colonies of the octocoral *Heliopora coerulea* were also observed. Disease assessment: 5 cases of bleaching were observed mainly on *Stylophora pistillata*

and *Montipora (effusa, grisea)*. Scattered blemishes on *Montipora* were observed; these mostly attributable to predation (*Drupella*?).

February 12, 2006
SWA07
GPS: 11°03.0825 S; 171°03.938 W
Northeast, ocean fringing reef slope. Depth range: 14.0 to 15.2 m. Mean coral cover was close to 54%. Colony density averaged 5.7 col/m^2. Dominant coral species in descending order were *Montipora (effusa, grisea)* and *Pocillpora verrucosa*. Other scleractinians present included: *Stylophora pistillata, Pavona maldivensis, Porites*, and *Fungia*. Additionally, scattered colonies of the octocoral *Heliopora coerulea* were also observed. Disease assessment: Predation on *Montipora* cf. *effusa, grisea* was observed, presumably mostly due to the gastropod *Drupella.*

SWA08
GPS: 11°02.753 S; 171°04.593 W
North, ocean fringing reef slope. Depth range: 14.0 to 14.6 m. Mean coral cover was close to 56%. Colony density averaged 10.4 col/m^2. Dominant coral species in descending order were Montipora cf. *effusa*/*grisea* and *Pocillpora verrucosa*. Other scleractinians present included: *Pocillopora eydouxi*, *Pavona duerdeni*, *Stylophora pistillata, Pavona maldivensis, Porites*, and *Fungia*. One colony of *Acropora* cf. *cophodactyla, globiceps* was observed. Disease assessment: Predation on *Montipora* cf. *effusa, grisea, Pocillopora verrucosa, P. eydouxi*, and *Stylophora pistillata* was observed, presumably mostly due to *Drupella.*

SWA06
GPS: 11°02.859 S; 171°05.211 W
Northwest, ocean fringing reef slope. Depth range: 13.1 to 14.3 m. Mean coral cover was close to 64%. Colony density averaged 8.2 col/m^2. Fleshy green algae exhibited elevated abundance (32%). Dominant coral species in descending order were *Montipora* cf. *effuse/grisea* and *Pocillpora verrucosa*. Disease assessment: Some tissue discoloration was observed mainly affecting branch tips. In addition, predation on *Montipora* cf. *effusa*/*grisea, Pocillopora verrucosa. and P. eydouxi* was observed, mostly due to *Drupella*. One specimen of *Acanthaster planci* was observed and predation marks were evident on colonies of *P. verrucosa* and *Montipora* cf. *nodosa*.

SWA01
GPS: 11°04.091 S; 171°04.871 W
South, ocean fringing reef slope. Depth range: 13.1 to 13.4 m. Mean coral cover was close to 29%. Colony density averaged 5.9 col/m^2. Dominant corals in descending order included: *Montipora* cf. *effuse/grisea* and *Pocillopora verrucosa*. Other corals present included: *Porites* cf. *lobata/lutea, Stylophora pistillata*, and *Montipora* cf. *nodosa*. Dead *Pocillopora* in growth position covered with crustose coralline algae and the fleshy alga *Microdyction* accounted for approximately 60% of the benthos. Many predation scars were observed mainly on *Montipora* probably due to *Drupella* and *Acanthaster*. Six

specimens of *Acanthaster planci* observed in 15 to 18-m depths, approx. 3-6 m of the transect line.

SWA04
GPS: 11°03.859 S; 171°05.192 W
Southeast, ocean fringing reef slope. Depth range: 13.7 to 14.3 m. Mean coral cover was close to 22%. Colony density averaged 6.4 col/m^2. *Montipora* cf. *effuse/grisea* was the dominant scleractinian. Other, less abundant stony corals present in the overall vicinity of the transect line included *Porites* cf. *lobata/lutea*, *Pocillopora verrucosa*, *P. eydouxi*, *Pavona varians*, *Pavona maldivensis*, *Pavona duerdeni*, *Leptoseris mycetoceroides*, *Stylophora pistillata*, *Fungia* sp., and *Montipora* cf. *nodosa*. Disease assessment: Abundant predation scars were observed mainly on *Montipora* probably due to *Drupella*. Two specimens of *Acanthaster planci* were observed in the general vicinity of the transect line.

SWA05P
GPS: 11°03.351 S; 171°05.515 W
East, ocean fringing reef slope. Depth range: 13.7 14.3 m. Mean percent live coral cover accounted for 33% of the benthos. Colony density averaged 4.5 col/m^2. *Porites rus* and *Porites* cf. *lobata/lutea* were the dominant corals. Disease assessment: No clear signs of bleaching were observed. Several cases of surface pink irritation were observed in *Porites* cf. *lobata*/*lutea* (photos, one sample collected: #217). Also, two cases of growth anomalies were observed on *Porites* cf. *rus* (photos and samples collected: #218, #212). One specimen of *Acanthaster planci* was observed in the general vicinity of the transect line.

Table 3.2-1. Summary statistics of benthic cover parameters at Swains Island. * Other benthic elements including: fleshy macroalgae, rubble, rock, etc.)

Site ID	Coral cover	Dead cover	Carbonate pavement	Sand	Coralline algae	Other*
SWA10P	41.2	1.0	0.0	0.0	17.6	40.2
SWA14	43.1	3.9	0.0	0.0	17.6	35.3
SWA07	53.9	25.5	1.0	0.0	14.7	4.9
SWA08	55.9	2.0	2.0	0.0	19.6	20.6
SWA06	64.7	2.0	1.0	0.0	0.0	32.4
SWA01	28.7	15.8	10.9	0.0	29.7	14.9
SWA04	21.6	35.3	0.0	2.9	31.4	8.8
SWA05P	33.3	17.6	15.7	0.0	2.9	30.4
SWA10P	41.2	1.0	0.0	0.0	17.6	40.2
SWA14	43.1	3.9	0.0	0.0	17.6	35.3
Mean	42.8	12.9	3.8	0.4	16.7	23.4
Std Dev	14.7	12.8	6.0	1.0	11.1	13.0

D.3.2.1. Benthic Towed-diver Survey – Corals
We surveyed the 18–m isobath along the forereef slope which we found to consist of continuous reef. For the nine towed-diver habitat surveys the habitat was consistent in

the lack of any substantial sand habitat, which never consisted of more then 5% of the total habitat.

D.3.3. Invertebrates

Geologically, Swains Island is the southernmost of the four atolls comprising the Tokelau Islands, but is under the jurisdiction of the U.S. and Territory of American Samoa. Few published marine biological or coral surveys for Swains are available, and this trip provided a good opportunity for detailed observations of the reefs. Local knowledge indicated that there was a devastating hurricane in 1991, possibly a coral bleaching event in 1994, and a tsunami consisting of three large waves that passed over the south of the atoll near Etena in 1995. After the tidal waves, all residents except a small family evacuated Swains, leaving only four residents, the parents and their two children living on the island. Presently, there are five residents of the island.

A total of eight surveys for marine invertebrates were done while at Swains Island, which were all on the outer reef of the north, south, east, and west sides of the island. All sites were steep sloping reef and had a depth range of 14 to 21 m.

Outer Reef

The outside reef areas of Swains Island had impressive coral cover but low diversity (mainly *Montipora* and *Porites*). This coral reef community appears to be in good recovery following a large scale disturbance that affected the entire reef around the island. Marine invertebrates were not very abundant or diverse over all the sites. The sites will be summarized by a breakdown of taxonomic groups.

Molluscs

Gastropods were the most common mollusc, which ranged from occasional to rare with a higher majority of coral-eating gastropods than most other types of snails. Giant clams, which were the only bivalves seen previously at this island, were not seen because their distribution was previously reported in the 4– to 6–m range, and all survey sites were well below that depth.

Crustaceans

As with most coral reef habitats, most decapod crustaceans, with the exception of hermit crabs, are cryptic during daylight hours. With this in mind, hermit crabs were the most likely crustaceans noted during the surveys. It is possible to observe lobsters as well, if hole, overhangs, and other recesses are examined during the surveys.

Hermit crabs were reported to be common through the 5– to 9–m depth range, but were less common in the deeper areas (with the exception of Site 5). By a cursory morphological examination, there were two common species observed during the surveys. No lobsters were seen during the surveys, but a segment of a molt was found at one site.

Echinoderms

There was a surprising lack of sea urchins, sea cucumbers, and sea stars throughout all sites surveyed. The crown-of-thorns sea star was the only commonly seen sea star, and it was seen at depths from 12 m and below. Brittle stars were found irregularly in Pocilloporid coral heads. A single species of sea cucumber was noted below 18 m on a sandy area of the slope but at one single site.

Other species

There were other species commonly seen at all sites surveyed, which tend to be grouped under the sessile fouling organisms category. There was a single species of yellow sponge seen regularly and two species of hydroids. Other common sessile species normally found in this habitat were conspicuously absent.

D.3.3.1. Benthic Towed-diver Survey – Macroinvertebrates

Along the southwest forereef, we witnessed a high abundance of *Acanthaster planci*, which correlated to a slightly lower (~30-40%) hard coral cover then on the northwestern reefs (~50-70%). The northeast reefs had approximately one *A. planci* per tow while the southern tows recorded between 8 and 23 *A. planci* per tow. No soft corals were recorded, and rubble levels were consistently low, island wide. Only two Holothurids were recorded at the island, and no urchins or giant clams were recorded. The lack of conspicuous invertebrates is notable.

D.4. Fish

From February 11 to February 13, 2006, the fish census team (Robert Schroeder, Paula Ayotte, and Craig Musburger) surveyed eight stations at Swains; all were resurveys ("monitoring") of sites established by CRED in February of 2002 or 2004. Quantitative belt transects, stationary point counts, and qualitative REA surveys (for species presence) were conducted at each of these sites, using the same methodology as in previous years (summarized above). At this time only about five adult residents occupied Swains Island. Potential fishing targets primarily for subsistence include most species of larger (>20 cm TL) fish (e.g., snapper [except *Lutjanus bohar*, which is believed to be ciguatoxic], parrotfish, surgeonfish, jacks, grouper). The level of possible outside fishing pressure is unknown.

Fish assemblages generally appeared to be roughly similar in abundance and diversity to our previous surveys to Swains. A minimum of 177 fish species were observed along the outer reef slope. The most numerically abundant species along the south side of the island was the midget chromis (*Chromis acares*), followed by *Pseudanthias pascalus*. Small *Paracirrhites arcatus* were common in occurrence. As a group, wrasses were the next most common family (27 species). Surgeonfish, grouper, such as *Cephalopholis* spp., and snapper, such as the twinspot snapper (*Lutjanus bohar*), were few. Parrotfish, goatfish, and emperors were rare. No sharks or humphead (or Maori) wrasse (*Cheilinus undulatus*) were seen along this side. Medium to large fish (from SPC surveys) along the south included surgeonfish, jacks, triggerfish, and snapper (*Aphareus furca* and *Aprion virescens*). One medium-sized (~70 cm TL) humphead wrasse was seen.

Along the east side of the island local species richness appeared to be slightly lower. *Chromis acares* and *P. pascalus* again dominated by numbers. More prominent species included *Scarus xanthopleura*, *Cephalopholis* spp., *Monotaxis grandoculis*, and fewer surgeonfish and snapper (*L. bohar*). A large school of rainbow runner (*Elagatis bipinnulata*) was recorded by SPC on the east, while snapper (e.g., *L. bohar, Macolor* spp., *L. monostigma*) were common. Medium-large grouper and parrotfish were few. Two moderate sized (80-100 cm TL) *Cheilinus undulatus* were seen.

On the north side of the island, *Chromis acares* was also most abundant. Damselfish and wrasses were fairly diverse; *Pseudocheilinus tetrataenia* occurred frequently. Surgeonfish and parrotfish were few. Snapper included *Aphareus furca, L. bohar* and *Macolor* spp. Medium-large fish (from SPC) along the north were fairly abundant and diverse (e.g., *L. bohar, Cephalopholis argus, Macolor niger* and *M. macularis, Naso* spp.). Parrotfish were few. An 80 cm TL *Cheilinus undulatus* was seen.

Along the leeward west side of the island, species richness was highest. Surgeonfish, wrasses, and damselfish were particularly abundant and diverse. Hawkfish were relatively more abundant than elsewhere around the island. Snapper and parrotfish were rare. SPC counts found snapper to be most abundant on this side of the island (e.g., *L. bohar, Macolor* spp., *Naso* spp.) Jacks were rare and sharks appeared less abundant than in earlier years, with only a single shark (black-tip, *Carcharhinus melanopterus*) seen on a REA survey. No bumphead parrotfish (*Bolbometopon muricatum*) were observed anywhere around the island.

From towed-diver surveys, rainbow runners (*Elagatis bipinnulata)* were the most commonly observed species with 1006 observations. This was largely because one school of 1000 individuals was observed during a tow. Barracuda (*Sphyraena qenie)* were also seen in large schools, with 218 sightings, as were bigeye jacks (*Caranx sexfasciatus)* with 800, but these were estimated to be less than 50 cm TL. Both of these species were frequently observed in schools alongside the rainbow runners. Other common large fish included blacktongue unicornfish (*Naso hexancanthus)* and twinspot snapper (*Lutjanus bohar)* each with 26 individuals observed. Very few sharks or jacks were seen during towed-diver surveys, with the reef whitetip shark (*Triaenodon obesus)* being the most common shark with four records and bluefin trevally (*Caranx melampygus*) the most common jack with a total of 5 records.. Other notable observations included the Maori wrasse (*Cheilinus undulates)* with nine individual sightings, and eight turtle sightings.

Appendix E: Rose Atoll

E.1. Benthic Habitat Mapping

Multibeam surveys were conducted around Rose Atoll from the *AHI* on March 5. Three circuits of the island resulted in coverage from less than 10 m to depths in excess of 300 m. The *AHI* also surveyed inside the lagoon on Mar 7. Shipboard mapping at night was conducted with the EM300 sonar on the night of March 5 and during daylight on March 6.

Much like Swains Island, Rose Atoll is a steeply sloped, conical seamount with rift zones that extend from each corner of the reef down to at least 3000 m. Otherwise the sides are smooth and exhibit few signs of mass wasting. The bathymetry immediately adjacent to the exposed reef is very steep. Inside the lagoon (Fig. G-4) the bathymetry is characterized by many coral heads ranging in size from a few decimeters up to 100 m or larger.

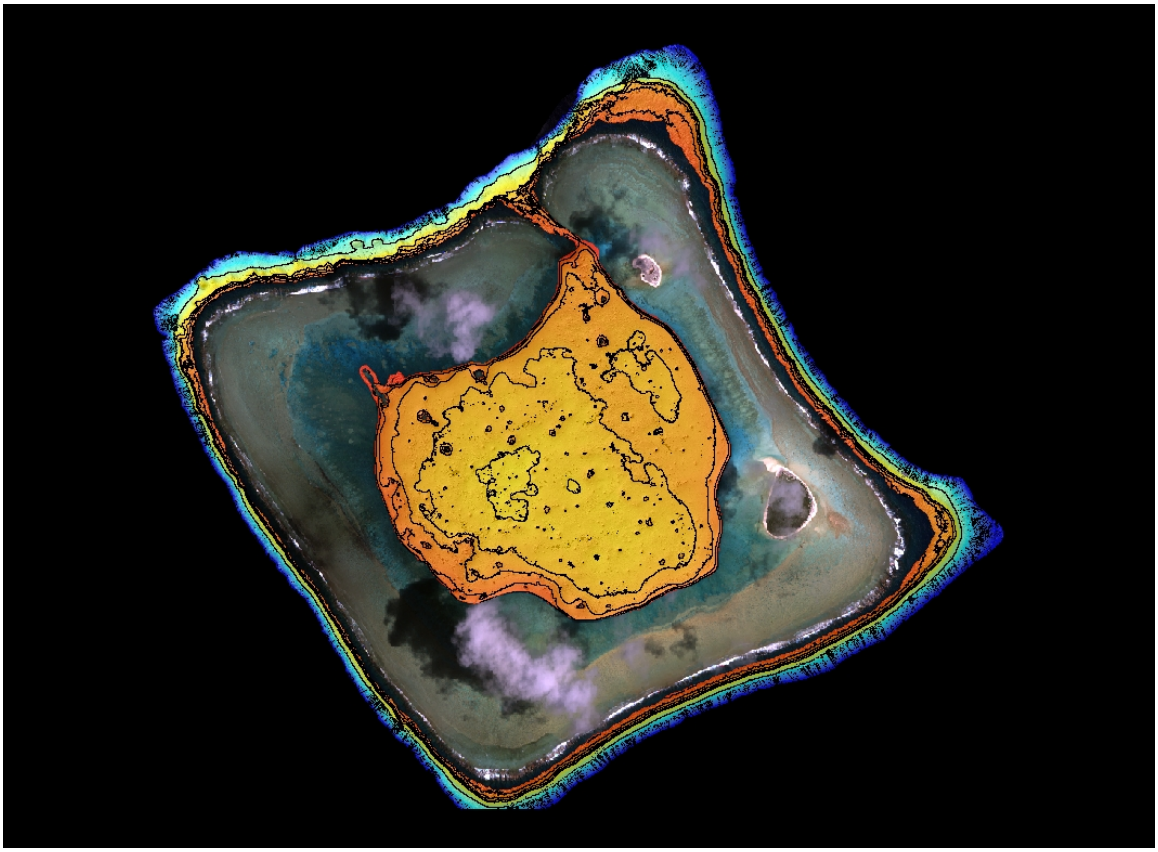

Figure E.1-1: Shallow-water bathymetry of Rose Atoll.

A.8. Oceanography and Water Quality

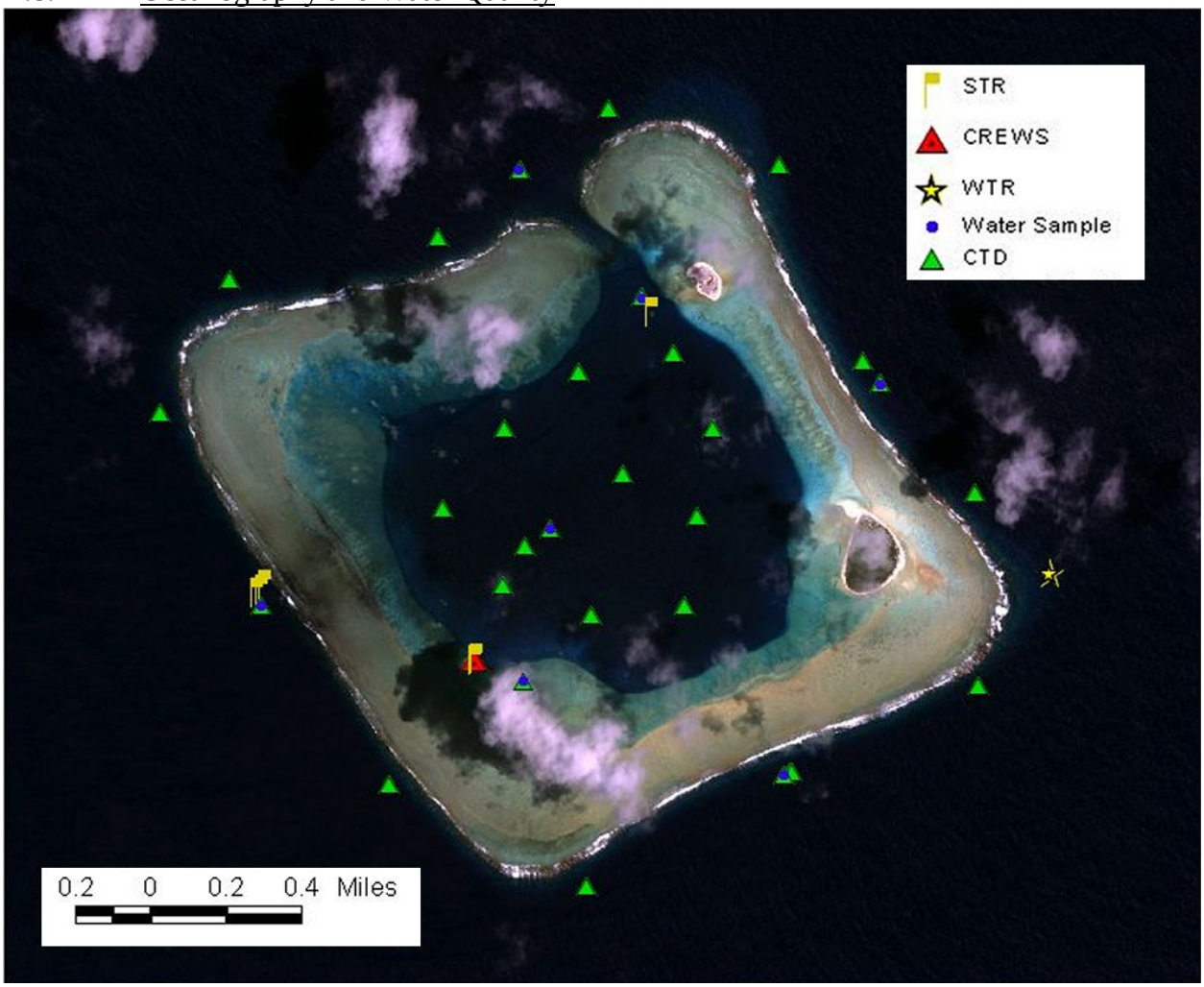

Figure E.2-1: HI0602 oceanographic instrumentation and sampling activities – Rose Atoll.

E.2. Sampling Activities

One CREWS buoy with an RPA on the anchor and one WTR were replaced with new instruments deployed at the established sites. The CREWS buoy appears to have been moved about 30 m to the west, presumably by the tropical storm of about a year ago, and the RPA was broken with its pieces strewn about. The redeployment was at the original site. A total of six STRs were deployed in the vicinity of Rose Atoll. Three of the STRs were replacements at lagoon patch reef sites while three of them were deployed in a line down the reef slope near an REA site at the position of the 1983 vessel grounding. The shallow STR that had been deployed on the patch reef near the CREWS in 2004 was replaced while the deeper location was moved to the buoy anchor. The STR that was deployed at the grounding site, attached to part of the wreck, was sunk into the abyss during the U.S. Fish and Wildlife Service cleanup effort and was not recovered. Two SVP drifter buoys were deployed in the vicinity of Rose Atoll, and one was deployed on transit between Rose and the Manua Island Group.

Shipboard CTD, ADCP and Water Sampling Plan
Rose Atoll - HI0602

Transect 1: 03/06/06 (CTD/Water Sampling/ADCP)
This will be a line transect starting 1.6 km to the North of the mouth of the pass into/out of Rose Atoll (point "CTD001") and proceeding for 15 km to the North with a cast every 4 km. It will be a continuation of a daytime transect started in the Zodiac on 03/05/06. The first, third, fourth, and fifth casts only need to be sent to 50 m with water samples being collected at 30 m and the surface. The second cast should be sent to 500 m with all sampling conducted according to CRED protocols. The reason for this is that the second cast is essentially the northern point of the next transect so we're doing double duty.

ID	LAT_DEG	LAT_MIN	LAT_H	LONG_DEG	LONG_MIN	LONG_H
CTD001	14	31.07490	S	168	9.53295	W
CTD002	14	29.32900	S	168	9.56979	W
CTD003	14	27.58280	S	168	9.57745	W
CTD004	14	25.83670	S	168	9.59962	W
CTD005	14	24.00560	S	168	9.63739	W

Transect 2: 03/06/06 (CTD/Water Sampling/ADCP)
This will be a ~63–km box transect around the island that will hit four of CRED's historical CTD stations. Begin the ADCP transect at pt "ctd002" (the north-central point). There's no need to do a cast at "ctd002" because we just did one on the last transect. Proceed around the transect in a clockwise direction with CTD casts with water samples being conducted at the center of each side of the box. The closest that the transect comes to the island is 5 km at its closest approach so that proximity to the island is within vessel safety protocols. All casts will be to 500 m presuming seafloor depth is greater than 600; if not, cast depth will be reduced (though this should not be an issue). Water samples will be collected according to CRED protocols on all casts.

ID	LAT_DEG	LAT_MIN	LAT_H	LONG_DEG	LONG_MIN	LONG_H
ctd001	14	33.08270	S	168	12.78840	W
ctd/cnr001	14	29.31130	S	168	12.79010	W
ctd002	14	29.27030	S	168	9.37519	W
ctd/cnr002	14	29.24680	S	168	5.64149	W
ctd003	14	32.99510	S	168	5.59251	W
ctd/cnr003	14	36.65440	S	168	5.52170	W
ctd004	14	36.72490	S	168	9.43912	W
ctd/cnr004	14	36.74210	S	168	12.69680	W

Transect 3: 03/08/06 (CTD/Water Sampling/ADCP)
This will be a ~ 63-km box transect around the island that will hit all eight of CRED's historical CTD stations using the positions from the 03/06/06 transect (above). Begin the ADCP transect at the nearest point after day ops. Proceed around the transect in a clockwise direction with CTD casts being conducted at each position but with water sampling only being conducted at the positions in the center of each side of the box. The closest that the transect comes to the island is 5 km at its closest approach so that proximity to the island is within vessel safety protocols. All casts will be to 500 m presuming seafloor depth is > 600; if not, cast depth will be reduced (though this should not be an issue). Water samples will be collected only at 150, 30 and 3 m.

Thirty-two shallow water CTDs were conducted around the periphery as well as inside of the atoll in as close to 33 m of depth whenever possible considering the slope of the island, surf conditions, or bottom depth inside the lagoon. Water sample profiles were conducted at 7 of these sites with a total of 23 chlorophyll, 23 nutrient, and 15 DIC samples being collected. Deepwater CTD casts were conducted at 17 sites along ADCP transects with water sample profiles being conducted at 13 of these sites. Twelve of these sites were along a 63–km box transect around the island that was run on two different

nights while five were along a line transect to the north of the pass. A total of 52 chlorophyll, 52 nutrient, and 18 DIC samples were collected. Two CTD casts were conducted from the ship to provide calibration data for the mapping effort. The completed shipboard sampling plans are included below.

A.9. Benthic Environment

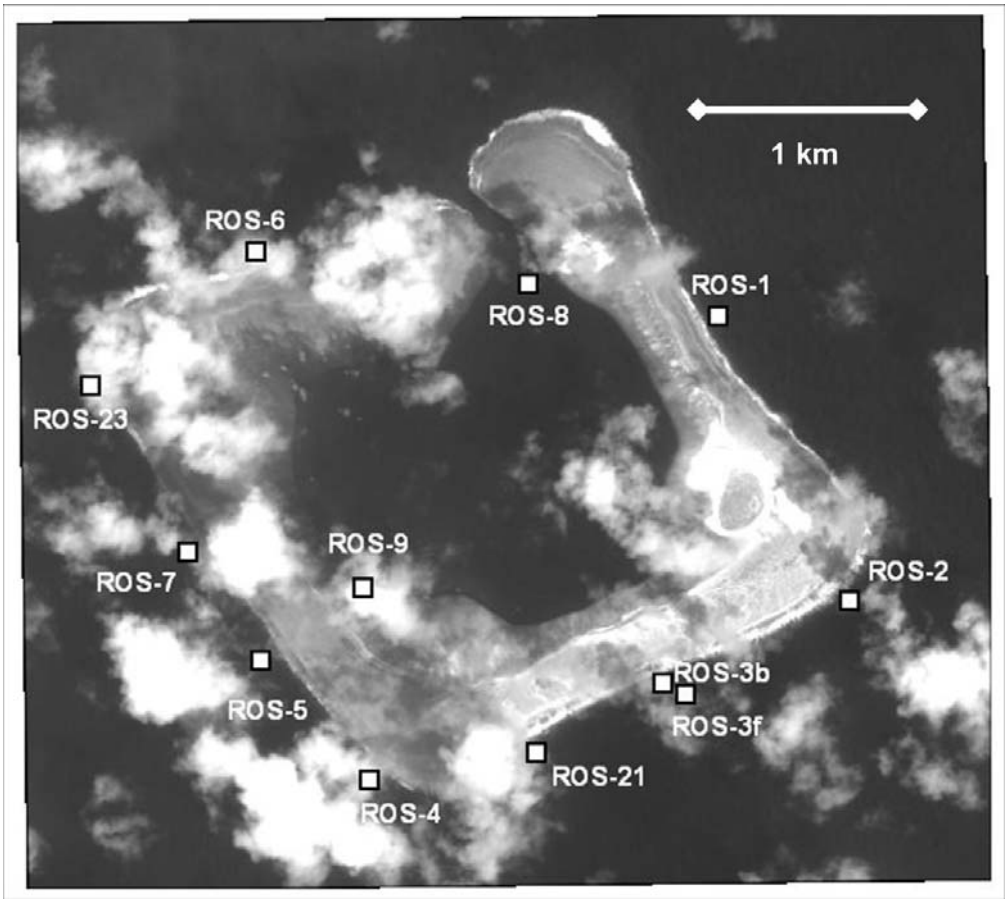

Figure E.3-1. REA site locations.

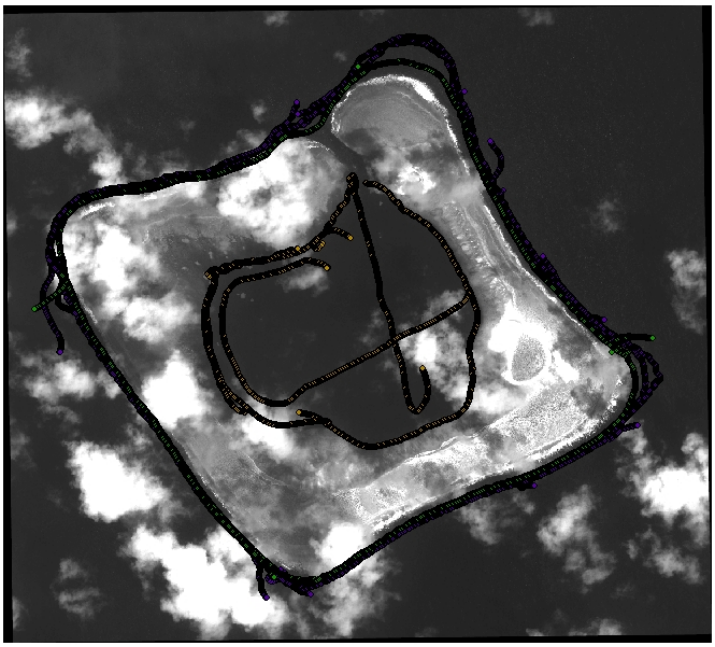

Figure E.3-2. Towed-diver Survey Tracks, Rose Atoll.

Table E.3-1. REA Site metadata.

Rose Atoll							
ROS-2	3/5/2006	14	33.088	168	08.389	13.7 – 15.2	28.3
ROS-1	3/5/2006	14	32.353	168	08.730	13.7 – 14.3	28.3
ROS-8	3/5/2006	14	32.265	168	09.222	7.6 – 8.2	28.3
ROS-3f*	3/6/2006	14	33.338	168	08.814		
ROS-6	3/6/2006	14	32.182	168	09.931	13.1 – 13.4	28.3
ROS-9P	3/6/2006	14	33.060	168	09.651	5.2 – 7.6	28.3
ROS-5	3/7/2006	14	33.243	168	09.920	12.2 - 13.7	28.3
ROS-7	3/7/2006	14	32.965	168	10.108	12.8 - 13.7	28.3
ROS-23	3/7/2006	14	32.533	168	10.362	13.7 - 15.2	28.3
ROS-21	3/8/2006	14	33.483	168	09.201	12.2 - 13.7	28.3
ROS-4	3/8/2006	14	33.559	168	09.635	13.7 - 15.2	28.3
ROS-3b*	3/8/2006	14	33.306	168	08.873	13.7	28.3

*This site was surveyed on separate days by the fish (f) and benthic (b) teams due to inclement sea conditions

Eleven sites were surveyed by the REA team at Rose Atoll. All eleven sites were surveyed in 2004. A twelfth site surveyed in 2004 (ROS-22) was not resurveyed in 2006 due to strong currents during two separate attempts to work there. Site locations are shown in the figure above.

E.3.1. Algae

Site Descriptions

Rose 2: 3-5-2006
GPS: 14°33.088S, 168°8.389W
This site was located west of the atoll. Weather conditions were good. Water surge was important. Visibility was higher than 40 m. The reef was a reef slope going down slowly. It was mostly formed by crustose corallines forming 'cathedrals.' Coral cover was moderate. Lots of small colonies of *Pocillopora* and *Acropora* were recorded. Algal communities were dominated by crustose corallines, *Microdyction*, *Dictyospheria verslusii*, *Caulerpa* sp. and *Halimeda*. *Chaetomorpha* was also seen in abundance as well as *Jania*. Turf was not very abundant. Blue-green algae were also observed.

Rose 1: 3-5-2006
GPS: 14°32.353S, 168°8.730W
This reef was located northwest of the atoll. Weather conditions were good. Visibility was higher than 40 m. The reef was a gentle slope formed mainly by crustose coralline algae. Coral cover was moderate. Algal communities were dominated by crustose corallines and *Microdyction*, although turf algae and *Dictyospheria* were seen abundantly. Additionally, *Caulerpa, Valonia, Gelid,* and *Halimeda* were observed.

Rose 8: 3-5-2006
GPS: 14°32.265S, 168°9.222W
This reef was a pinnacle located in the lagoon of Rose Atoll. Weather conditions were good and there was no water surge. Sedimentation was moderate making the visibility lower than 15 m. Coral cover on the pinnacle was very low. Only few small colonies of essentially *Acropora* and *Porites* were observed. Algae were very rare. The floor and the walls of the pinnacle were covered by blue-green algae. At least four different kinds of cyanobacteria were observed. During the random swim however, *Halimeda, Valonia,* and a branching coralline were collected.

Rose 6: 3-6-2006
GPS: 14°32.182S, 168°9.193W
This reef was located northwest of the atoll. Weather conditions were good but water surge was important. Visibility was around 30 m. Coral cover was moderate. Algal diversity was moderate too. Communities of macroalgae were dominated by encrusting corallines. Turf algae, *Dictyosphaeria*, *Peyssonellia,* and *Jania* were also abundant. Blue-green algae were important too. *Halimeda* and branching corallines as well as *Dictyota* were also observed in abundance.

Rose 9P: 3-6-2006
GPS: 14°33.060S, 168°9.651W
This reef was a pinnacle located in the lagoon of Rose Atoll. Weather conditions were good although the wind speed was high. The water surface was rough and there was a big swell (high tide). Coral cover around the pinnacle was moderate to important. The

dominant corals were *Favia, Astreopora,* and *Montipora*. Small colonies of *Acropora* were also seen on the walls of the pinnacle. Around the pinnacle on the sand floor, there were large colonies of massive *Porites*. The pinnacle was covered by mats of cyanobacteria. At least three different kinds of blue-green algae were observed (from pink to black mats). The dominant algae were crustose algae and turf algae, but they were rare in comparison to blue-green algae.

Rose 5: 3-7-2006
GPS: 14°33.243S, 168°9.920W
This site was located southwest of the atoll. Weather conditions were cloudy but no rain. Water surge and the swell were important. Visibility was higher than 40 m. Coral cover was moderate. The dominant corals were *Montipora* and *Pocillopora*. Because of the environmental conditions, only qualitative study of macroalgae was carried out at this reef. From observations, algal communities seemed dominated by crustose corallines, turf algae, *Galaxaura* and *Dictyota*. The other dominant community in this reef was blue-green algae in the community. Additionally, *Halimeda* and small rhodophytes were observed.

Rose 7: 3-7-2006
GPS: 14°32.965S, 169°10.108W
This site was located west of Rose Atoll. Weather conditions were cloudy and windy. We had some rain. Water surge and the swell were very important. Visibility was higher than 50 m. Coral cover was moderate. Dominant corals were *Pocillopora* and *Montipora*. Benthic communities were dominated by blue-green algae. The major alga was crustose corallines. Additionally, *Bryopsis, Jania, Dictyota,* and *Peyssonellia* were observed in abundance.

Rose 23: 3-7-2006
GPS: 14°32.533W, 168°10.362W
This site was located northwest of the atoll. Weather conditions were good. Water surge and the swell were important. Visibility was higher than 40 m. Coral cover was moderate. Algal communities were dominated by corallines, turf, and *Dictyota*. Blue-green algae were dominant on the benthos too. Additionally, *Halimeda, Caulerpa,* and *Jania* were collected.

Rose 21: 3-8-2006
GPS: 14°33.483S, 168°9.201W
This site was located south of the atoll. Weather conditions were good. However, there were an important swell and a moderate current. Visibility was higher than 30 m. The reef slope showed a moderate coral. Coral communities were dominated by *Pocillopora*. Algal diversity was moderate. Algal communities were dominated by crustose corallines and *Microdyction*. Additionally, *Chaetomorpha, Dictyosphaeria verslusii, Dictyota,* and *Halimeda* were recorded in relative abundance as well as blue-green algae.

Rose 4p: 3-8-2006
GPS: 14°33.559S, 168°9.635W
This reef slope was located southwest of the atoll. Weather conditions were good; however, a strong current and an important swell were noticed. Visibility was higher than 40 m. The coral cover was relatively important with *Pocillopora* dominating coral communities. Algal diversity was moderate. The dominant algae were crustose corallines, *Microdyction*, *Dictyota*, and *Peyssonellia*. Turf algae, *Halimeda*, *Dictyosphaeria verslusii*, and blue-green algae were also abundant.

Rose 3: 3-8-2006
GPS: 14°33.338S, 168°8.814W
This reef slope was located southeast of the atoll. Weather conditions were good. Water surge was important but the current was moderate. Visibility was higher than 40 m. Coral cover was moderate and coral communities were definitely dominated by *Pocillopora*. Algal communities were dominated by crustose corallines, *Peyssonellia*, *Microdyction*, *Halimeda*, and *Dictyota*. *Chaetomorpha*, as well as *Valonia*, was also abundant.

Table E.3.1-1. RAM for Rose Atoll.

	ROS2	**ROS1**	**ROS8**	**ROS6**	**ROS9P**	**ROS5**	**ROS7**	**ROS23**	**ROS21**	**ROS4P**	**ROS3**	**Island average**
GREEN ALGAE												
Bryopsis				**16.7** 8.5			**50.0** 6.0		*	**8.3** 5.0		**9.5**(18.9) 4.8(1.8)
Caulerpa	**25.0** 3.7	**16.7** 5.5						**8.3** 6.0	*			**5.6**(9.3) 3.5(0.9)
Chaetomorpha	**66.7** 7.0	**16.7** 7.0							**50.0** 7.0		**66.7** 7.5	**41.7**(27.6) 5.8(0.5)
Cladophoropsis		**16.7** 7.0										NA
Chlorodesmis						*						
Dictyosphaeria	**83.3** 6.7	**50.0** 6.0		**41.7** 6.2		*		**33.3** 5.8		**75.0** 6.2	**33.3** 6.0	**40.8**(33.2) 5.5(0.4)
Halimeda	**25.0** 7.0	**8.3** 6.0	**8.3** 3.0	**66.7** 5.9	*	*	**25.0** 6.0	**66.7** 5.8	**50.0** 5.8	**83.3** 5.3		**36.7**(28.7) 5.1(1.1)
Microdictyon	**100** 2.8	**83.3** 3.5							**91.7** 3.3		**91.7** 3.5	**91.7**(28.7) 2.6(0.3)
Neomeris	**8.3** 7.0									**8.3** 8.0		**8.3**(0.0) 5.0(0.7)
Udotea					*	*						
Valonia	*	*	*						**16.7** 7.0		**25.0** 4.0	**20.8**(5.9) 3.7(2.1)
Verdigellas	*	*									*	
RED ALGAE												
Dasya										*		
Galaxaura				**16.7** 6.5		**33.3** 6.5				*		**5.0**(11.2) 4.3(0.0)
Gelid		**50.0** 7.2		**100** 5.6					**66.7** 6.4	**58.3** 7.3	**58.3** 7.3	**40.8**(33.7) 5.8(0.7)

	ROS2	**ROS1**	**ROS8**	**ROS6**	**ROS9P**	**ROS5**	**ROS7**	**ROS23**	**ROS21**	**ROS4P**	**ROS3**	**Island average**
Grateloupia	**8.3** 9.0			*	*						**8.3** 7.0	**8.3**(0.0) 5.3(1.4)
Griffithsia		**8.3** 11.0										NA
Jania	**91.7** 7.8	**8.3** 10.0		**50.0** 7.3			**75.0** 7.0	**41.7** 7.2	**66.7** 8.6	**75.0** 7.9	**75.0** 7.9	**48.3**(34.4) 7.1(1.0)
Peyssonnelia	**100** 3.8	**91.7** 3.5		**100** 3.6		*	**83.3** 3.2	**91.7** 3.1	**100** 3.5	**83.3** 3.7	**91.7** 3.1	**74.2**(39.6) 3.0(0.3)
Crustose coralline	**100** 1.2	**100** 1.1	**66.7** 2.8	**100** 1.3	**83.3** 2.1		**100** 1.5	**100** 1.3	**100** 1.2	**100** 1.0	**100** 1.2	**95.0**(11.2) 1.3(0.6)
BROWN ALGAE												
Dictyota				**25.0** 5.0		*	**91.7** 5.1	**50.0** 5.0	**16.7** 9.0	**91.7** 4.7	**16.7** 6.0	**29.2**(36.5) 5.0(1.6)
Lobophora						*						
CYANOPHYTES	**100** 5.0	**91.7** 4.7	**83.3** 1.7	**100** 3.3	**66.7** 2.5	*	**100** 3.1	**100** 2.3	**100** 2.6	**100** 3.0	**91.7** 4.5	**93.3**(11.0) 3.0(1.1)
TURF	**91.7** 2.9	**100** 2.3	**91.7** 1.4	**100** 2.3	**100** 1.3		**91.7** 2.5	**100** 3.3	**66.7** 3.8	**100** 3.3	**100** 3.6	**94.2**(10.4) 2.4(0.9)

E.3.1.1. Benthic Towed-diver Survey — Algae

The macroalgae was observed to be the highest at the ~15–m 'mid-depth' isobath (5–10%). Crustose coralline algae was observed to be the dominant habitat along the forereef, with an average of 40–60% cover at all depths.

Cyanobacteria (blue-green algae) was observed to be present at all depths and documented as a significant portion of some of the shallow isobath tows (10–40%). This was noted in 2004 and could potentially be related to the shipwreck in 1993 of the longliner *Jin Shiang Fa*. In areas where the cyanobacteria was significant, there appeared to be a correlation with high levels of stress in the hard coral (40–50%).

E.3.2. Corals

Colonies belonging to at least 21 cnidarian genera were observed by Kenyon and counted within belt transects during quantitative surveys (see table above). Members of the genera *Pocillopora*, *Porites*, *Montastrea*, and M*ontipora* dominated the coral fauna in terms of number of colonies, with each genus contributing more than 10% of the total number of colonies. A total of 4267 cnidarian colonies (of which 3950 were scleractinians) were counted within a total survey area of 605 m^2, for an average colony density of 7.1 cnidarian colonies/m^2. Density values at individual sites ranged from 3.4/m^2 at ROS-7 (the site of a ship grounding in 1993) to 10.4/m^2 at ROS-3. The highest generic diversity (17 genera) along the transect belts was found at ROS-2, ROS-5, and ROS-21. Inspection of a histogram showing the size class distribution of cnidarian colonies counted and classified within belt transects (see below) shows that the majority (68.9%) of colonies measure less than 20 cm in maximum diameter, with the greatest number of colonies occurring within the 10–20–cm size class.

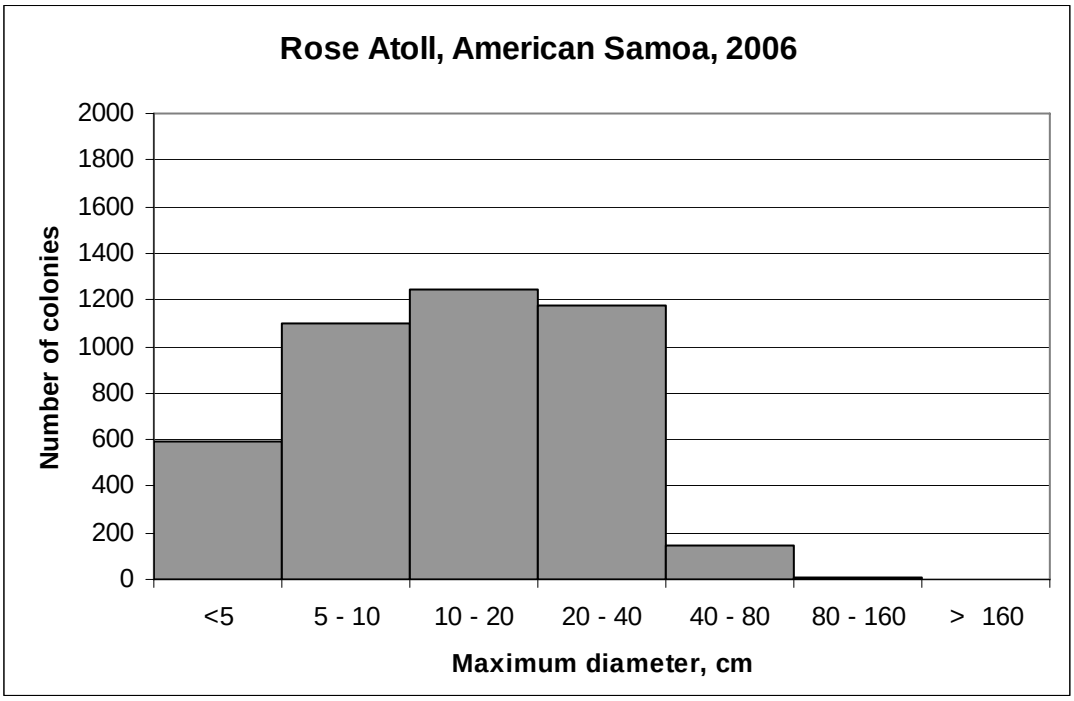

Figure E.3.2-1. Coral colony size distribution, Rose Atoll.

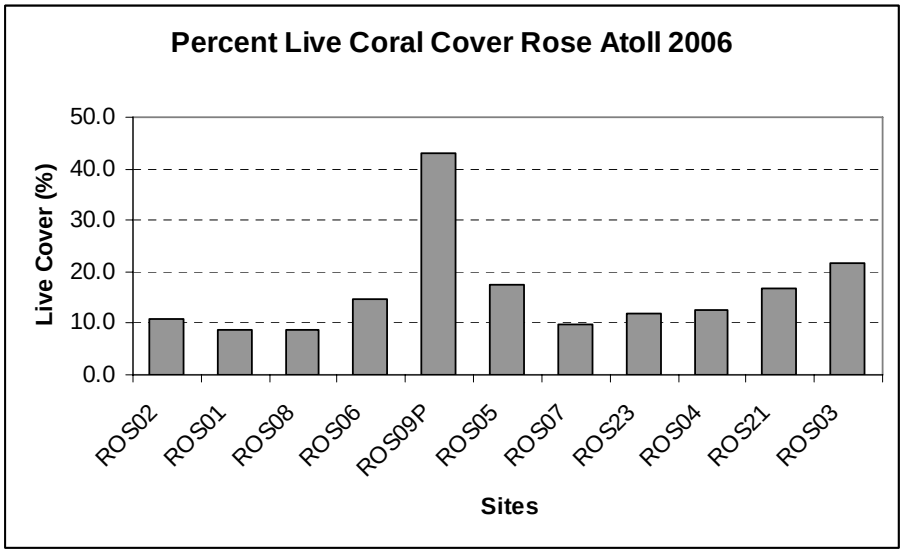

Figure E.3.2-2. Coral cover, Rose Atoll.

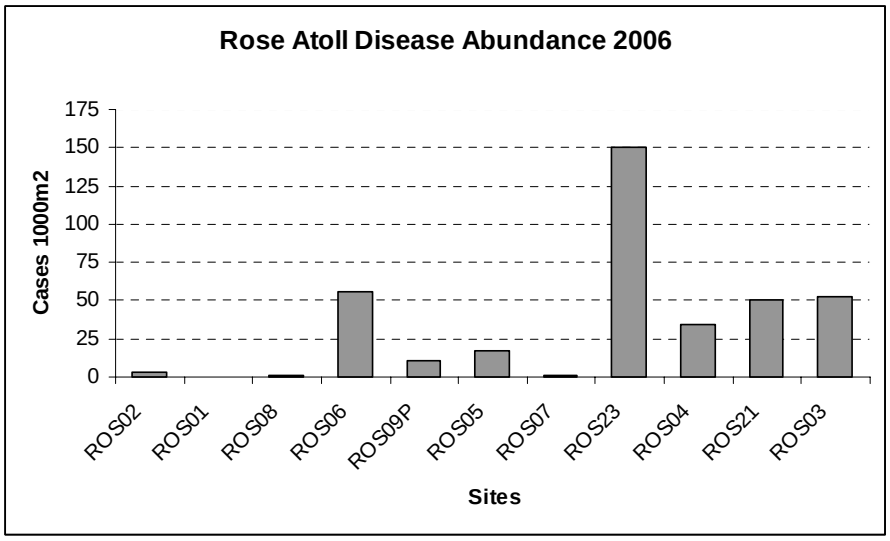

Figure E.3.2-3. Coral Disease Abundance, Rose Atoll.

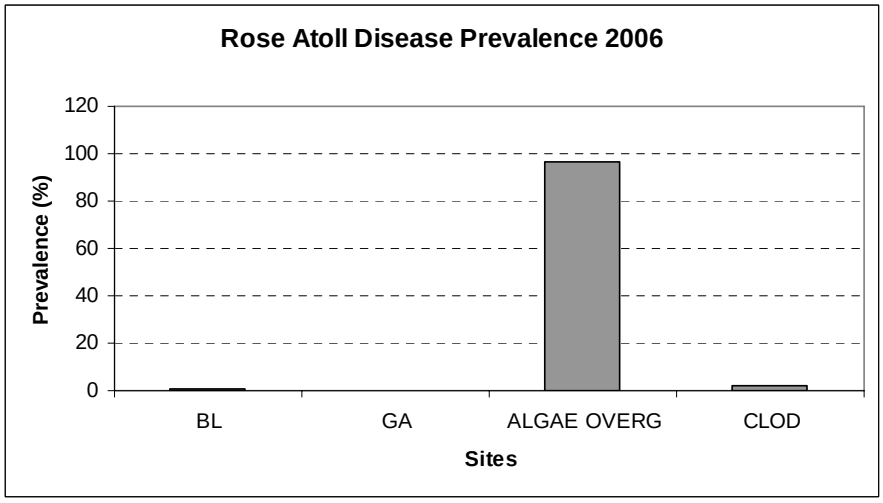

Figure E.3.2-4. Coral Disease prevalence, Rose Atoll. BL: bleaching, GA: growth anomaly; ALGAE OVEG: algae overgrowth; CLOD: coralline lethal orange disease; OT: other coralline algae disease, mainly ring syndrome.

E.3.2.1 Rose Atoll Permanent Transect Studies

Preliminary results of coral population and permanent transect studies: Rose Atoll National Wildlife Refuge, 5-9 March 2006 (Jim Maragos, USFWS)

Introduction

Sixteen sites were surveyed at Rose Atoll NWR for coral population parameters by the author. Eight of the sites (ROS- 8P, 9P, 10P, 13P, 26P, 27P, 29P and 31P) were in the lagoon and eight (ROS- 1, 2, 3, 4P, 5P, 7P, 21, 23P) on ocean-facing forereefs. Fourteen of the sites are permanently marked 50–m long and 1–m wide transects for assessing coral populations and giant clam (*Tridacna maxima*) frequencies, including two new

permanent transects at sites ROS-1P and ROS-3P on the northeast and southeast ocean reefs, respectively. The author acknowledges the assistance of NOAA scientists and crew on the expedition that facilitated the resurvey of seven of the permanent lagoon sites (Amy Hall, Elizabeth Keenan, Chip Young, and Gaetano Maurizio). The USFWS has had a special interest in monitoring the lagoon and ocean reefs at Rose because of the lingering impacts of a ship grounding and coral beaching event that occurred 12 years ago.

In October 1993, a 275–ton Taiwanese long-line fishing vessel ran aground and broke up on the shallow southwest reef crest and forereef of the atoll, resulting in a massive fuel spill that killed off coralline algae and corals on the southwest reef crest and backreef. Salvage tug operations several weeks later were successful in only removing the bow section of the ship, leaving behind more than 200 tons of metallic debris and another 15 tons of nonmetallic debris on the perimeter reefs and lagoon, respectively. This insult more-or-less coincided with a massive coral bleaching event at the atoll in April 1994 (Maragos, 1994) that extended to depths of 20–25 m and led to the demise of many corals. During the subsequent 5 years, scientists at the American Samoa DMWR and the USFWS began monitoring reef crest algae, invertebrate, and fish populations at the atoll, as the shipwreck continued to disintegrate and corrode into thousands of pieces and release increasing quantities of dissolved iron into the ocean. It was determined by these studies (Green et al., 1998) that the iron was stimulating cyanobacteria populations on the reef crest and neighboring backreef and patch reefs and causing them to spread to other parts of the atoll that were not directly affected by the grounding. In March 1999, the author joined the USFWS and was assigned the task of planning and initiating the cleanup of the atoll with emergency funds provided by the USFWS and later from funds provided by the U.S. Coast Guard from the Oil Spill Liability Trust Fund Act.

Half of the reef crest metallic debris (75 tons) and smaller ocean-facing reef slope debris (30 tons) was cut and removed by hand in 1999–2000. Additional debris (30 tons) washed up on the reef crest after a January 2004 hurricane and the remaining 15 tons of nonmetallic debris in the lagoon was removed in August 2004 and January 2005, respectively. By June 2005 all but 2 tons of the remaining reef slope debris was removed after 40 tons of the largest pieces of metallic debris were successfully removed from the southwest facing ocean reef slope. Over the years all debris from the atoll was surface-transported and dumped at a U.S.E.P.A.-approved offshore dumpsite and located 3 nmi north of Rose Island.

In July 2005, two deep submersible dives off the southwestern perimeter reef confirmed that the bow section descended into deep water in 1993 and is no longer of concern regarding the cleanup and recovery of the atoll. The remaining few pieces of debris will be removed in January 2007 and the atoll reef crests and lagoon monitored on a biennial basis by the USFWS through 2015. The USFWS acknowledges the support of the NOAA ships *Townsend Cromwell, Oscar Elton Sette,* and *Hi‘ialakai* expeditions that have emphasized complementary assessment and monitoring of ocean habitats at the atoll in 2002, 2004, and 2006. The author also acknowledges participation of DMWR staff

(Emmanuel Tardy, Leslie Whaylen, Risa Oram) during USFWS-sponsored invertebrate and fish surveys at the atoll during 2004-2005.

Materials and Methods

Coral population surveys followed the techniques used during earlier phases of the expedition by the author. Transect surveys at both permanent and REA sites totaled a distance of 50 meters at all sites except ROS-1P (surveys shared with Jean Kenyon), ROS-10P (only 20 m in length), and the new permanent site at ROS-3P (only 38 m in length due to insufficient time, but perhaps covered by Kenyon). The width of each transect surveyed for coral populations was 1 meter at all sites, giving a total area per site of 50 m^2 for all sites except ROS-1P (35 m^2 including all of the first transect, the 5–m space between the two and the first 5 m of the second), 10P (20 m^2) and ROS-3P (38 m^2). To facilitate comparisons between sites and over time, all population totals were corrected to those estimated within a 50 m^2 area. Census of coral populations was accomplished in situ at all ocean sites and one lagoon site (ROS-8P) with coral populations at the remaining lagoon sites censused using photoquadrats. With the assistance of the above named NOAA individuals, a 1–meter square photoquadrat was centered over the transect line and photographed along each 1–meter interval along the lines using a high resolution digital camera (Olympus 5050Z) in an underwater housing.

The photographs were later viewed via computer screen to census corals in the same manner as done in situ. All corals whose centers fell within one-half meter of the transect line were assigned to a genus and one of seven size classes: 1–5 cm, 6–10 cm, 11–20 cm, 21–40 cm, 41–80 cm, 81–160 cm, and >160 cm, based on a visual estimate of the width of each coral's maximum diameter. These data were later used to calculate generic diversity richness, frequency (number of corals/m^2), mean diameter (cm), and cover of corals (m^2/50 m^2); and plotted on graphs to show size distributions and trends over time.

The results of the 2000 photoquadrat accuracy assessment at site ROS-9P are also covered here. Stainless steel pins measuring 3/8th inch diameter and 12 inches in length were installed in the coral reef substrate at site ROS-9P (and at all other sites) at 5-m intervals along the line using a short-handled 6-lb sledge hammer and underwater epoxy. Then on successive days, the 50–m transect line was laid along the pins and the first 36 meters of the transect were photographed using the methodology except that a film camera was used (Nikon RS U/W camera and 13–mm wide angle lens) mounted on a photoquadrat frame. After the first day's photographs were taken, the transect line was removed and reinstalled along the transect on the second day before photographs were taken again.

Except at the new permanent transects established at sites ROS-1P and ROS-3P during this trip, all permanent transects at Rose Atoll NWR (and at most other USFWS sites in the Pacific Remote Islands National Wildlife Refuge Complex) have been set at depths of 10 m +/- 2 m since 1999. The purpose was to ensure adequate time to either install or relocate/repair transect pins, lay the line, take the photoquadrats and remove the line in a 1-hour interval using scuba at each site. Photoquadrats help reduce field time vis-à-vis in

situ measurements but require considerable post-field processing time. As a result, only limited data are available for this preliminary report. Moreover, the coral population data separately presented by Jean Kenyon were based on census of corals at REA sites between depths of 13 to 17 m. Coral population data collection at two depth regimes at many of the same sites offers opportunities to assess coral abundance and distribution as a function of depth.

Preliminary Results

Coral species diversity at Rose Atoll continues to remain much lower than at the adjacent Samoa volcanic islands to the west but much higher than reported at Swains in 2004 by the author. Of interest was the new record of star coral *Galaxea fascicularis* for Rose Atoll at site ROS-5P (J.Kenyon, pers. comm.), the cryptic encrusting coral *Stylocoeniella armata* at site ROS-and the second records of the adhesive anemone *Crptodendrum adhaesivum* at the adjacent southwest reef site at ROS-4P and *Scapophyllia cylindrica* at site ROS-9P. The dendrophyllid coral *Turbinaria* was also more widely reported than during past visits. Several genera of corals common at Rose before the coral bleaching event of 1994 continue to be rare or absent at the atoll in 2006, especially the brain corals *Goniastrea, Platygyra,* and *Favites;* the fire coral *Millepora;* the poritid coral *Goniopora;* and the mussid corals *Acanthastrea* and *Lobophyllia.* As noted below, other brain corals are declining (*Favia*) on ocean reefs or rare possibly because of recent bleaching events or injury from the January 2004 hurricane.

Oualitative observations reveal that most habitats continue to improve from 2004 conditions especially on the southwest reef crests and ocean reef slopes off the southeast and northeast sides of the atoll. Site ROS-7P, the closest site down-drift from the shipwreck site showed reduced frequencies and high recent mortalities of all sizes of *Pocillopora* corals. However, further down-drift at site ROS-23P coral populations seem to be healthier, as well as both those up-drift of the wreck (ROS-4P, -5P). The "cyanobacteria zone" off the southwest perimeter reefs and reef crests continues to shrink in size although still stressing reef environments substantially at the downdrift site closest to the former shipwreck site (ROS-7P). Also most of the patch reefs in the lagoon continue to be afflicted with the stringy masses of cyanobacteria, and other scientists observed the affliction at some northwest ocean reef slope sites.

Comparisons are possible among six sites analyzed to date for both 2004 and 2006 surveys at Rose Atoll. These six include two lagoon sites (ROS-8P, -9P) and four ocean reef slope sites (ROS-1, -2, -3, -21). Coral frequencies are much higher at all of these sites in 2006. Especially dramatic were increases from 4.4, 3.8, 5.5, and 3.6 corals per m^2 in 2004 to 7.1, 6.2, 14.1, and 9.6 corals per m^2 in 2006 at sites ROS-2, -3, -21 and -8P, respectively. This was primarily due to the increase of smaller-sized corals, although there were also declines noted in larger-sized corals at sites ROS-1 and -21.

Table corals (*Acropora)* showed modest increases at intermediate sizes at site ROS-21 in 2006, but showed declines in larger-sized corals at windward ocean facing reef slopes (ROS-1, -2), perhaps attributed to recent hurricanes. The related encrusting coral

Astreopora showed major increases at the two lagoon sites reviewed here (ROS-8P, -9P). The other common acroporid encrusting/plate coral *Montipora,* maintained high abundance in both the lagoon and ocean reefs although the numbers of large colonies declined while smaller colonies increased. Other encrusting corals *Coscinaraea* showed increases at several ocean sites.

The encrusting brain coral *Cyphastrea* showed declines at three of four ocean sites (ROS-1, -2, -3) and increases at the fourth (ROS-21). The previously dominant brain coral *Favia stelligera* showed declines in numbers and health at ocean sites ROS-2 and -21, while a sibling species *Favia matthaii* continues its abundance in the lagoon. At site ROS-9P, the numbers of smaller (younger) corals increased dramatically while larger colonies of the species declined substantially. A related brain coral adapted to disturbed environments, *Leptastrea,* showed higher abundance at the north lagoon site ROS-8P. Another related brain coral *Montastrea* showed similar increases in smaller-size classes and declines in larger-size classes at the exposed ocean reef sites where it is most common (ROS-1, -2, -21).

The common agaricid coral *Pavona* continues to be common at Rose Atoll especially on ocean reefs, but larger colonies declined at sites ROS-1 and -21 while a lagoon site ROS-8P reported a modest increase. The rose/cauliflower coral *Pocillopora* continues to dominate most habitats on ocean-facing reef slopes, although many died off at site ROS-7P closest to the shipwreck. The coral showed modest declines at larger-size classes at site ROS-1 and increases in all size classes at site ROS-21. The lobe coral *Porites* is dominant on many Pacific coral reefs except at Rose Atoll although this coral achieves large size only at greater depths off ocean reefs and sheltered behind the back reefs off the southwest patch reefs, (e.g., sites ROS-9P, -13, -26, -27, -29, and -31). Large numbers of small *Porites* colonies were reported at the north lagoon site ROS-8P.

Pisonia trees at Rose Island

The author and three others (Elizabeth Keenan, Amy Hall, Gaetano Maurizio) also briefly visited Rose Island on March 8 and took leaf samples from the four surviving *Pisonia grandis* trees, down from nine trees reported in early 2005. Although scale and ant insect infestations are lower on the trees, the few remaining trees continue to remain imperiled by their scarce numbers and competition from coconut trees which have been planted and are now spreading throughout the island.

E.3.2.2. Benthic Towed-diver Survey – Corals

The dominant habitats observed along the forereef consisted of continuous reef and carbonate pavement. The dominant habitats along the backreef and lagoon environments were observed to be pinnacle patch reefs, rubble, and sand flats. Typical depths of lagoon interior are 20–25 m. The outer reef slopes are generally very steep, except for gently sloping terraces on the north end and on the northeast end of the diamond-shaped atoll. Along the forereef, we observed the hard coral cover to be on average between 10 and 20% at all three depths surveyed. The highest observed average was seen at the ‘shallow’ ~7–m isobath. Soft corals were seen on average of 1–5%, with the highest average observed at the ‘deepest’ ~21–m isobath.

E.3.3. Invertebrates

During the period between March 5 through March 8, Rose Atoll was surveyed and a total of 11 benthic surveys were completed. Nine sights evenly spaced around the outside of the reef were surveyed, including the site of a shipwreck that has caused environmental changes at the site of the grounding. The other two sites were inside the lagoon (one in the north and one in the south) at pinnacles surrounded by sand and small patch reefs. Two of the sites had permanent transects set in place (at a shallower depth than the rest of the REA transects) which were surveyed by one coral and one invertebrate diver. There was a great deal of reef structure on the windward side of the atoll composed of coralline algae, which created an extremely rugose terrain, and the leeward sides had typical carbonate structure. Most of the reef slope environments were dominated by crustose coralline algae, the green algae *Microdictyon,* and coral. Most of the west reef sites were dominated by *Pocilloporid* corals.

Molluscs

Giant clams were present at 3 of 11 sites and were abundant at one lagoon site, although most of them were off the transect. Also at this site was an abundance of spondylid oysters and *Chama* bivalves. The other molluscs found inside the lagoon and outside the atoll were gastropods and nudibranchs and were occasional to common. They were typically composed of *Conidae, Cypraeidae,* and *Thaididae* gastropods with the most common nudibranch of the genus *Phyllidia*. Sites 7 and 5 were in the vicinity of a recent wreck site. Site 7 has been extremely affected by the remainder of the iron wreckage, with the site being overtaken by cyanobacteria and turf algae. Site 1, on the other hand appears to be quite healthy and had the greatest diversity of invertebrate species of any site. Overall, the macroinvertebrate communities on the forereef were composed of very cryptic species associated with living and dead *Pocilloporid* coral heads and rubble.

Echinoderms

Echinoderms were not diverse or abundant at any of the sites at this atoll. *Holothuriods* (sea cucumbers), for example, were only present at the second lagoon site, and also present were one species, *Holothuria whitmaei*, which happened to be spawning. There were 3 species of echinoid (urchin) present at 5 sites out of 11 total sites. The most common was *Echinothrix calimaris*, which was present at three sites. There was also only one type of asteroid (sea star) found at the atoll, which was *Linckia multifora*, and was present at three sites also. There was only one type of ophiuroid (brittle star) cited in this study, *Ophicoma pica*, and there was one unknown species of crinoid (sea fan).

Crustacea and other groups

Hermit crabs were the most common crustacean at both lagoon sites and outer reef slopes. There were large (*Dardanus* sp.) and small hermits (*Calcinus* sp.). The other major groups were soft corals, sponges, hydroids, zoanthids, and the coral dwelling species of gastropods and trapezid crabs.

Table E.3.3-1. Total sites surveyed: 11.

Date	Island	Site #	Habitat type	Wind/lee ward	Min depth	Max depth	Latitude	lLongitude
3/5/2006	Rose	2	forereef	wind	49	51	14°`33.088	168° 08.389
3/5/2006	Rose	1	forereef	wind	47	55	14°`32.353	168° 08.730
3/5/2006	Rose	8	Lagoon	wind	28	34	14°`33.037	168° 30.772
3/6/2006	Rose	6	forereef	wind	44	52	14°`32.182	168° 09.931
3/6/2006	Rose	9P	Lagoon		12	28	14°`33.062	168° 09.646
3/7/2006	Rose	7	backreef	lee	46	57	14°`32.965	168° 10.108
3/7/2006	Rose	5	backreef	lee	45	50	14°`33.243	168° 09.920
3/7/2006	Rose	23	backreef	lee	48	55	14°`32.524	168° 10.360
3/8/2006	Rose	21	backreef	lee	46	54	14°`33.481	168° 09.202
3/8/2006	Rose	4P	backreef	lee	51	60	14°`33.559	168° 09.635
3/8/2006	Rose	3	backreef	lee	45	50	14°`33.315	168° 08.880

E.3.3.1. Benthic Towed-diver Survey – Macroinvertebrates

As in 2004 *Pocillopora sp*. heads along the western forereef were again observed to be pale, and it did not appear to be crown-of-thorns sea star (*Acanthaster sp*.) predation, with no *Acanthaster* observed. From 2002, 2004, and 2006 surveys, over ~145 km of habitats between depths of 3 m and 30 m were surveyed without a single observation of crown-of-thorns. A total of 481 giant clams (*Tridacna sp.*) were observed on an average of 10 per km, with 93% counted in the inner lagoon and backreef. With a few exceptions, sea urchins were only observed in the 'shallow' ~7–m isobath.

E.4. Fish

From March 5 to March 9, 2006, the fish REA team surveyed 14 monitoring stations around Rose (including 2 within the lagoon). A preliminary minimum estimate of 158 species was recorded around the atoll. Medium-large fish appeared to be roughly similar in abundance to that of the Manua Islands. Sharks (white-tip and black tip) were more common, mainly in very shallow water just below the surf zone. The lagoon patch reef on the west side harbored high density and diversity of fishes, including large ones (e.g., large schools of *Scarus frontalis, Lutjanus kasmiri, Mulloidichthys vanicolensis*). The outer slope was also characterized by healthy fish communities and good visibility (>30 to 60 m). Parrotfish and surgeonfish were abundant along the southwest side, especially at the site of the 1993 longline vessel grounding (ROS-7). Dense schools of *Naso lituratus* and *Acanthurus triostegus* were common here. Heavy cover by cyanobacteria and related blue-green "algae," in response to iron-enrichment from corroding wreckage, was still visible at this outer reef slope station. A few pieces of wreckage were spotted in the area, even though USFWS claimed to have removed over 90% of the steel. No major recruitment pulses were observed but small juveniles of *Gomphosus various* and *Paracirrhites arcatus* were common.

The final day at Rose was spent conducting validation of the standard BLT and SPC methods at a single station (ROS-5) along the outer reef slope of the southwest arm. Three complete sets of full transects/counts were completed at this site. For the first two surveys the transect lines were left in place. For the third survey, the boat relocated and anchored at the same GPS site and lines were re-laid. Variance estimates of the fish

census methods will be calculated. (The benthic-coral REA team conducted similar validation surveys at this site.)

Fish Family Summaries:

Angelfish (four species) were represented by a few *Centropyge flavissumus* and *C. loricula*.

Butterflyfish (18 species) were uncommon but mostly *Chaetodon reticulatus*.

Damselfish diversity was relatively low (19 species) with *Chromis acares* again highly dominant.

Goatfish (six species) were also few and mostly *Parupeneus insularis*.

Grouper (four species) were mainly represented by *Cephalopholis argus* and *C. urodeta*.

Hawkfish (four species) did not appear to be as abundant, relative to some other islands, even though their branching coral habitat (*Pocillopora*) was common. Main species were *Paracirrhites arcatus* and *P. fosteri*.

Parrotfish (10 species) were relatively common, especially along the west. Primary species were *Chlorurus sordidus, Scarus fosteni, S. frontalis*, large *C. microrhinus, S. oviceps*, and *S. psittacus*. On one dive along the southwest side, a nearly continuous "train" of *S. frontalis* was swimming north for most of the dive; on a subsequent dive that day, along the same side of the atoll, they were seen swimming south. No bumphead parrotfish (*Bolbometapon muricatum*) were seen.

Though not abundant, snapper (seven species) were represented mostly by *Aphareus furca*, with fewer *Lutjanus bohar, L. kasmira, L. gibbus, L. monostigma*, and *Macolor* spp.

Surgeonfish (21 species) were rather common, mainly *Ctenochaetus striatus, Acanthurus nigricans, A. nigroris, Naso lituratus, N. vlamingii, N. brevirostris*, and others.

Triggerfish (five species) were few, mostly *Melichthys vidua*.

Wrasses were numerous and diverse (27 species). The bird wrasse (*Gomphosus varius*) appeared to be the most numerous, followed by lesser *Pseudocheilinus tetratania, Thalassoma quinquevittatum, Labroides* spp., and others. A few medium-sized Maori wrasse (*Cheilinus undulatus*) were seen around the atoll.

The most commonly observed fish over 50 cm total length on tow-surveys was the blackfin barracuda (*Sphyraena qenie)* with 399 observations, 296 of which were seen at Rose Atoll in several large schools. The second most commonly observed fish was the bigeye trevally (*Caranx sexfasciatus*) with 220 observations, with the majority observed

in one large school close to the pass at Rose Atoll. Observations of both the parrotfish and the snappers were also notable with 197 and 192 individuals observed, respectively. The Pacific steephead (*Chlorurus microrhinus)* and the twinspot snapper (*Lutjanus bohar)* accounted for the majority of these observations. The most commonly observed shark for this survey period was the benthic feeding reef whitetip shark (*Triaenodon obesus*) with 23 observations, compared to only 8 the previous survey period. Other sharks including the blacktip reef shark (*Carcharhinus melanopterus*), the gray reef shark (*Carcharhinus amblyrhyncos*), and lemon shark (*Negaprion acutidens)* were observed 7, 2, and 1 times, respectively throughout this survey period. Other notable observations include 13 sightings of the Maori wrasse (*Cheilinus undulatus*) and no sightings of the bumphead parrotfish (*Bolbometopon muricatum*) as compared to previous years.

Appendix F: Seamount Mapping

F.1. Northeast Bank

Shipboard mapping was conducted during the nights of February 28 and March 1 to characterize the top of Northeast Bank, which lies 45 km west northwest of Ofu. This seamount rises to within 50 m of the surface, and its top has features that are characteristic of carbonate reefs. In the future, towed-camera operations should be conducted to characterize the state of these reefs. It should be noted that the Seamount Catalog (located at http://earthref.org/index.html) names this feature as Muli Seamount. American Samoans do not use that name.

F.2. Two-Percent Bank

Shipboard mapping was conducted during the night of March 2 to characterize Two-Percent Bank, which lies 60 km southwest of Ta'u. The shallowest portion of the feature was not surveyed; instead portions of the unmapped deeper portions of the seamount were surveyed during a 4-hour period. It should be noted that the Seamount Catalog (located at http://earthref.org/index.html) names this feature as Tulaga Seamount. American Samoans do not use that name.

F.3. Vailulu'u Seamount

Shipboard mapping was conducted during the night of March 4 to characterize the top of Vailulu'u Seamount, which is known to be an active undersea volcano. Two previous surveys have shown that the summit is volcanically active and is undergoing a period of lava dome building. The data collected during this cruise will be compared to data from the earlier surveys to determine whether further volcanic construction can be detected.

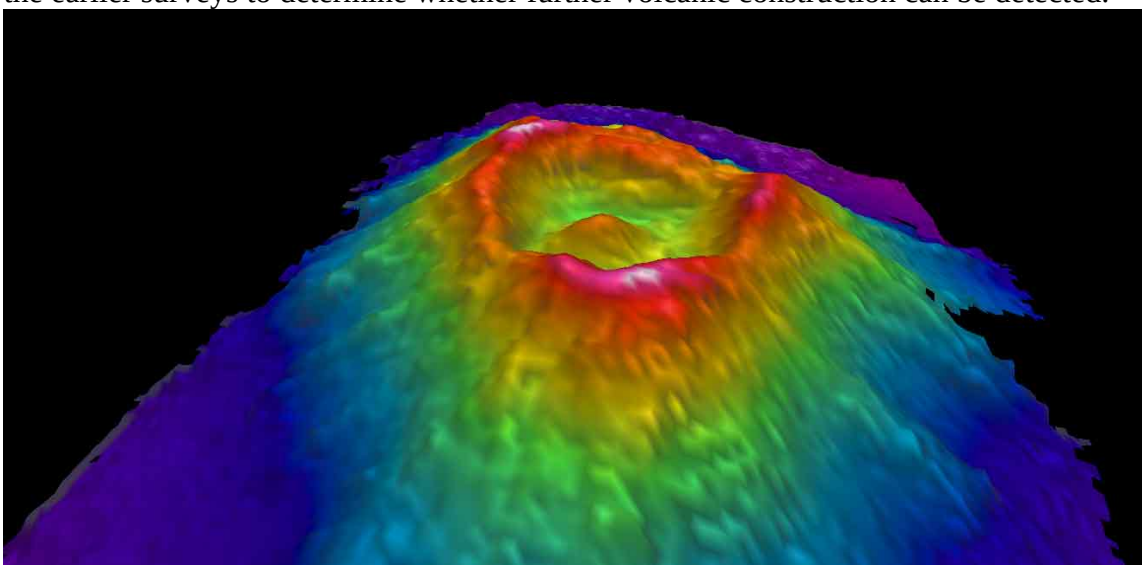

Figure F.3-1. Multibeam Imagery of Vailulu'u Seamount.

Appendix G: Education and Outreach (Frances Le'iato, Della Tuamoheloa)

Two local students from the American Samoa Community College participated on the cruise as observers. Frances Le'iato participated on the leg to Swains Island (February 9-14) and Adela (Della) Tuamoheloa participated on the leg around Tutuila (February 17-24). Both had opportunity to participate and interact with all of the small-boat field survey teams (fish/benthic REA, towed-diver, oceanography, mapping, night-ops). Their experience proved to be very positive and local student participation is recommended for future cruises.

E-mail from Adela Tu'amoheloa <madella07@yahoo.com> 24Feb2006:

> *Hello there Hi'ialakai!!! I am Della Tuamoheloa, the student you took on board for a week. I know I didn't say goodbye to the rest of the crew, now i just want to say thank you instead. Thank you for everything that your crew had done for me. For the past week, I've learned so many things in the field of Marine Science and the trip helped me to challenge myself to pursue a career in this field. There are so many things out in the ocean that amazes me. Just like what Steph said, "this job is always an adventure".... Everybody on board contribute to carving the path to my future, and all the success I will achieve are the fruits of your services. From the Captain and officers, Deck Crew, Safety Crew, different scientists, Chief Steward and Ms. Parker and all the engineers and everyone on Hi'ialaki, I thank you from the bottom of my heart. My only regret is, I don't have my degree now and not enough experience to stay on board and be an employee of Hi'ialakai/ NOAA. No promises, but I believe some day in the future I will come seeking employment on your ship. Thank you once again for your smiles, shelter and informing me of your different jobs. To all the teams: Mapping, Oceanography, R.E.A, and the Tow Team, I had so much fun and i miss you guys. The memories are still fresh in mind, and I thank you for them. All of the teams are the best and please continue on what you're doing. I pray that you will be safe and return to shore safely. Please, send my love and gratitude to the crew members.*
>
> *Thank You,*
> *Della Tuamoheloa*