UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Silver Spring, Maryland 20910

CRUISE REPORT[1]

VESSEL: *Hi`ialakai*, Cruise 08-02 (Fig. 1)

CRUISE PERIOD: 18 February–19 March 2008

AREA OF OPERATION: American Samoa

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Division (CRED), Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), NOAA, and their partner agencies conducted integrated coral reef ecosystem assessment and monitoring surveys in waters surrounding Tutuila, Ofu, Olosega, Ta`u, Swains Islands, and Rose Atoll. All activities described in this report were covered by the following permits: DMWR 2008/002, NPAS-2008-SCI-0005, FBNMS-2008-0001, USFWS 12521-08002, USFWS 12521-08003, USFWS 12521-08004, USFWS 12521-08005, USFWS 12521-08006, USFWS 12521-08007, USFWS 12521-08008.

ITINERARY:

18 February — Start of cruise. Embarked Marc Nadon (fish), Paul Brown (fish), Kevin O'Brien (fish), Paula Ayotte (fish), Jason Helyer (coral), Jean Kenyon (coral), Suzy Cooper-Alletto (algae), Sarah Myhre (algae), Molly Timmers (invertebrates), Noah Pomeroy (invertebrates), Stephane Charette (towed diver, fish), Kevin Lino (towed diver, fish), Edmund Coccagna (towed diver, benthic), Jacob Asher (towed diver, benthic), Oliver Vetter (oceanography), Ellen Smith (oceanography), Frank Mancini (oceanography), Daniel Merritt (oceanography), Jim Bostick (divemaster and chamber operator), Jamie Carter (data manager), and Scott Ferguson (chief scientist). Departed Pago Pago, American Samoa, at 0905 and began transit to Cape Matatula on the NE tip of Tutuila (~ 16 nmi). Boat orientation and dive safety briefings were performed, and an introductory meeting was held for new scientific personnel. Boat launches began at 1205 with all boats working west along the north shore. The

[1] PIFSC Cruise Report CR-09-003
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	Rapid Ecological Assessment (REA) teams aboard HI-1 completed 2 multidisciplinary REA surveys at sites TUT-17 and TUT-4. A second fish REA team aboard HI-2 completed 2 additional fish surveys at sites TUT-50 and TUT-51. The towed-diver team conducted 4 towed-diver surveys. The oceanography team replaced 2 subsurface temperature recorders (STRs), recovered 1 ecological acoustic recorder (EAR), and deployed 1 new EAR anchor to be equipped with an instrument after refurbishment ashore. They also conducted 7 shallow-water conductivity, temperature, and depth (CTD) casts and 2 shallow-water sample profiles. Four shipboard deepwater CTD casts were performed during nighttime operations.
February 19	Continued working along the north shore of Tutuila. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites TUT-5, TUT-14, and TUT-18. A second fish REA team aboard HI-2 completed 3 additional fish surveys at sites TUT-52, TUT-53, and TUT-54. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered 1 EAR, deployed 1 new EAR anchor to be equipped with an instrument after refurbishment ashore, recovered and redeployed a sea surface temperature (SST) buoy, recovered 1 STR, and deployed 2 new STRs. They also conducted 6 shallow-water CTD casts and 1 shallow-water sample profile. Two shipboard deepwater CTD casts were performed during nighttime operations.
February 20	Continued working along the north shore of Tutuila. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites TUT-13, TUT-19, and TUT-12. A second fish REA team aboard HI-2 completed 3 additional fish surveys at sites TUT-55, TUT-56, and TUT-57. The towed-diver team conducted 6 towed-diver surveys. The oceanography team deployed 1 STR, conducted 7 shallow-water CTD casts and performed 2 shallow-water sampling profiles. Six shipboard deepwater CTD casts were performed during nighttime operations.
February 21	Continued working along the northwest shore of Tutuila to Cape Taputapu and then along the southwest shore. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites TUT-8, TUT-7, and TUT-6. A second fish REA team aboard HI-2 completed 3 additional fish surveys at sites TUT-58, TUT-59, and TUT-60. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered and redeployed 1 wave-and-tide recorder (WTR), recovered and redeployed 1 SST buoy, recovered 1 STR, and deployed 2 new STRs. They also conducted 6 shallow-water CTD casts and performed 1 shallow-water sampling profile. One shipboard deepwater CTD cast was performed during nighttime operations.

February 22	Worked along the south shore of Tutuila starting near the airport and moving east. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites TUT-21, TUT-10, and TUT-15. A second fish REA team aboard HI-2 completed 4 additional fish surveys at sites TUT-61, TUT-62, TUT-63, and TUT-64. The towed-diver team conducted 6 towed-diver surveys. The oceanography team conducted 18 shallow-water CTD casts and performed 5 shallow-water sampling profiles.
February 23	Worked along the southeast shore of Tutuila. The benthic REA team aboard HI-1 completed 3 benthic REA surveys at sites TUT-2, TUT-3, and TUT-16. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted surveys at sites TUT-65 and TUT-66. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered and redeployed 1 SST buoy and recovered and redeployed 1 STR. They also conducted 5 shallow-water CTD casts and performed 2 shallow-water sampling profiles.
February 24	Worked along the southwest shore of Tutuila near Fagatele and Larsen's Bays. Disembarked Paul Brown. The REA teams aboard HI-1 completed 3 benthic REA surveys at sites TUT-11, TUT-22, and TUT-23. The invertebrate divers installed 6 autonomous reef monitoring structures (ARMS) at Fagatele Bay and 3 ARMS at Larsens Bay. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted surveys at sites TUT-67 and TUT-68. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered 1 SST anchor, deployed 1 new SST buoy, recovered 2 STRs, and deployed 3 STRs.
February 25	Worked along the south shore of Tutuila. The benthic REA team aboard HI-1 completed 3 benthic REA surveys at sites TUT-9, TUT-1, and TUT-20. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted surveys at sites TUT-69 and TUT-70. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered 1 STR. The ship moored alongside the commercial pier in Pago Pago at 1100 with boats working nearby and completing operations by about 1530.
February 26–27	NOAA's National Marine Sanctuaries Program and ship personnel conducted educational activities aboard ship from 0800 to 1500 with the ship's small boats taking students out for underway activities. A total of 61 students and 11 teachers, as well as 13 educators and volunteers, participated in the activites. Embarked Kerry Grimshaw. Departed Pago Pago Harbor at 1600. Conducted a 500-m CTD cast and began multibeam mapping to fill in gaps in existing coverage along the ridge extending SE of Tutuila. Transited to Ofu and Olosega Islands.

February 28	Commenced work around Ofu and Olosega. The Commanding Officer and Chief Scientist went ashore to confer with local officials about the work the ship and small boats were conducting. The benthic REA team aboard HI-1 completed 3 benthic REA surveys at sites OFU-2, OFU-3, and OFU-4. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted surveys at sites OFU-50 and OFU-51. The towed-diver team conducted 5 towed-diver surveys. The oceanography team recovered and redeployed 6 STRs. Three shipboard deepwater CTD casts were performed during nighttime operations.
February 29	Continued work around Ofu and Olosega. The benthic REA team aboard HI-1 completed 3 benthic REA surveys at sites OLO-4, OLO-2, and OLO-5. OLO-6 was attempted and terminated early due to low underwater visibility due to rain runoff. The fish REA team aboard HI-2 completed OLO-4, OLO-2, OLO-5, and OLO-52. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered and redeployed 1 STR, conducted 25 shallow-water CTD casts, and performed 6 shallow-water sampling profiles. One shipboard deepwater CTD cast was performed during nighttime operations.
March 1	Poor weather necessitated moving to Ta`u where work could be conducted in sheltered areas. The benthic REA team aboard HI-1 completed 3 benthic REA surveys at sites TAU-12, TAU-9, and TAU-8. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted a survey at TAU-50. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered and redeployed 1 SST and 2 STRs, and conducted 16 shallow-water CTD casts.
March 2	Continued work around Ta`u. The benthic REA team aboard HI-1 completed 3 benthic REA surveys at sites TAU-2, TAU-1, and TAU-7. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted a survey at TAU-51. The towed-diver team conducted 6 towed-diver surveys. The oceanography team recovered and redeployed 1 STR, conducted 22 shallow-water CTD casts, and performed 4 shallow-water sampling profiles.
March 3	Weather day. Sustained northerly winds of 40 kn with numerous rain squalls that prevented small boat and diving operations from occurring.
March 4	Completed work around Ofu and Olosega. The benthic REA team aboard HI-1 completed 3 benthic REA surveys at sites OFU-9, OLO-1, and OFU-6. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted a survey at OFU-52. The towed-diver team conducted 4 tows. Two shipboard deepwater CTD casts were performed during nighttime operations.

March 5	Completed work at Ta`u. The REA teams aboard HI-1 completed 3 benthic REA surveys at sites TAU-4, TAU-5, and TAU-11. The fish REA team aboard HI-2 completed the same 3 sites and, in addition, conducted a survey at TAU-52. The towed-diver team conducted 3 tows and conducted 2 dives to measure the large coral colonies to the east of Ta`u. The oceanography team recovered and redeployed 1 STR and conducted 1 dive on the large coral colony to the west of Ta`u. One shipboard deepwater CTD cast was performed during nighttime operations.
March 6	Arrived Pago Pago at 0900. End of cruise. Disembarked Kenyon, Timmers, and Carter. Embarked Brainard, Vargas-Ángel, and Moffitt.
March 7	In port. Held a science planning meeting at 1000 to discuss Leg 1 and the VIP tours scheduled for March 10.
March 8	In port.
March 9	In port. Disembarked Ferguson. Embarked Palawski and Richards.
March 10	Conducted VIP tours of *Hi`ialakai*, including scientific presentations on the following topics: Overview of the Pacific Reef Assessment and Monitoring Program and the *Coral Reef Ecosystem Monitoring Report for American Samoa: 2002–2006*, benthic REA methods and findings, fish REA methods and findings, towed-diver survey methods, and oceanographic observations. VIPs included Governor Togiola Tulafono of American Samoa and several cabinet directors; members of the American Samoa Coral Reef Advisory Group; and staff of the National Park of American Samoa, American Samoa Community College, and American Samoa 's Department of Commerce, Department of Marine and Wildlife Resources, and Environmental Protection Agency. Start of cruise. Embarked Marc Nadon (fish), Paul Brown (fish), Kevin O'Brien (fish), Paula Ayotte (fish), Jason Helyer (coral), Bernardo Vargas-Ángel (coral), Suzy Cooper-Alletto (algae), Sarah Myhre (algae), Stephane Charette (towed diver, fish), Kevin Lino (towed diver, fish), Edmund Coccagna (towed diver, benthic), Jacob Asher (towed diver, benthic), Noah Pomeroy (oceanography), Ellen Smith (oceanography), Kerry Grimshaw (oceanography), Daniel Merritt (oceanography), Jim Bostick (divemaster and chamber operator), Russell Moffitt (data manager, invertebrates), Russell Brainard (Chief Scientist and invertebrates), Governor Togiola Tulafono, Lelei Peau (Deputy Director, Dept. of Commerce), and the governor's security officer Lee Vaouli. Departed Pago Pago, American Samoa, at 1305 and began transit to Rose Atoll. Conducted fire/emergency, abandon ship, and dive safety management drills and shipboard orientation meetings. Conducted nightly scientific planning meeting to prepare for operations at Rose Atoll.

March 11 — Arrived Rose Atoll at 0630. Commenced field operations around Rose Atoll. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites ROS-1, ROS-2, and ROS-3. A second fish REA team aboard HI-5 completed 4 additional fish surveys at sites ROS-50, ROS-51, ROS-52, and ROS-53. The towed-diver team conducted 6 towed-diver surveys circumnavigating the atoll forereef. Three ARMS were installed on the northern forereef terrace at ROS-21. The oceanography team deployed an AquaDopp current meter in the lagoon entrance channel, recovered the Coral Reef Early Warning System (CREWS) buoy from the pinnacles in the SW portion of the lagoon, deployed an SST buoy, replaced 3 STRs, conducted 6 shallow-water CTD casts, and performed 1 shallow-water sampling profile. Governor Togiola Tulafono, Lelei Peau, and USFWS refuge manager Don Palawski toured the perimeter of Rose Island and found a historic monument toppled and mostly buried in the sand. Governor Togiola Tulafono, Lelei Peau, and Don Palawski were escorted on snorkeling surveys to observe coral pinnacles within the lagoon, deployment of an SST buoy, recovery of the CREWS buoy, replacement of an STR, a towed-diver survey along the northern forereef, and 3 ARMS that had been deployed earlier in the day. Lelei Peau was escorted on a scuba dive to observe the coral reef communities of the SE forereef. At night, acoustic Doppler current profiler (ADCP) transects and 4 shipboard deepwater CTD casts were conducted around the atoll.

March 12 — Continued operations around Rose Atoll. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites ROS-21, ROS-6, and ROS-23. A second fish REA team aboard HI-5 completed 3 additional fish surveys at sites ROS-54, ROS-55, and ROS-56. The towed-diver team conducted 4 towed-diver surveys around the atoll lagoon. The oceanography team deployed an EAR outside the channel entrance, replaced a wave-and-tide recorder on the eastern forereef terrace, recovered 3 STRs, and deployed 4 STRs. Three ARMS were deployed on the eastern forereef terrace. Governor Togiola Tulafono, Lelei Peau, and Don Palawski initiated unburying the monument on Rose Island and were later assisted by scienstists, officers, and crew in repositioning the monument to an upright position. Lelei Peau was escorted on a scuba dive to observe the coral reef communities of the NW forereef. At night, a 50-km transect was run north of Rose Atoll to conduct 2 CTD casts to a depth of 75 m to collect water samples for examining dissolved inorganic carbon (DIC) concentrations away from the atoll. ADCP transects were performed both outbound and inbound to Rose Atoll.

March 13 — Continued operations around Rose Atoll. Governor Togiola Tulafono and bodyguard Lee were disembarked via HI-2 to the M/V *Sili* for return to Ta`u Island. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites ROS-5, ROS-4, and ROS-21. A

second fish REA team aboard HI-2 completed 4 additional fish surveys at sites ROS-57, ROS-58, ROS-59, and ROS-60. The towed-diver team conducted 6 towed-diver surveys around the atoll forereef. The oceanography team conducted a total of 47 shallow-water CTD casts, including water sampling for chlorophyll and nutrients at 13 sites and for DIC at 4 of those sites. Three ARMS were deployed on the SW forereef. Don Palawski conducted bird counts on Rose Island and recorded a global positioning system (GPS) position of the monument location. Lelei Peau was escorted on a scuba dive to observe the coral reef communities of the SE forereef. At night, a 50-km transect was run south of Rose Atoll to conduct 2 CTD casts to a depth of 75 m to collect water samples for examining DIC away from the atoll. ADCP transects were performed both outbound and inbound to Rose Atoll.

March 14 — Continued operations around Rose Atoll. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites ROS-7, ROS-8, and ROS-9. A second fish REA team aboard HI-2 completed 4 additional fish surveys at sites ROS-61, ROS-62, ROS-63, and ROS-64. The towed-diver team conducted 6 towed-diver surveys around the atoll forereef, in the lagoon, and calibration surveys. The oceanography team recovered the AquaDopp current meter from the entrance channel, recovered 1 STR, and conducted water sampling and profiling at 3 sites for DIC, including water sampling for chlorophyll and nutrients at 2 sites. Three ARMS were deployed around a lagoon pinnacle at ROS-9. Don Palawski conducted bird counts on Rose Island, assessed the status of the island sampling grid system, and monitored the health of Pisonia and coconut trees. Lelei Peau was escorted on a scuba dive to observe the coral reef communities of the SE forereef. A reconnaissance survey was performed in the western backreef of the lagoon. The ship departed Rose Atoll at 1700 to transit to Ta`u Island.

March 15 — Arrived off SW Ta`u Island at 0700. Lelei Peau was escorted on a scuba dive to observe the ancient massive coral colony known as “Big Momma” along Ta`u’s SW forereef. The ship departed Ta`u Island at 1000 to transit to Swains Island.

March 16 — Arrived off Swains Island at 0700. The fish and benthic REA teams aboard HI-1 completed 3 multidisciplinary REA surveys at sites SWA-7, SWA-8, and SWA-6. A second fish REA team aboard HI-2 completed 4 additional fish surveys at sites SWA-50, SWA-51, SWA-52, and SWA-53. The towed-diver team conducted 6 towed-diver surveys circumnavigating the island 1.5 times at average depths of 15–20 m. The oceanography team recovered and redeployed a vertical string of STRs at 28 m, 14 m, and 7 m on the western forereef and deployed an STR at 7 m near SWA-7. Lelei Peau and Don Palawski visited Swains Island and conducted bird surveys. Lelei Peau was escorted on a scuba dive to observe the coral reef

communities of the N forereef. During the initial deepwater CTD cast, one of the ship's generators went down, resulting in the cancelation of oceanographic and mapping operations for the remainder of the night.

March 17 — Continued operations around Swains Island. The fish and benthic REA teams aboard HI-1 completed 1 multidisciplinary REA survey at site SWA-10. A second fish REA team aboard HI-2 completed 1 additional fish survey at site SWA-54. The towed-diver team conducted 3 towed-diver surveys aournd the island. The oceanography team conducted 18 shallow-water CTD casts around the circumference of the island. Lelei Peau was escorted on a scuba dive to observe the coral reef communities of the SE forereef. Morning diving operations were initially delayed due to a passing squall with thunder and lightning. After diving operations commenced, the ship received a safety stand-down from the NOAA Office of Marine and Aviation Operations (OMAO) requiring all diving operations to be aborted. All small boats and personnel were returned to the ship to thoroughly inspect all dive and medical safety equipment and to conduct a series of 4 dive accident management drills for the remainder of the day. ADCP transects and 4 deepwater CTD casts were performed during the night. Multibeam mapping was conducted to fill gaps in benthic mapping coverage.

March 18 — Continued operations around Swains Island. The fish and benthic REA teams aboard HI-1 completed 4 multidisciplinary REA surveys at sites SWA-5, SWA-4, SWA-9, and SWA-16. A second fish REA team aboard HI-2 completed 4 additional fish surveys at sites SWA-55, SWA-56, SWA-57, and SWA-58. The towed-diver team conducted 4 towed-diver surveys around the island. The oceanography team deployed 1 STR at SWA-8 in 14 m of water, conducted 6 CTD casts in the island lagoon, and conducted temperature surveys of the entire northern backreef. Lelei Peau was escorted on 2 scuba dives to observe the coral reef communities of the SW forereef. Operations were completed at 1600, and the ship departed Swains Island to transit to Pago Pago.

March 19 — Continued transiting to Pago Pago. Scientific personnel conducted end-of-cruise debriefings, and a post-cruise meeting was conducted with ship and science team leaders. The ship moored alongside the pier in Tutuila at 1400 to end the cruise. Disembarked Brainard, Peau, Grimshaw, Cooper-Alletto, and Smith. Brainard presented summary of cruise and preliminary results to the American Samoa Coral Reef Advisory Group with representatives from each of the territorial and federal coastal resource management agencies in attendance. The entire scientific party and almost all of the ship's officers and crew participated in a celebratory reception and dinner at the Governor's Mansion hosted by Governor Togiola Tulafono and the First Lady in honor of the success of this collaborative cruise.

Table 1:--Cruise statistics for HI-08-02.

	Totals	Tutuila	Ofu and Olosega	Ta`u	Rose Atoll	Swains Island
Towed-diver habitat/fish surveys	110	45	15	15	22	13
Combined tow lengths (km)	251.82	98.89	35.81	33.94	54.33	28.85
Fish REA surveys	112	44	13	12	27	16
Benthic REA surveys	62	23	10	9	12	8
ARMS deployed	33	9	12		12	
WTR recovered	2	1			1	
WTR deployed	2	1			1	
SST buoys recovered	4	3		1		
SST buoys deployed	6	4		1	1	
EARs recovered	2	2				
EARs deployed	1				1	
STRs recovered	27	8	7	3	6	3
STRs deployed	34	12	7	4	7	4
CREWS buoys recovered	1				1	
CREWS buoys deployed	0					
Deepwater CTD casts (from *Hi`ialakai*)	29	14	7		4	4
Shallow (30-m) CTD casts (from small boats)	186	49	25	38	47	27
Shallow-water sampling profiles	41	13	6	4	13	5
Nutrient water samples collected	165	51	26	36	31	21
Chlorophyll water samples collected	165	51	26	36	31	21
Salinity water samples collected	9				9	
Shallow DIC water samples collected	7				7	
Deep DIC water samples collected	4				4	
ADCP transects (km)	232	112	56		32	32
Multibeam mapping (sq. km.)	506	526	320	320		186
SCUBA dives	1038	391	147	165	218	117

MISSIONS:

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.

B. Deploy and recover an array of CREWS buoys, SST buoys, subsurface WTRs, STRs, and EARs to allow remote long-term monitoring of oceanographic and environmental conditions affecting coral reef ecosystems of American Samoa.

C. Conduct shallow-water CTD casts and water sampling casts to depths of approximately 30 m to examine physical and biological linkages supporting and maintaining these island and atoll ecosystems.

D. Conduct shipboard oceanographic and meteorological observations, using CTD casts deployed to a depth of 500 m; collecting water samples to a depth of 150 m; collecting ADCP data around reef ecosystems; measuring sea surface temperature and salinity; and collecting fundamental meteorological data, such as air temperature, wind speed and direction, barometric pressure, and relative humidity to examine physical and biological linkages supporting and maintaining these island and atoll ecosystems.

E. Conduct 2 separate shipboard water sampling schemes at Rose Atoll: one to a depth of 75 m to examine DIC for the calculation of ocean acidification over reef ecosystems and a second to a depth of 500 m, each with 5 water samples, which will be used to study the chlorophyll and nutrient values of the opean ocean in the vicinity of reefs. Shallow-water sampling from small boats to a depth of approximately 30 m around reef ecosystems will be used to complement both of these open-ocean data sets.

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

G. Host, together with the Fagatele Bay National Marine Sanctuary, 2 days of educational activities aboard ship. Learning activities to include oceanographic sampling and coral reef observations aboard *Hi`ialakai*'s jet-boats, water quality labs based on shallow-water CTD casts, plankton tows with subsequent laboratories using digital microscopes and live-rock laboratories that require identifying invertebrates and quantifying diversity. Additionally, each student will be given an in-depth tour of the ship, including a fire-fighting demonstration and review of recompression chamber operations, ship-handling and bridge familiarity, and onboard medical facilities.

H. Conduct terrestrial surveys of seabirds and vegetation on Rose Atoll by U.S. Fish and Wildlife Service representative.

I. Escort American Samoa Governor Togiola Tulafono and Deputy Director of the American Samoa Department of Commerce Lelei Peau to Rose Atoll and Swains Island.

RESULTS:

See Appendices B–F.

SCIENTIFIC PERSONNEL:

Scott Ferguson, Chief Scientist (Leg 1), Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), Coral Reef Ecosystems Division (CRED)
Russell E. Brainard, Ph.D., Chief Scientist (Leg 2), PIFSC, NMFS, CRED
Marc Nadon, Fish Team, Joint Institute for Marine and Atmospheric Research (JIMAR), University of Hawaii (UH), CRED
Paul Brown, Fish Team, National Park of American Samoa
Kevin O'Brien, Fish Team—Benthic, JIMAR, UH, CRED
Paula Ayotte, Fish Team, JIMAR, UH, CRED
Jason Helyer, Benthic Team—Coral Populations, JIMAR, UH, CRED
Jean Kenyon, PhD, Benthic Team—Coral Disease, JIMAR, UH, CRED
Molly Timmers, Benthic Team—Invertebrates (leg 1), JIMAR, UH, CRED
Noah Pomeroy, Benthic Team—Invertebrates/ARMS (Leg 1), Oceanography Team (Leg 2), PIFSC, NMFS, CRED
Suzy Cooper-Alletto, Algae Team, JIMAR, UH, CRED
Sarah Myhre, Algae Team, JIMAR, UH, CRED
Stephane Charette, Towed-diver Team—Fish, JIMAR, UH, CRED
Kevin Lino, Towed-diver Team—Fish, JIMAR, UH, CRED
Benjamin Richards, Towed-diver Team—Fish alternate (Leg 2), JIMAR, UH, CRED
Edmund Coccagna, Towed-diver Team—Benthic, JIMAR, UH, CRED
Jacob Asher, Towed-diver Team—Benthic, JIMAR, UH, CRED
Oliver Vetter, Oceanography Team (Leg 1), JIMAR, UH, CRED
Frank Mancini, Oceanography Team (Leg 1), JIMAR, UH, CRED
Ellen Smith, Oceanography Team, JIMAR, UH, CRED
Daniel Merritt, Oceanography Team, JIMAR, UH, CRED
Kerry Grimshaw, Rotating Diver (Leg 1), Oceanography Team (Leg 2), JIMAR, UH, CRED
Jamie Carter, Data Management (Leg 1), Perot Systems Government Services, National Ocean Service-Pacific Services Center
Russell Moffitt, Data Management (Leg 2), Benthic Team—Invertebrates/ARMS, JIMAR, UH, CRED
Don Palawski, Terrestrial Team, U.S. Fish and Wildlife Service (USFWS)
Governor Togiola Tulafono, American Samoa Governor
Lelei Peau, Deputy Director, American Samoa Department of Commerce
Lee Vaouli, Security, American Samoa Governor's Office

EDUCATIONAL PERSONNEL:

Alastair Hebard, Hawaiian Islands Humpback Whale NMS
David Nichols, Hawaiian Islands Humpback Whale NMS
Suzy Cooper-Alletto, Algae Team, JIMAR, UH, CRED

DATA COLLECTED:

Digital images from algal photoquadrats
Algal voucher specimens necessary for algal species identification
Algal field notes of species diversity and relative abundance
Video transects of benthos and overall site character at each site
Number of coral colonies, by species, within belt transects of known area, and overall coral colony density at each site
Qualitative assessment, using a Dominant, Abundant, Common, Occassional, Rare (DACOR) code, of coral species' relative abundance at each site
Size-class distributions of corals (by species and overall) at each site
Digital images of diseased coral
Field notes on signs of coral bleaching or disease
Samples of diseased coral for histopathological analysis
Digital still photos of overall site character and typical benthos at each site
Transect surveys of all fish ≥ 2 cm in 600 m^2; ID to species and size estimates
Stationary point count surveys of fish ≥ 25 cm; ID to species and size estimates
Fish species presence checklists for community diversity estimates at each site
Digital images of rare or interesting fish species
Digital images of the benthic habitat from towboard surveys
Macroinvertebrate counts from towed-diver surveys
Quantitative surveys of reef fishes (> 50 cm total length [TL]) to species level from towed-diver surveys
Habitat lineation from towed-diver surveys
Benthic composition estimations from towed-diver surveys
CTD profiles to 500 m
Water samples to 500 m: Chlorophyll and Nutrient, 5 depths per cast
Water samples to 75 m: DIC and salinity, 2 depths per cast
CTD casts: 30 m
Shallow-water samples (30 m): Chlorophyll and Nutrient, 4 depths per cast
Shallow-water samples (30 m): DIC and salinity, 2 depths per cast
Environmental acoustics of reefs, marine mammals and boat traffic
Sea surface and subsurface temperature at varied depths
Sea surface and subsurface salinity at variable depths
Spectral wave energy and tidal elevation
Directional ocean currents
Solar radiation, air temperature, wind speed and direction, turbidity, and photosynethtically active radiation
ADCP transects

Submitted by:

Scott Ferguson
Chief Scientist, Leg 1

Russell E. Brainard, Ph.D.
Chief Scientist, Leg 2

Approved by:

Kacky Andrews
Program Manager
NOAA Coral Reef Conservation Program

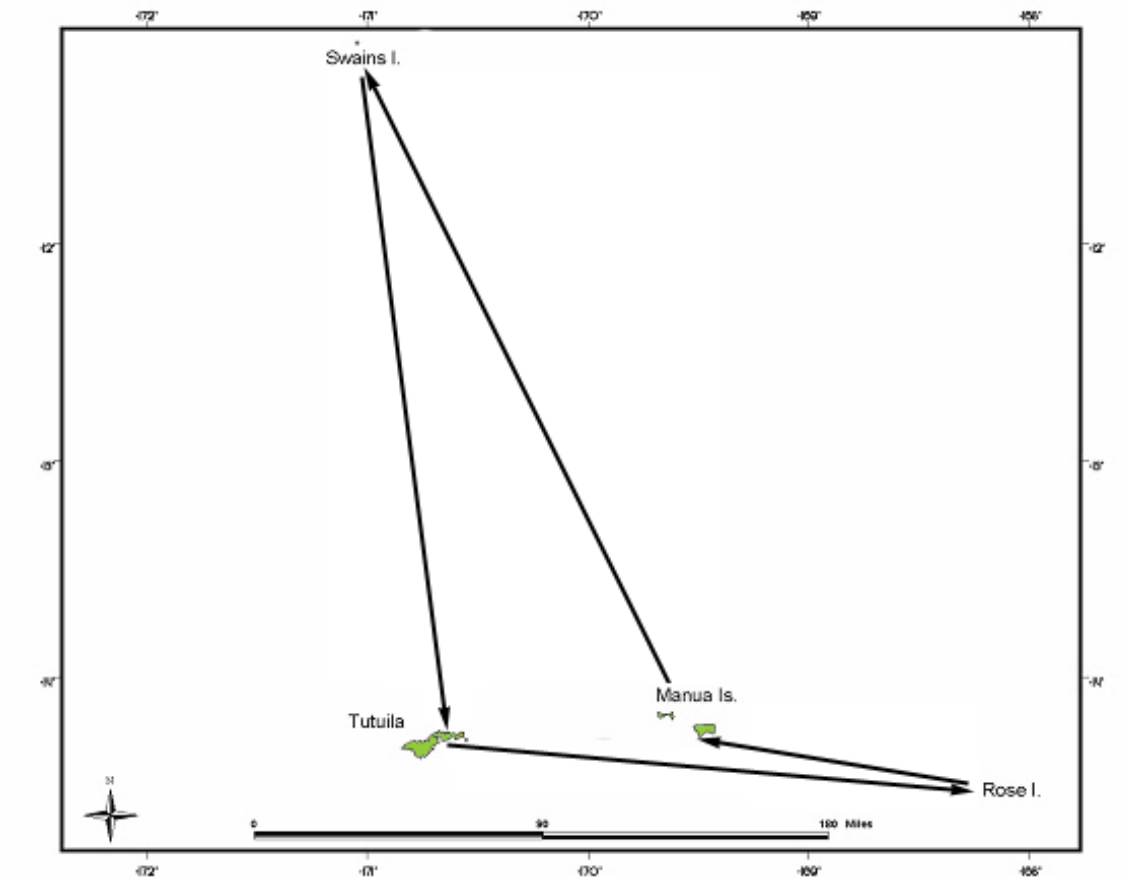


Figure 1:--Track of the *Hi`ialakai* HI-08-02, 18 February–19 March 2008.

Appendix A: Methods

A.1. Oceanography and Water Quality Methods
(Oliver J. Vetter, Frank Mancini, Daniel Merritt, and Ellen Smith)

The Coral Reef Ecosystem Division (CRED) has been conducting interdisciplinary research throughout the nearshore waters of American Samoa since 2002. 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 ongoing monitoring and assessment of the waters of American Samoa. During the HI-08-02 cruise, the oceanography team utilized both established and new methods to monitor long-term trends and assess oceanographic conditions that influence the conditions of the coral reef ecosystems.

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, including those instruments listed below:

- Sea surface temperature (SST) buoys: Measure and internally record high-resolution surface water temperature, and telemeter a subset of collected data in near real time.
- Wave-and-tide recorders (WTR): Measure surface gravity waves, tides, and subsurface water temperature.
- Subsurface temperature recorders (STR): Measure high-resolution subsurface water temperature.
- Ecological acoustic recorders (EAR): Record ambient subsurface biotic and abiotic sounds.

Detailed in situ oceanographic and water quality surveys were accomplished with the following sampling techniques:

- Shallow-water conductivity, temperature, and depth (CTD) casts (max depth 30 m) were conducted from small boats at regularly spaced intervals along the 30-m isobath around each island/atoll/shoal with an SBE 19*plus* Seacat Profiler (Sea-Bird Electronics Inc.), a conductivity, temperature, and depth recorder, and a C-Star (WET Labs Inc.) auxiliary transmissometer. Shallow vertical water profiles provide insight into local water property variation and water mass interactions. In addition to the standard set of shallow-water water quality sampling, a set of 1 surface and 3 near-bottom (< 200 cm) carbonate chemistry (alkalinity and total dissolved inorganic carbon) water samples were hand collected from across a range of geomorphological reef zones, benthic habitat types, and depths. An SBE 19*plus* with an SBE 43 dissolved oxygen sensor was deployed concurrently with the carbonate chemistry collections, and salinity samples were regularly collected to aid in the calibration of the SBE 19*plus*. All carbonate chemistry samples were immediately treated with saturated mercuric chloride and sealed in 500-cm^3 high-quality borosilicate glass bottles equipped with positive closure according to the protocols of Dickson et al. (2007) and will be shipped to NOAA's Pacific Marine Environmenal Laboratory (PMEL) for post-cruise analysis.

- Shipboard deepwater CTD casts were conducted from the NOAA Ship *Hi`ialakai* with an SBE 911*plus* CTD with an auxiliary SBE 43 dissolved oxygen sensor and an *ECO* FLNTU (WET Labs Inc.) combination fluoresence and turbidity sensor. Shipboard CTD casts to 500 m, complemented by water samples collected at 3-, 80-, 100-, 125- and 150-m depths for nutrient and chlorophyll analysis were conducted at regularly spaced intervals around each island/atoll/shoal and other permanent stations. Additionally, shipboard CTD casts to a 75-m depth, complemented by water samples collected at 2- and 75-m depths, were conducted at select locations for dissolved inorganic carbon and total alkalinity analysis.
- Surface and subsurface water temperatures as a function of depth were continuously recorded during all towed-diver operations, providing a broad and diverse spatial and thermal sampling method. For site and isobath information, refer to the activity summaries for the towed-diver habitat/fish survey team, which are provided in each of the 5 island-area appendices. These data are part of the towed-diver team ArcView (ESRI) project.
- Shipboard meterological observations included wind speed and direction, relative humidity, air temperature, and barometric pressure.

Shipboard oceanographic measurements of sea surface temperature and salinity were collected with a flow-through SBE 37 MicroCAT thermosalinograph, and upper ocean currents were collected using a hull-mounted RD Instruments 75 kHz Ocean Surveyor acoustic Doppler current profiler (ADCP).

A.2. Rapid Ecological Assessment (REA) Methods

(Fish: Marc Nadon, Paula Ayotte, Kevin O'Brien, and Paul Brown; Corals: Jason Helyer, Jean Kenyon [Leg 1], and Bernardo Vargas-Ángel [Leg 2] ; Algae: Suzy Cooper Alletto and Sarah Myhre; Invertebrates: Molly Timmers and Noah Pomeroy [Leg 1], Russell Moffitt, and Rusty Brainard Lleg 2])

The survey methodologies for benthic observations used during HI-08-02 were the same as previously used during Rapid Ecological Assessment (REA) surveys conducted in 2004 and 2006. At each REA site, two 25-m transect lines were laid out, separated from each other by approximately 2–3 m. At most sites, transects were laid out at depths between 3 and 15 m. The survey methodologies for fish observations changed slightly between the 2004 and 2006 surveys and are discussed below. The REA methods for each specific discipline are detailed below.

A.2.1. Algae

Standardized quantitative sampling methods for remote tropical Pacific islands were developed and published for marine algae (Preskitt et al., 2004). To allow for vertical sampling in areas of high relief (walls), the method was modified slightly by Vroom et al. (2005) and entails photographing quadrats, collecting algal voucher specimens, creating in situ algal species lists, and ranking relative algal abundance. This modified "Preskitt method" has been used by CRED since 2003 in the Northwestern Hawaiian Islands, Guam/Mariana Islands, Pacific Remote Island Areas, and American Samoa.

Macroalgae were tentatively 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). A total of 6 quadrats were located at random points along the first 2 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) for microscopic analysis and species verification. 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, algae that fell within the functional groups of turf, cyanophytes, branching 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.2.2. Corals

To investigate the population dynamics and relative health states of the coral and benthic communities in American Samoa, 3 complimentary survey techniques were employed: coral population surveys, coral health and disease assessments, and benthic cover estimates using the line-point intercept method. All 3 methods were conducted along two 25-m transects at each site.

A.2.2.1. Coral Population Survey

Information on coral population structure was collected along two 25-m transects using a belt survey method in which each coral colony whose center fell within 0.5 m of either side of the transect line was identified to genus/species and assigned to a coral size class (10-cm bins with the exception of the 0–5-cm and 6–10-cm size classes) based upon the estimated length of each coral's maximum diameter. Coral population data will be used to estimate population size classes, mean diameter, density, diversity, and relative abundances of the coral species/genera recorded.

A.2.2.2. Coral Health and Disease Assessment

Health and disease surveys were used to quantitatively assess, evaluate, and monitor the health condition of coral colonies. Coral disease surveys consisted of documenting the presence of disease within 1–3 m on each side of the transect lines (~ 300–500 m^2). Within the survey belt, each diseased coral colony was identified to the lowest taxonomic level possible and the following information recorded: (1) colony size; (2) type of affliction, including but not limited to bleaching (BLE), acute tissue loss or white syndrome (WSY), subacute tissue loss (TLS), skeletal growth anomalies (SGA), Hyperpigmented irritations/responses (HYP), discolorations other than bleaching (DIS), algal infections (ALG), cyanobacterial infections (CYA), other unidentified diseases and syndromes (OTH); (3) percent live/dead; (4) severity of the affliction (mild: 1–10%, moderate: 10–25%, marked: 25–50%, severe: 50–75%, acute: 75–100%); (5) photographic records; and (6) tissue samples for histopathological analyses. In addition, samples and photographs will be used to aid in further disease characterization. Disease data will be used to estimate disease incidence and prevalence.

A.2.2.3. Line-Point Intercept Method

In addition, percent cover of the benthic substrate was quantified using the line-point intercept (LPI) method. For each 25-m transect, the benthic element falling directly underneath each 50-cm mark on the transect line was recorded using the following scheme: live coral, recently dead coral, carbonate pavement, coral rubble, sand, rock, turfalgae, macroalgae, crustose coralline algae, invertebrate, and other. Live benthic elements, including coral, algae, and invertebrates, were identified to the lowest taxonomic level possible. These data provide the basis for calculating quantitative estimates of live coral cover, as well as percent cover of the other benthic elements.

A.2.3. Fish

The fish team, composed of 4 divers, conducted 2 types of surveys at preselected sites: belt transect and new stationary point count. Two separate teams were deployed to perform the surveys; each team consisted of 2 divers conducting 2 new stationary point counts and 2 belt-transect surveys, conditions permitting. The first team accompanied the benthic REA team and surveyed previously visited monitoring sites, while the second team deployed on a separate boat and surveyed new, randomly chosen sites. Both teams performed surveys using a 30-m transect line set along a single depth contour. As the line was set, 2 observers swam along either side of the line, identifying, counting, and sizing all fishes > 20 cm in total length (TL) within an area 25 m long and 4 m wide. Afterwards, the divers returned along their respective sides of the line identifying, counting, and sizing all fishes $\leq$ 20 cm TL in a belt 25 m long by 2 m wide.

Once their belt transect was completed, divers moved to the 7.5-m and 22.5-m marks on the transect line to start the stationary point counts (7.5-m radius). During the first 5 min of the new stationary point counts, divers only recorded the presence of species within their survey areas. Afterwards, the divers proceeded down their respective species list, sizing and counting all individuals within the 7.5-m radius of their cylinder, one species at a time. Individuals from a single species were only recorded once. Cryptic species missed during the initial 5-min survey could still be added to the list. Once this procedure was completed, the transect line was moved to another nearby location and the procedure was repeated, with the new stationary point counts conducted first and followed by the belt-transect surveys.

Fishes observed off transect or after the initial 5 min of the new stationary point counts were recorded for presence data. No collections were made by the fish team during this survey period.

A.2.4. Macroinvertebrates

Quantitative counts and percent cover for specific target marine invertebrates were done along 2 separate belt transects (1 × 25 m) at 5-m intervals. Size frequency distribution of urchin species were recorded for the first 25 individuals of each species. Based on data from previous REA surveys, 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 South Pacific, and they are species that are generally visible (i.e., non-cryptic) and easily enumerated during the course of a single 50–60-min dive.

The target species are listed below:

CNIDARIA
Octocorals—soft corals (*Sinularia, Cladiella, Lobophyton, Sarcophyton,* etc.)
Zoanthids—rubber corals
Actiniaria—Anemones (*Heteractis, Stichodactyla, Phymanthus,* etc.)

ECHINODERMS
Echinoids—sea urchins
Holothuroids—sea cucumbers
Asteroids—sea stars

MOLLUSCA
Bivalves—spondylid oysters, pearl oysters, tridacnid clams (Giant Clams)
Large Gastropods—*Charonia* (Triton's Trumpet) and *Lambis* sp. (Spider Conch)
Coralliophilidae gastropods
Cephalopods—octopus

CRUSTACEA
Hermit crabs, lobsters, large crabs

Specific in situ methods for each transect:
Conduct enumerations at 5-m intervals along the transect line (1 × 25 m):

- Count all species of urchins. Also record test diameter for the first 25 of all species present
- Presence/Absence (P/A) for octocorals (*Carijoa, Sarcophyton, Lobophyton, Cladiella*), zoanthids, colonial anemones
- Count Cnidarians = Anemones (> 7-cm diameter), sea fans
- Count Holothuroids = all visible species
- Count Asteroids = all visible species
- Count Molluscs = Bivalves (*Pinctada, Tridacna*), large gastropods (*Charonia, Lambis*), Coralliophilid gastropods
- Count Crustacea = Large hermit crabs (e.g., *Dardanus* sp. and *Aniculus maximus*), large brachyuran (*Carpilius, Etisus, Dromia*), spiny and slipper lobster, Trapezid crabs, and small hermit crabs

In addition, autonomous reef monitoring structures (ARMS) were deployed at representative forereef habitats and one lagoonal habitat. ARMS provide a mechanism to quantify indices of marine invertebrate diversity composed primarily of cryptic species that are not easy to identify or account for during REA surveys. The ARMS will remain deployed on the benthos for 2 years enabling the recruitment and colonization of lesser known, cryptic marine invertebrates.

A.3. Towed-diver Survey Methods

(Stephane Charette, Jason Helyer, Benjamin Richards, and Jacob Asher)

The fish towboard, outfitted with a forward-looking digital video camera, recorded fish distribution and habitat complexity. The diver on this board recorded fishes larger than 50 cm TL along a 10-m swath during a 50-min survey. The downward looking benthic towboard, affixed with a high-resolution digital camera with dual strobes, photographed the benthic substrate every 15 sec. The diver on this board subjectively estimated mean substrate percentage cover every 5 min, recorded habitat type and complexity, and tallied the quantity of conspicuous targeted macroinvertebrates (crown-of-thorns seastars, urchins, giant clams, and sea cucumbers). Each towboard was equipped with an SBE 39 temperature and pressure recorder, which recorded temperature and depth at 5-s intervals along the tow track. A Garmin GPSMap 76 global positioning system was used to record position at 5-sec intervals along each tow track to georeference collected data.

Towed-diver surveys were conducted across multiple habitats, including the forereef, backreef, lagoon, and insular shelf.

A.4. Terrestrial Ecosystem Surveys

(Don Palawski, USFWS Refuge Manager; Governor Togiola Tulafono, American Samoa; and Lelei Peau, Deputy Director of American Samoa Department of Commerce)

Objectives

1. Provide on-site briefing to the Governor and Deputy Director regarding the natural resources and U.S. Fish and Wildlife Service management of Rose Atoll National Wildlife Refuge;
2. Reposition historic U.S. Navy survey monument;
3. Assess the condition of sampling grid markers on Rose Island;
4. Assess the condition of Pisonia trees;
5. Assess the status of the mature coconut trees;
6. Determine turtle activity on Rose Island;
7. Identify seabird species present and their breeding status.

Biological Survey Methods

The short duration of visits to Rose Island (total = 15 hours) made complete counts of most bird species impossible. The team instead recorded the stage of active seabird nests. All shorebirds seen during the circumnavigation of the island were counted. Not all of the areas of the island were surveyed, given the high nesting density of sooty terns, brown noddies, and red-footed boobies and the desire to avoid unnecessary disturbance to these species. The team specifically assessed the status of the coconut groves and Pisonia trees. The team also took digital photographs of birds, plants, and habitats.

A.5. References

Dickson AG, Sabine CL, Christian JR (eds, 2007) Guide to best practices for ocean CO_2 measurements. PICES Special Publication 3, 191 pp.

Preskitt LB, Vroom PS, Smith CM (2004) A rapid ecological assessment (REA) quantitative survey method for benthic algae using photo quadrats with SCUBA. Pac Sci 58:201–109.

Vroom PS, Page KN, Peyton KA, Kukea-Shultz JK (2005) Spatial heterogeneity of benthic community assemblages with an emphasis on reef algae at French Frigate Shoals, Norhtwestern Hawaiian Islands. Coral Reefs 24:574–581.

Appendix B: Tutuila and Aunu`u

B.1. Oceanography and Water Quality

Moorings

A total of 7 subsurface temperature recorders (STRs) were recovered, and 12 STRs were deployed around Tutuila and Aunu`u Islands during the HI-08-02 American Samoa Reef Assessment and Monitoring Program (ASRAMP) cruise (Fig. B.1.1 and Table B.1.1). New STRs were deployed at depths of ~ 30 m on the north side and the southwest side of Tutuila to study temperature fluctuations in water slightly deeper than previously studied water. Additional STRs were deployed at the 2 existing ecological acoustic recorder (EAR) sites on the north shore of Tutuila, and a shallow-water (~ 5 m) STR was deployed within Fagatele Bay National Marine Sanctuary. One STR was removed from Fagatele Bay because it was deemed redundant. STRs were also deployed on the anchors of each of the sea surface temperature (SST) buoys.

Three SST buoys and anchors were recovered and replaced. The SST buoy deployed in Fagatele Bay in 2006 had broken free from its mooring at some point and was replaced with a new unit during this cruise. The Fagatele Bay SST buoy that broke free was retrieved from the National Park of American Samoa (NPAS) personnel while in port at Pago Pago Harbor.

Two EAR units were recovered on the north shore of Tutuila and new lead anchors were deployed in place of older and lighter concrete anchors. These 2 EAR units will be returned to Honolulu for refurbishment and sent to Paul Brown at the NPAS for redeployment at a later date. The EAR unit deployed in Fagatele Bay was also moved to a lead anchor, and the final EAR deployed in Alega Bay on the south shore of Tutuila was inspected and found to be in good condition.

One wave-and-tide recorder (WTR) was recovered and replaced on the original anchor just southeast of Fagatele Bay off Steps Point.

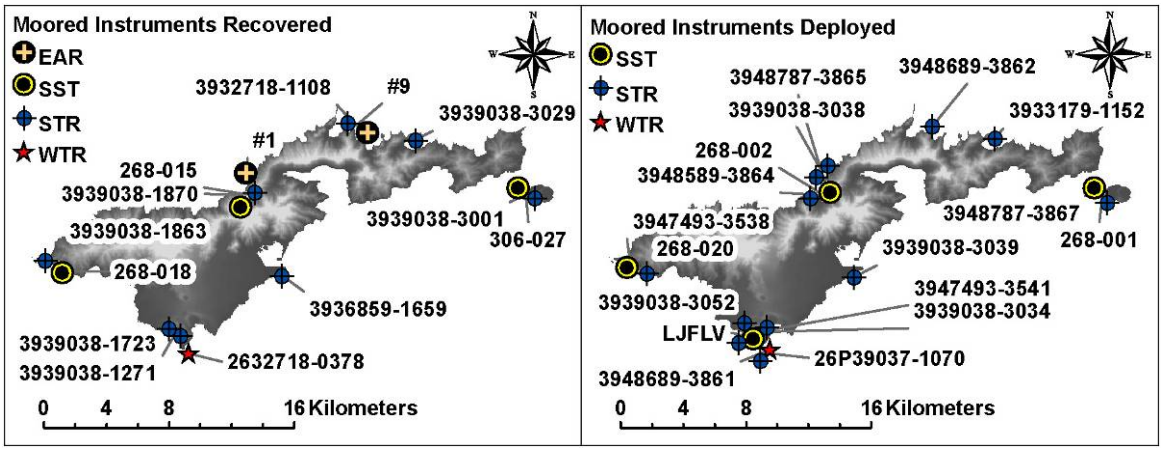


Figure B.1.1.--Moored oceanographic instrumentation map for Tutuila Island.

Global postioning system (GPS) coordinates; date and time, using the Coordinated Universal Time (UTC) standard; and depth, recorded in feet (ft), were collected at 135 points around Tutuila to test Ikonos derived bathymetry as well as serve as seed data for areas for which there were no derived depth estimates due to cloud masking. Sixteen terrain "features of interest" that were apparent in the derived bathymetry were also inspected and photodocumented.

Table B.1.1.--Moored oceanographic instrumentation table for Tutuila and Aunu`u Islands. For instruments recovered and deployed around Tutuila during the HI-08-02 ASRAMP cruise, this table provides instrument type, serial number, sensor depth, and data start and end dates (UTC).

Instrument	Serial Number	Latitude	Longitude	Depth (m)	Data Start	Data End
SST	306-027	14 17.0210 S	170 33.7350 W	0.00	2/18/06 21:20	2/23/08 21:10
STR	3939038-3029	14 15.1137 S	170 37.4248 W	6.10	INSTRUMENT FAILED	
SST	268-015	14 17.0620 S	170 43.3480 W	0.00	2/20/06 22:30	2/19/08 23:50
STR	3939038-1870	14 17.0620 S	170 43.3480 W	8.23	2/20/06 23:00	2/19/08 23:30
SST	268-018	14 19.7000 S	170 50.0110 W	0.00	2/21/06 0:50	2/21/08 22:00
STR	3939038-1863	14 19.7000 S	170 50.0110 W	28.04	2/22/06 0:30	2/20/08 23:30
WTR	2632718-0378	14 22.5024 S	170 45.4941 W	21.34	AWAITING DOWNLOAD	
STR	3939038-3001	14 17.0210 S	170 33.7350 W	8.84	INSTRUMENT FAILED	
STR	3936859-1659	14 19.8291 S	170 42.1547 W	1.22	2/24/06 2:00	11/5/07 9:30
STR	3939038-1271	14 21.8114 S	170 45.8175 W	21.34	2/24/06 23:00	6/7/07 17:30
STR	3939038-1723	14 21.8085 S	170 45.7857 W	13.41	2/26/06 0:30	7/9/07 17:30
EAR	#1	14 16.2930 S	170 43.4087 W	17.68	AWAITING DOWNLOAD	
STR	3932718-1108	14 14.6887 S	170 39.6063 W	13.41	4/13/07 12:30	2/18/08 10:00
EAR	#9	14 14.6887 S	170 39.6063 W	13.41	AWAITING DOWNLOAD	
STR	3933179-1152	14 15.1137 S	170 37.4248 W	6.10	LOGGING DATA	
STR	3948689-3862	14 14.6887 S	170 39.6063 W	13.41	LOGGING DATA	
STR	3939038-3038	14 16.2930 S	170 43.4087 W	17.68	LOGGING DATA	
SST	268-002	14 17.0743 S	170 43.3596 W	0.00	LOGGING DATA	
STR	3948589-3864	14 17.0743 S	170 43.3596 W	14.33	LOGGING DATA	
STR	3948787-3865	14 16.2880 S	170 43.4260 W	30.48	LOGGING DATA	
SST	268-020	14 19.7000 S	170 50.0110 W	0.00	LOGGING DATA	
STR	3947493-3538	14 19.7000 S	170 50.0110 W	27.74	LOGGING DATA	
WTR	26P39037-1070	14 22.5024 S	170 45.4941 W	21.34	LOGGING DATA	
STR	3948689-3861	14 22.4970 S	170 45.4820 W	30.78	LOGGING DATA	
STR	3948787-3867	14 17.0210 S	170 33.7350 W	8.84	LOGGING DATA	
SST	268-001	14 17.0210 S	170 33.7350 W	0.00	LOGGING DATA	
SST	LJFLV	14 22.0021 S	170 45.8033 W	0.00	LOGGING DATA	
STR	3939038-3052	14 22.0021 S	170 45.8033 W	21.03	LOGGING DATA	
STR	3947493-3541	14 21.8085 S	170 45.7857 W	13.41	LOGGING DATA	
STR	3939038-3034	14 21.7881 S	170 45.7845 W	5.18	LOGGING DATA	
STR	3939038-3039	14 19.8246 S	170 42.1585 W	2.13	LOGGING DATA	

Preliminary Moorings Results

Temperature data were recovered from 8 locations around Tutuila: 5 STRs and 3 SST buoys (Figs. B.1.2 and B.1.3). A total of 7 temperature sensors were recovered, 2 of which yielded no data. STR No. 1659 was found buried under the sand in approximately 1 m of water on the south side of Tutuila; however, it appears to have had no significant effect on this time series. The large diurnal fluctuations in this time series reflect the effects of heating and cooling in very shallow water. Since February 2006, subsurface and surface water temperatures around Tutuila have fluctuated seasonally with lows (~ 26°C) occuring July–October and highs (~ 31°C) occuring January–April. The Coral Reef Ecosystem Division (CRED) SST buoys and shallow STRs show diurnal variability, with warming during the day and cooling at night, as expected. Surface temperature in Fagasa Bay on the north shore of the island (SST buoy No. 268-015) showed the largest daily fluctuations in surface temperature, reaching up to 4°C, while surface

waters at Amanave Bay on the southwest side of the island (SST buoy No. 268-018) fluctuated the least (< 1°C).

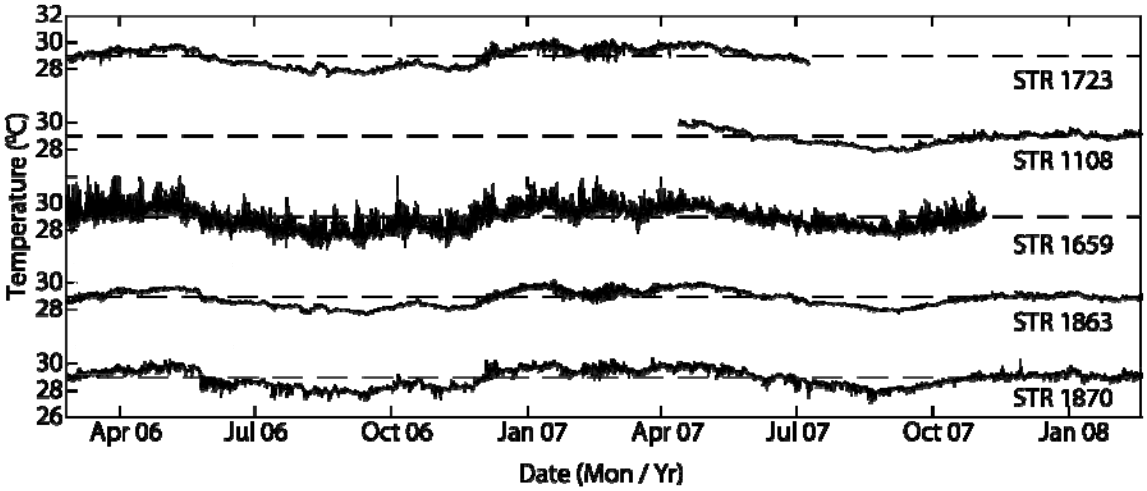


Figure B.1.2.--Temperature data obtained from 5 STR sites around Tutuila.

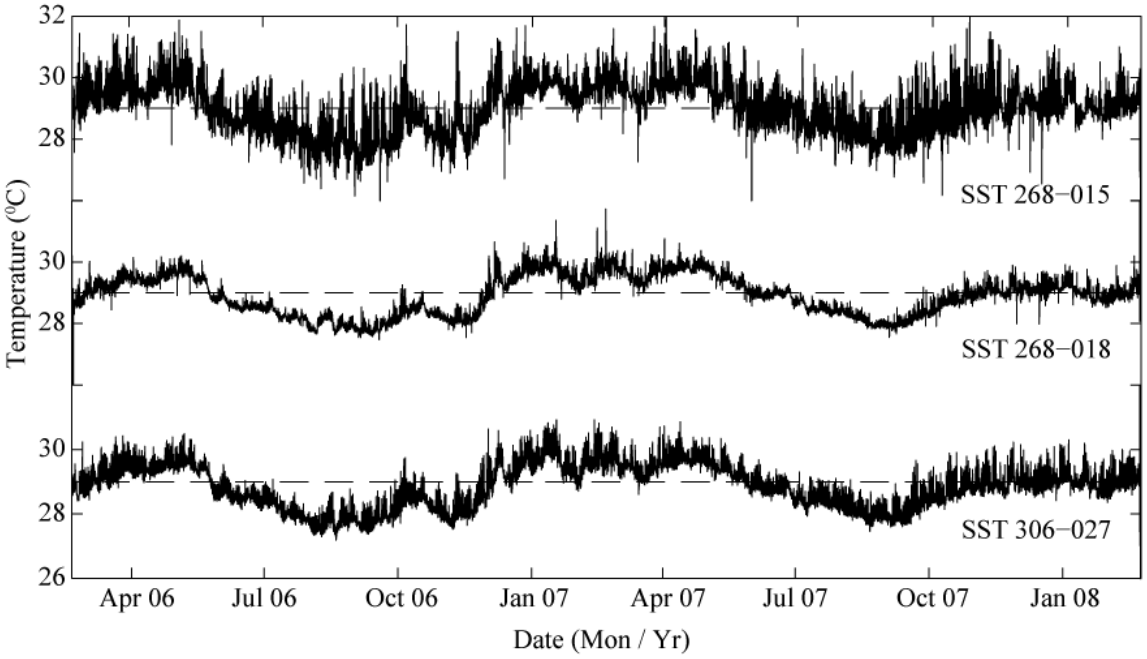


Figure B.1.3.--Temperature data obtained from 3 SST buoys around Tutuila.

Water Quality

Along the 30-m isobath around Tutuila and Aunu`u Islands, 49 shallow-water conductivity, temperature, and depth (CTD) casts were conducted. Casts were performed during daytime hours over 5 consecutive days as noted below (Fig. B.1.4).

Day 1: TUT-01–TUT-07
Day 2: TUT-08–TUT-13
Day 3: TUT-14–TUT-26

Day 4: TUT-27–TUT-44
Day 5: TUT-45–TUT-49

Discrete water samples from a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m were collected concurrently with shallow-water CTD casts at 12 of the CTD sites, yielding a total of 51 chlorophyll-*a* and 51 nutrient samples.

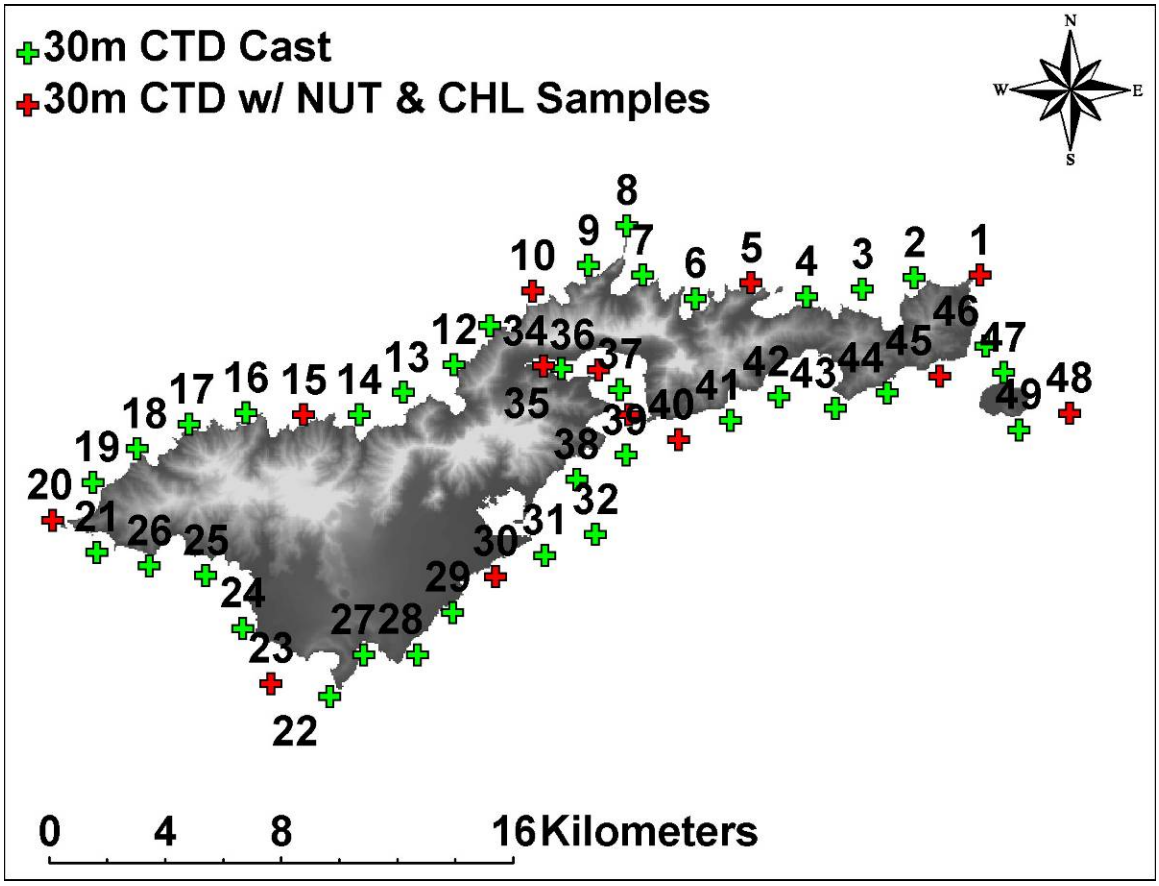


Figure B.1.4.--Shallow-water CTD casts and water sampling sites around Tutuila, labeled by cast number.

Around Tutuila, 14 shipboard CTD casts were conducted (Fig. B.1.5). All casts were made to a depth of 500 m during nighttime hours and all except cast TUT-14 had associated water samples collected at depths of 3 m, 80 m, 100 m, 125 m, and 150 m for nutrient and chlorophyll-*a* (Chl-*a*) analyses. Nutrient and Chl-*a* samples were processed and stored according to protocols provided by Pacific Marine Environmental Laboratory (PMEL) scientists. Samples were sent to PMEL and the University of Hawai`i when the cruise returned.

Day 1: TUT-01–TUT-04
Day 2: TUT-05–TUT-06
Day 3: TUT-07–TUT-12
Day 4: TUT-13
Day 10: TUT-14

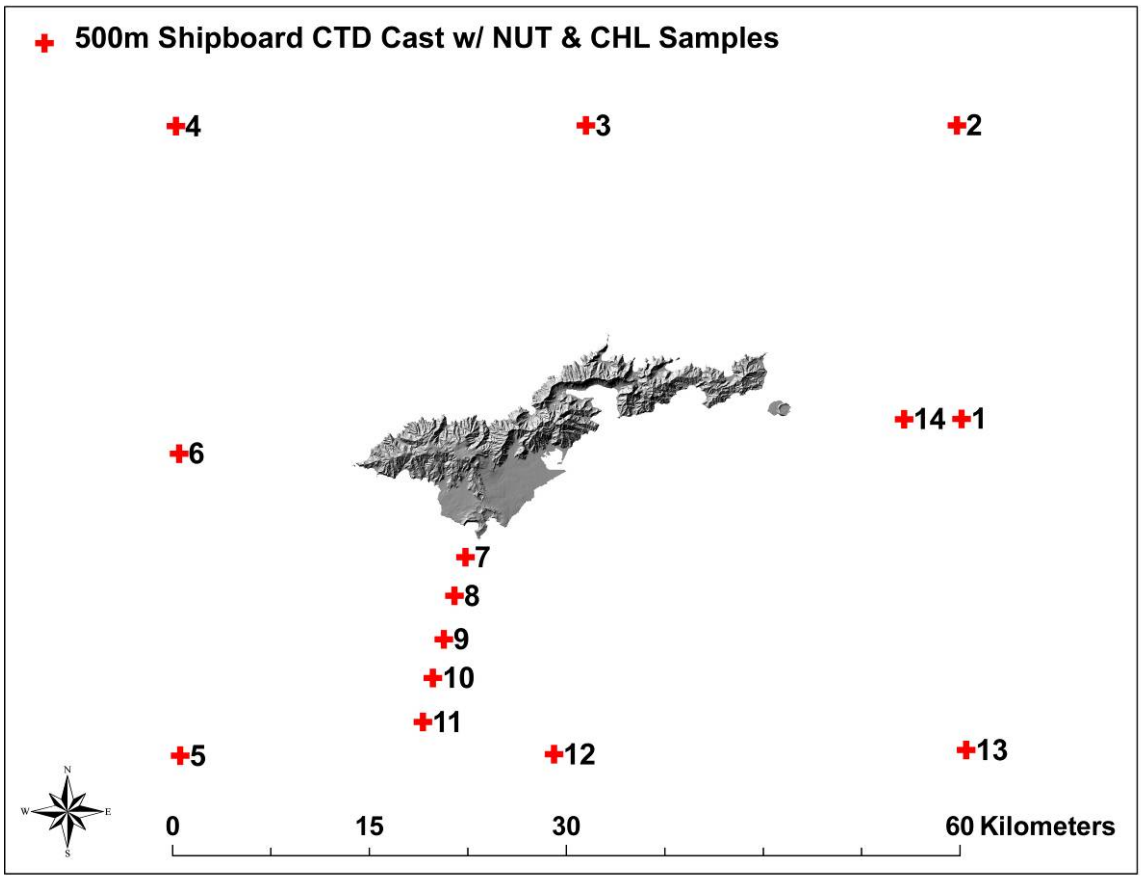


Figure B.1.5.--Shipboard CTD, nutrient, and Chl-*a* operations. Deepwater shipboard CTD, nutrient, and Chl-*a* sites near Tutuila during the HI-08-02 cruise, labeled by cast number.

Preliminary Water Quality Results

Temperature, salinity, density, and beam transmittance throughout the 30-m water column were relatively vertically homogeneous around Tutuila (Figs. B.1.6 and B.1.7). The northeast coast (casts 1-6) had the warmest water (29.6 °C) in the upper 20 m of the water column. The coolest water (28.6 °C) was measured below 20 m on the east side and around Aunu`u Island; these regions (1–45) were exposed to trade winds making the coolness of this deep water (20–30 m) attributable most likely to wind-driven vertical mixing. The southeast facing regions (casts 22-45) showed little variability in the parameters measured, except for beam transmission, which varied spatially. The west side, often in the lee of the major surface currents and wind-driven seas, showed the least vertical variability in hydrographic properties and displayed relatively warmer temperatures, lower salinity and density values, and higher beam transmittance than did other regions of the island.

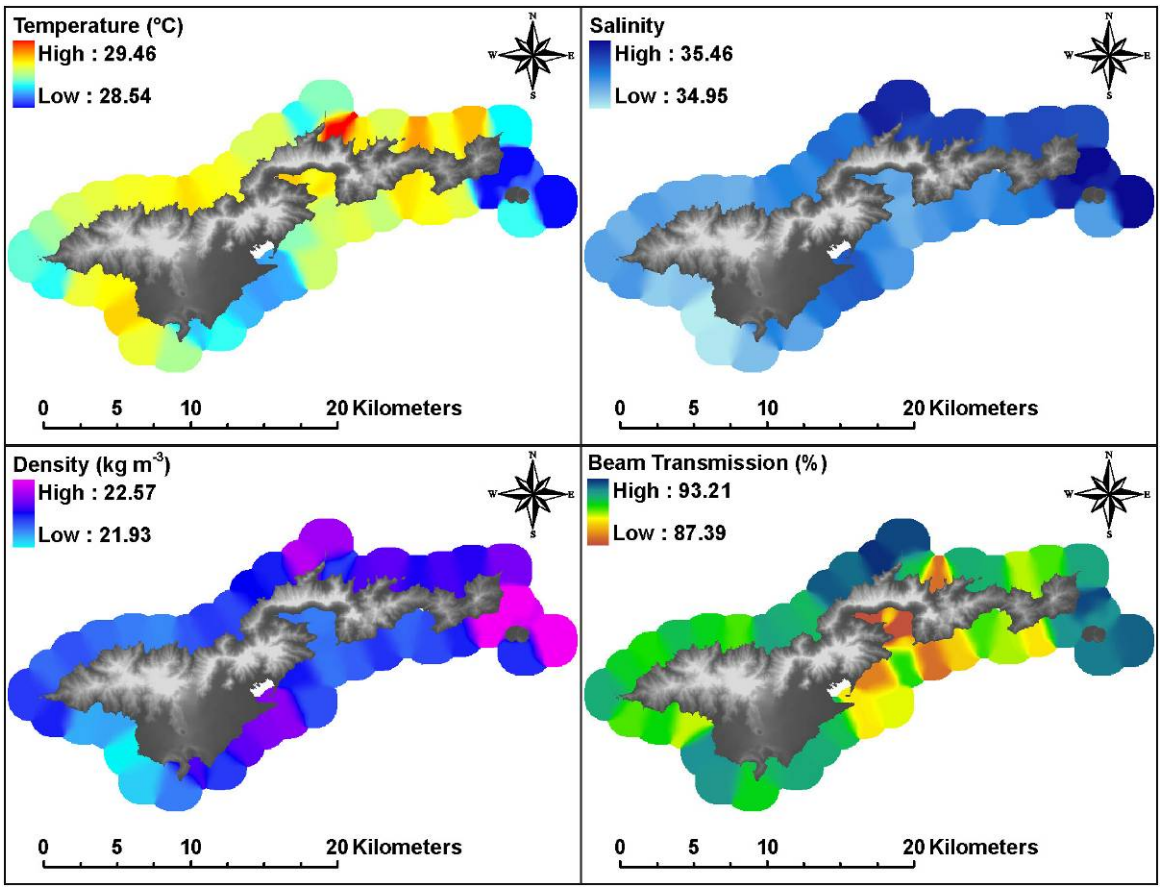


Figure B.1.6.--Interpolated shallow-water CTD cast data at a depth of 20 m around Tutuila during the HI-08-02 cruise: temperature (upper left), salinity (upper right), density (bottom left), and beam transmission (bottom right).

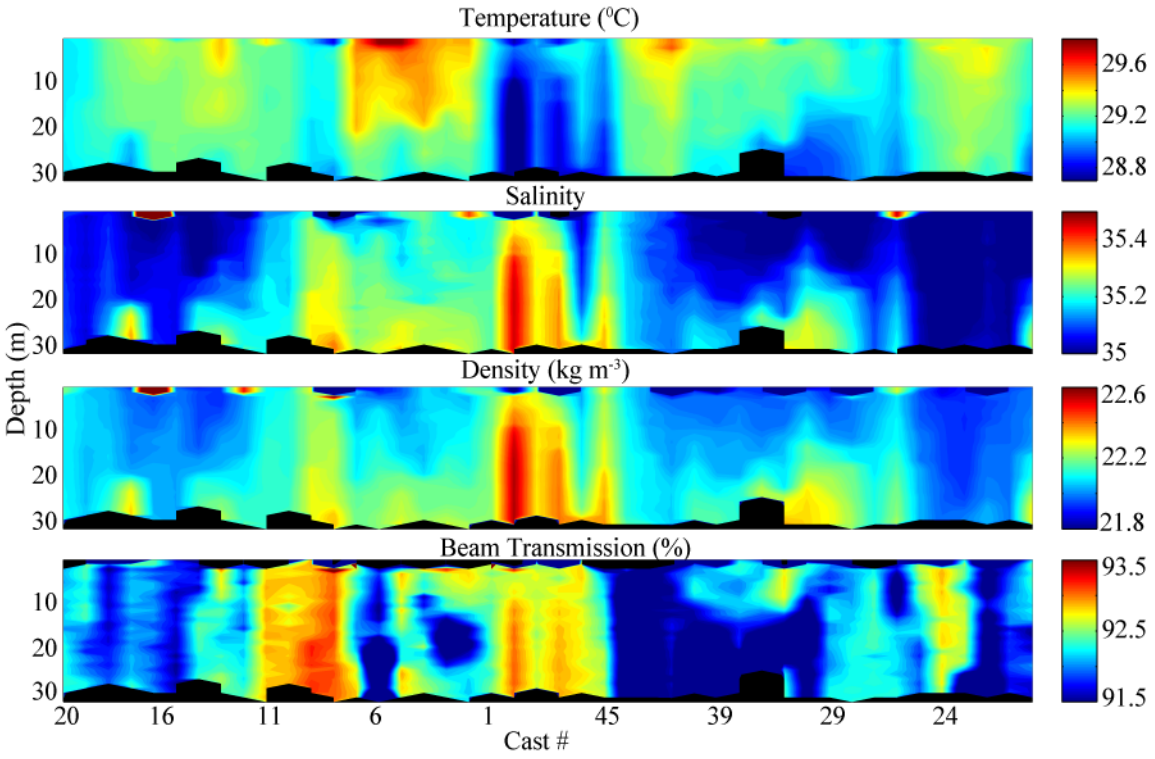


Figure B.1.7.--Cross-section plot of shallow-water CTD data (temperature, salinity, density, and beam transmission) collected around Tutuila during the HI-08-02 cruise. Refer to Figure B.1.4 for CTD cast locations.

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

Around Tutuila during the period of February 18–25, 2008, 44 Rapid Ecological Assessment (REA) sites were visited by a team of up to 8 scientists. At 21 of those sites, only fish surveys were conducted over differing depth ranges. These site locations are shown in Figures B.2.1 and B.2.2, and the survey dates and efforts are shown in Tables B.2.1 (benthic surveys) and B.2.2 (fish surveys). Individual site descriptions are included for the following discipline communities: coral, coral and coralline disease, macroinvertebrates, algae, and fish.

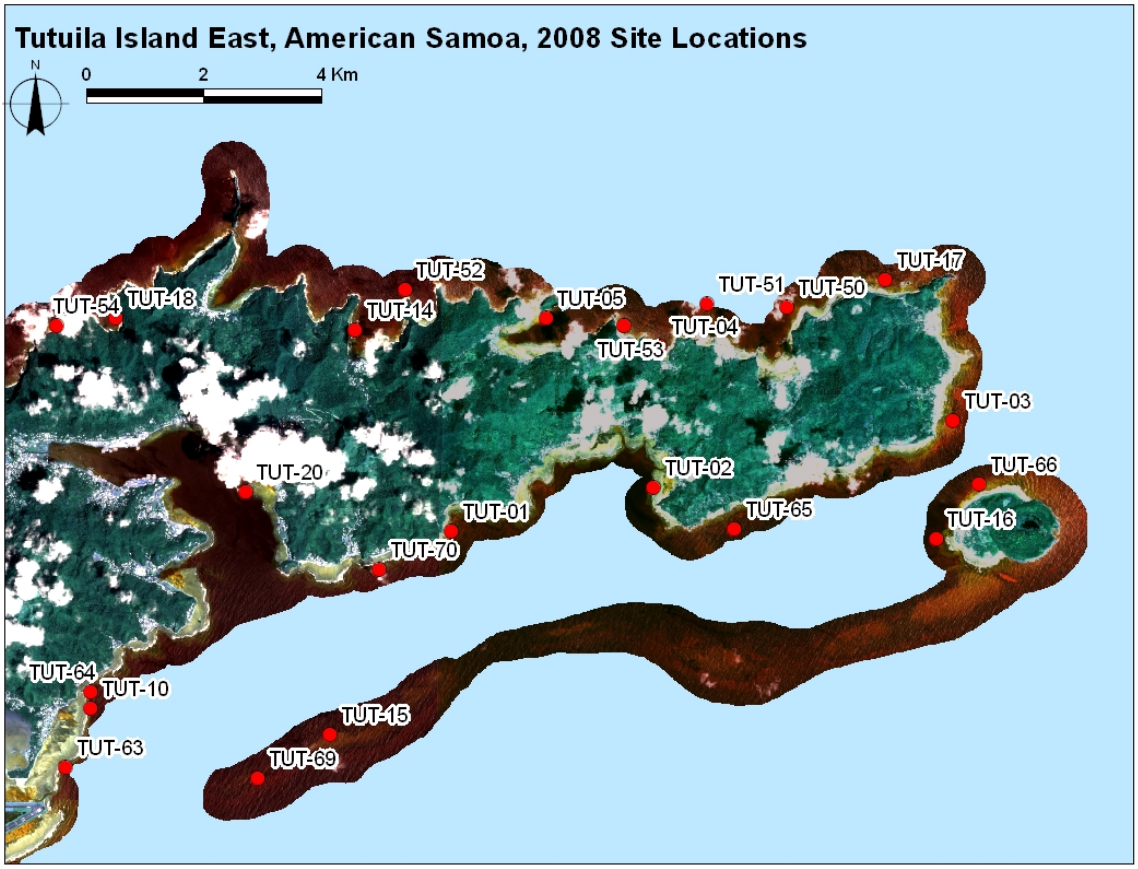


Figure B.2.1.--REA site locations around the east side of Tutuila Island during the HI-08-02 cruise.

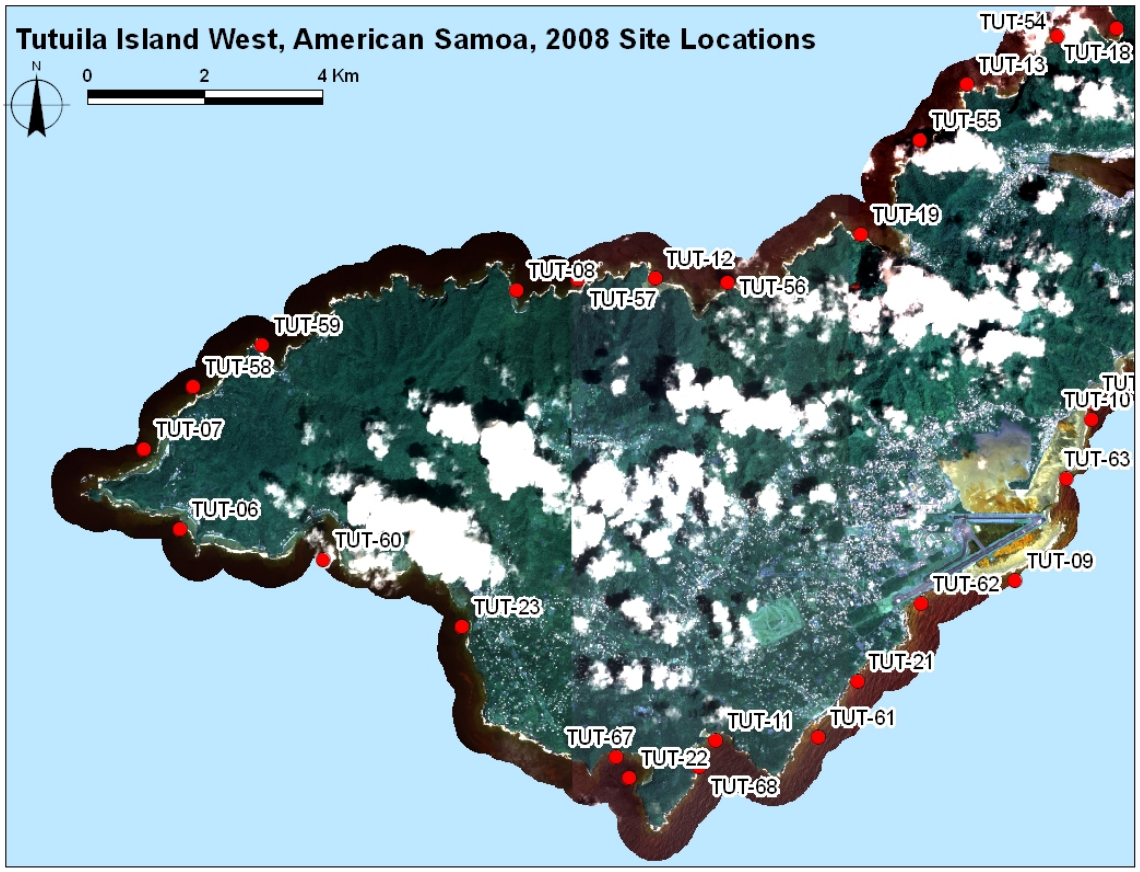


Figure B.2.2.--REA site locations around the west side of Tutuila Island during the HI-08-02 cruise.

Table B.2.1.--Tutuila 2008 benthic REA site survey dates, teams present, and additional comments. All dives were conducted in the forereef stratum.

Site ID	Date	Teams Present	Comments
TUT-01	2/25/2008	Coral, Disease, Algae, Invertebrates	
TUT-02	2/23/2008	Coral, Disease, Algae, Invertebrates	
TUT-03	2/23/2008	Coral, Disease, Algae, Invertebrates	
TUT-04	2/18/2008	Coral, Disease, Algae, Invertebrates	
TUT-05	2/19/2008	Coral, Disease, Algae, Invertebrates	
TUT-06	2/21/2008	Coral, Disease, Algae, Invertebrates	
TUT-07	2/21/2008	Coral, Disease, Algae, Invertebrates	
TUT-08	2/21/2008	Coral, Disease, Algae, Invertebrates	
TUT-09	2/25/2008	Coral, Disease, Algae, Invertebrates	
TUT-10	2/22/2008	Coral, Disease, Algae, Invertebrates	
TUT-11	2/24/2008	Coral, Disease, Algae, Invertebrates	ARMS deployment, incomplete invertebrate survey
TUT-12	2/20/2008	Coral, Disease, Invertebrates	Algae team equipment failure
TUT-13	2/20/2008	Coral, Disease, Algae, Invertebrates	
TUT-14	2/19/2008	Coral, Disease, Algae, Invertebrates	
TUT-15	2/22/2008	Coral, Disease, Algae, Invertebrates	
TUT-16	2/23/2008	Coral, Disease, Invertebrates	Algae team equipment failure
TUT-17	2/18/2008	Coral, Disease, Algae, Invertebrates	
TUT-18	2/19/2008	Coral, Disease, Algae, Invertebrates	
TUT-19	2/20/2008	Coral, Disease, Algae, Invertebrates	
TUT-20	2/25/2008	Coral, Disease, Algae, Invertebrates	
TUT-21	2/22/2008	Coral, Disease, Algae, Invertebrates	
TUT-22	2/24/2008	Coral, Disease, Algae, Invertebrates	ARMS deployment
TUT-23	2/24/2008	Coral, Disease, Algae	No Invertebrate team

ARMS is an acronym for autonomous reef monitoring structures.

Table B.2.2.--Tutuila 2008 fish REA site survey dates, depths, and additional comments. All dives were conducted in the forereef stratum.

Site ID	Date	Depth (m)	Comments
TUT-01	02/25/2008	11	*
TUT-02	02/23/2008	12	*
TUT-03	02/23/2008	10	*
TUT-04	02/18/2008	10	
TUT-05	02/19/2008	11	Only 1 BLT done
TUT-06	02/21/2008	12	
TUT-07	02/21/2008	11	Only 1 BLT done
TUT-08	02/21/2008	11	No BLTs done
TUT-09	02/25/2008	11	*
TUT-10	02/22/2008	15	
TUT-11	02/24/2008	11	*
TUT-12	02/20/2008	10	
TUT-13	02/20/2008	12	
TUT-14	02/19/2008	11	
TUT-15	02/22/2008	14	
TUT-16	02/23/2008	10	*
TUT-17	02/18/2008	10	
TUT-18	02/19/2008	13	Only 1 BLT done
TUT-19	02/20/2008	15	
TUT-20	02/25/2008	11	*
TUT-21	02/22/2008	12	
TUT-22	02/24/2008	12	*
TUT-23	02/24/2008	11	*
TUT-50	02/18/2008	5	
TUT-51	02/18/2008	21	Only 1 REP done
TUT-52	02/19/2008	21	
TUT-53	02/19/2008	5	
TUT-54	02/19/2008	5	
TUT-55	02/20/2008	21	Only 1 nSPC done
TUT-56	02/20/2008	6	
TUT-57	02/20/2008	21	Only 1 nSPC done
TUT-58	02/21/2008	21	Only 1 nSPC done
TUT-59	02/21/2008	6	
TUT-60	02/21/2008	20	
TUT-61	02/22/2008	20	
TUT-62	02/22/2008	5	
TUT-63	02/22/2008	18	
TUT-64	02/22/2008	5	
TUT-65	02/23/2008	20	*
TUT-66	02/23/2008	5	*
TUT-67	02/24/2008	20	*
TUT-68	02/24/2008	5	*
TUT-69	02/25/2008	18	*
TUT-70	02/25/2008	4	*

*Since 1 fish team member was ill and unable to participate in dives, the protocol for fish surveys was modified slightly: the 3 remaining fish team members were deployed on a boat separate from the benthic REA team; during each dive, 2 team members conducted 2 belt-transect (BLT) surveys and 1 stationary-point count (nSPC) surveys while the third member conducted 2 nSPC surveys in an area close to the original transect line.

Site Descriptions

February 18, 2008

TUT-17
14º14.777′ S, 170º34.320′ W
Depth Range: 8.53–13.72 m
This site is located on the NE forereef of Tutuila. A total of 25 coral genera were recorded within the belt-transect survey, and *Porites, Pavona, Montipora*, and *Montastrea* were the most abundant coral taxa. A large colony of *Acropora abrotanoides* was also recorded. Line-point intercept analysis found 48% coral cover, 1 case of coralline lethal orange disease, 1 case of coralline fungal disease, 1 case of skeletal growth anomaly on *Acropora abrotanoides*, and 1 case of subacute tissue loss on *Coscinaraea* in a survey area of 300 m^2. Overall, noncryptic macroinvertebrates were observed in low abundance. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis,* followed by *Calcinus* hermit crabs. Hydroids were common, and *Tridacna* and *Lobophyton* were rare. Sponges and tunicates were abundant. Several top shells were observed. Live corals dominated this site with crustose coralline red algae having the highest abundance of macroalgae in this site's photoquadrats. *Lobophora variegata* and small amounts of *Halimeda*, *Peyssonnelia*, *Laurencia*, and *Chlorodesmis fastigiata* were observed as well. *Dictyosphaeria cavernosa* was found during the random swim survey. Reef fishes were mostly small damselfishes (*Pomacentrus* and *Chromis*) at this site, with large fish virtually absent. Acanthurids (*Ctenochaetus strigosis* and *Acanthurus nigricans*) were observed in moderate numbers and sizes.

TUT-04
14º15.244′ S, 170º36.163′ W
Depth Range: 8.53–9.75 m
This site was located on the NE forereef of Tutuila. A total of 22 coral genera were recorded within the belt-transect survey, and *Montastrea curta*, *Porites,* and *Pavona* were the dominant coral taxa. Line-point intercept anaylsis found 39% coral cover, 5 cases of mild bleaching on *Montastrea*, and 1 case of hyperpigmentation response on *Porites* in a survey area of 258 m^2. Overall, noncryptic macroinvertebrates were observed in low abundance. The dominant macroinvertebrates observed were *Calcinus* hermit crabs followed by the echinoid *Echinostephus aciculatis.* Hydroids and Cladiella were common. *Tridacna* and *Lobophyton* were rare. Sponges and tunicates were abundant. Several top shells were observed; however, visibility was low at around 25 ft. Live coral dominated this site. Macroalgae found inside this site's photoquadrats included turf algae, *Lobophora variegata*, crustose coralline red algae, *Galaxaura* sp., and blue-green algae. The random swim survey yielded the genera *Halimeda*, *Chlorodesmis,* and *Dictyota*. The fish assemblage at this site was unremarkable, with low diversity and low number of fish. Small damselfishes (*Pomacentrus* and *Stegastes*) again were dominant, followed by *Ctenochaetus strigosis*.

TUT-50
14º15.019′ S, 170º35.208′ W
Depth Range: 2–6 m
This site is located on the NE fringing reef of Tutuila near Aoa Bay. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with low reef complexity. Reef fishes were mostly small damselfishes (*Stegastes*, *Pomacentrus*, and *Chrysiptera*) with few large fishes (mostly scarids).

TUT-51
14º14.983′ S, 170º35.935′ W
Depth Range: 19–21 m
This site is located on the NE fringing reef of Tutuila near Aoa Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had medium coral cover with high reef complexity (large spur-and-groove formations). Reef fishes were moderately abundant with many large fishes (scarids). Of note were large schools of fusiliers (*Pterocaesio tile*).

February 19, 2008

TUT-05
14º15.114′ S, 170º37.415′ W
Depth Range: 11.28–14.02 m
This site was located on the NE forereef of Tutuila in Masefau Bay. A total of 22 coral genera were recorded within the belt-transect survey, and *Porites rus* was the dominant coral accounting for more than half of the corals recorded. Line-point intercept analysis found 32.6% coral cover, dominated by *Porites rus;* 3 cases of bleaching (*Porites* and *Goniastrea*); 1 skeletal growth anomaly (*Halomitra*); 1 case of discoloration (*Coscinaraea*); and 1 case of coralline algal lethal orange disease in a survey area of 300 m^2. With the exception of hermit crabs, noncryptic macroinvertebrates were observed in low abundance. Coralliophilidaes were common. *Tridacna* was rare. Sponges and tunicates were abundant. Macroalgae in this site's photoquadrats consisted of *Amphiroa*, turf algae, cyanophytes, crustose coralline red algae, *Halimeda*, *Peyssonnelia*, *Dictyota*, *Galaxaura*, *Codium*, *Lobophora variegate*, and *Chlorodesmis fastigiata.* The random swim survey yielded *Halimeda opuntia* and *Cheilosporum spectabile*. In terms of fishes, there were many acanthurids at this site, including large numbers of *Ctenochaetus striatus* and *Ctenochatus cyanocheilus*. Small damsels like *Chromis margaritifer* and *C. iomelas* were also abundant.

TUT-14
14º15.244′ S, 170º39.155′ W
Depth Range: 9.14–14.33 m
This site was located on the N coast of Tutuila in Afono Bay. A total of 22 coral genera were recorded within the belt-transect survey, and *Porites, Montipora,* and *Pavona* sp. were the dominant coral taxa. Line-point intercept analysis found 12.7% coral cover, 5 cases of discoloration (*Coscinaraea*, *Porites*), 2 cases of skeletal growth anomaly (*Porites*), 3 cases of predation (*Pocillopora*, *Acropora humilis*), and 2 cases of hyperpigmented response (*Porites*) in a survey area of 300 m^2. Overall, noncryptic macroinvertebrates were observed in low

abundance. Hermit crabs and Coralliophilidae were common. Trapezids, *Tridacna*, and *Echinostrephus* were rare. Sponges and tunicates were abundant. The genera *Halimeda* dominated this site's photoquadrats. Other macroalgae included turf algae, *Lobophora variegata*, cyanophytes, *Peyssonnelia*, *Dictyota,* and *Amphiroa*. On the random swim survey, *Ventricaria ventricosa* was recognized. Small damselfishes were abundant here, with especially high numbers of *Plectroglyphidodon lacrymatus* and *Pomacentrus vaiuli*. The ubiquitous *Ctenochaetus striatus* gave a good showing as well.

TUT-18
14º15.109′ S, 170º41.342′ W
Depth Range: 6.40–8.84 m
This site was located on Tutuila's north forereef. This site was overgrown by the corallimorpharian *Rhodactis*, which appeared to be outcompeting encrusting montiporid corals. Twenty coral genera were recorded within the belt-transect survey, and *Montipora*, *Pavonas,* and *Leptastrea* were the dominant coral taxa. Line-point intercept analysis found 33.3% coral cover (scleractinian), domination by corallimorph; 3 cases of discoloration (*Pavona varians, Psammocora*), 4 cases of subacute tissue loss (*Montipora* sp.), and 1 case of coralline algal fungal disease in a survey area of 300 m^2. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis,* followed by Coralliophilidae mollusks and *Calcinus* hermit crabs. Vermetids were common. Sponges and tunicates were abundant. Beds of anemones also dominated the benthos. Macroalgae identified in this site's photoquadrats included cyanophytes, crustose coralline red algae, turf algae, *Amphiroa*, *Chlorodesmis fastigiata*, and *Peyssonnelia*. *Ventricaria ventricosa* was noted along the random swim survey. As far as fishes are concerned, *Chromis iomelas* was found here in very large numbers. Schools of these fish were perhaps the most dominating feature of the landscape. *Ctenochatus striatus* was the most abundant acanthurid.

TUT-52
14º14.859′ S, 170º38.702′ W
Depth Range: 19–23 m
This site is located on the NE fringing reef of Tutuila near Afono Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. The site had medium coral cover with high reef complexity (large spur-and-groove formations). Reef fishes were moderately abundant with many large fishes (snappers, scarids, fusiliers). Of note were large schools of fusiliers (*Pterocaesio* spp.).

TUT-53
14º15.186′ S, 170º36.695′ W
Depth Range: 5–6 m
This site is located on the NE fringing reef of Tutuila near Masefau Bay. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. The site had low coral cover with medium reef complexity. Reef fishes were mostly small damselfishes (*Stegastes*, *Pomacentrus*, *Chrysiptera*) with few large fishes (mostly scarids).

TUT-54
14º15.184′ S, 170º41.889′ W
Depth Range: 5–6 m
This site is located on the NW fringing reef of Tutuila near Samituutuu Point. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. The site had low coral cover with medium reef complexity. Reef fishes were mostly small damselfish (*Stegastes*, *Pomacentrus*, *Chrysiptera*) with few large fish (mostly scarids and acanthurids).

February 20, 2008

TUT-13
S 14º15.619′, W 170º42.704′
Depth Range: 12.80–17.07 m
This site was located on the N forereef of Tutuila. Sixteen coral genera were recorded within the belt-transect survey, and *Montipora* was the dominant coral taxon. Line-point intercept analysis found 16.7% coral cover, and 4 *Porites* colonies were affected by disease states (predation, tissue loss, hyperpigmented response, and discoloration) in a survey area of 174 m^2. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis*, followed by *Calcinus* hermit crabs. *Linckia multifora* were rare. Immature Tridacnas (Maximum shell length > 12 cm) were present. Turf algae dominated this site's photoquadrats along transect lines, although cyanophytes, crustose coralline red algae, *Halimeda*, *Lobophora variegate*, and *Ventricaria ventricosa* were noted. The random swim survey included *Chlorodesmis fastigiata*, *Peyssonnelia*, and *Neomeris annulata.* Small fishes were dominant at this site, including the damselfishes *Chromis margaritifer*, *Pomacentrus vaiuli*, and *Pomachromis richardsoni* and the wrasses *Thalassoma quinquevittatum* and *T. amblycephalum*. The largest fish observed was a single 30-cm wrasse, *Oxycheilinus unifasciatus*.

TUT-19
14º17.003′ S, 170º43.678′ W
Depth Range: 12.50–14.63 m
This site was located on the N forereef of Tutuila in Fagasa Bay. Transects were laid on a spur-and-groove reef that dropped down to a depth of approximately 30 m. A total of 23 coral genera were recorded within the belt-transect survey, and *Pavona* and *Porites* were the dominant coral taxa. Line-point intercept analysis found 21.6% coral cover, 4 cases of of coralline lethal orange disease, 2 cases of coralline cyanophyte disease, 1 case of predation (*Pocillopora*), 2 cases of discoloration (*Fungia, Coscinaraea*), and 1 case of subacute tissue loss (*Coscinaraea*) in a survey area of 300 m^2. The dominant macroinvertebrates observed were hermit crabs followed by the echinoid, *Echinostephus aciculatis.* A thin, smooth, and leathery encrusting white sponge, possibly from the genus *Haliscara*, was extremely abundant throughout this site. Other sponges and tunicates were common. Photoquadrat abundances of macroalgae found at this site included crustose coralline red algae, turf algae, *Lobophora variegata*, *Amphiroa*, cyanophytes, *Halimeda*, *Peyssonnelia*, *Chlorodesmis fastigiata*, *Caulerpa sertularoides*, and *Galaxaura.* The random swim survey yielded *Portieria hornemannii*, *Cheilosporum spectabile*, and *Galaxaura marginata*. Again, small fishes comprised the highest abundances at this site. Along with the damsels *Chromis iomelas*, *C. amboinensis*, and *Pomachromis richardsoni*, surgeonfish (*Ctenochaetus striatus*) were observed in large numbers. Fishes larger than those damsels and

surgeonfish were moderately abundant and included the parrotfishes *Scarus rubroviolaceus*, *S. psittacus*, *S. frenatus*, *Chlorurus japanensis*, and *Calatomus carolinus*. Again, a large wrasse (*Oxycheilinus unifasciatus*) was noted.

TUT-12
14º17.385′ S, 170º45.546′ W
Depth Range: 12.80–15.24 m
This site was located within Massacre Bay on the N coast of Tutuila. Generic richness was low with only 10 coral taxa recorded within the belt transect. *Montipora* and *Coscinaraea* were the 2 most abundant coral taxa. Line-point intercept analysis found 2.0% coral cover, 1 case of coralline algal lethal orange disease, 1 case of presumed coralline lethal disease, and 3 cases of subacute tissue loss (*Psammocora*, *Montipora* sp.). Noncryptic macroinvertebrates were observed in low abundance. The dominant macroinvertebrate observed was the echinoid, *Echinostephus aciculatis.* Several nudibrachs from the family Phillillidae, burrowing crabs, and brittle stars were common under rocks in the rubble field. Algal data was not collected due to equipment failure. The surgeonfish *Ctenochaetus striatus* were by far the most numerous fish present and were seen primarily as recruits or small juveniles. A small trevally (*Caranx melampygus*) was recorded, while a large parrotfish (*Hipposcarus longiceps*) was seen off transect.

TUT-55
14º16.134′ S, 170º43.139′ W
Depth Range: 19–23 m
This site is located on the NW fringing reef of Tutuila near Fagasa Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. The site had medium coral cover with high reef complexity (large spur-and-groove formations). Reef fishes were moderately abundant with many large fishes (snappers, scarids, fusiliers). Of note was a large group of the endangered Napoleon wrasse, including a large terminal male ~ 1.5 m in total length.

TUT-56
14º17.432′ S, 170º44.905′ W
Depth Range: 5–7 m
This site is located on the NW fringing reef of Tutuila near Fagafue Bay. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with medium reef complexity. Reef fish were mostly small damselfishes (*Stegastes*, *Pomacentrus*, *Chrysiptera*) with few large fishes (mostly scarids and acanthurids).

TUT-57
14º17.409′ S, 170º46.274′ W
Depth Range: 20–23 m
This site is located on the NW fringing reef of Tutuila near Aotoau Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had medium coral cover with high reef complexity (large spur-and-groove formations). Reef fishes were moderately abundant with many large fishes (snappers, scarids, fusiliers). This site was similar to all the other deep sites along the north shore.

February 21, 2008

TUT-08
14º17.508′ S, 170º46.827′ W
Depth Range: 8.84–12.80 m
This site was located on the NW forereef of Tutuila. A total of 22 coral genera were recorded within the belt-transect survey, and *Porites* and *Montipora* were the dominant coral taxa. Line-point intercept analysis found 26.5% coral cover, 4 cases of skeletal growth anomalies (*Acropora clathrata, Fungia*), 1 case of snail predation (*Acropora humilis*), 1 case of discoloration (*Pavona varians*), 1 case of bleaching (*Pocillopora eydouxi*), 1 case of subacute tissue loss (*Turbinaria*), 1 case of hyperpigmented response (*Porites*), 3 cases of coralline lethal orange disease, and 2 cases of coralline cyanobacterial disease in a survey area of 300 m^2; also observed was a large (with a diameter > 1 m) *Acropora cytherea* colony off-transect with ~ 12 small skeletal growth anomalies. The dominant macroinvertebrates observed were hermit crabs, followed by trapezid crabs and marine snails from Coralliophilidae. A thin, smooth, and leathery encrusting white sponge, possibly from the genus *Haliscara*, was extremely abundant throughout this site. Other sponges and tunicates were common. Macroalgae found in this site's photoquadrats included crustose coralline red algae, turf algae, cyanophytes, *Halimeda*, *Portieria hornemanni*, *Amphiroa*, *Peyssonnelia*, and *Galaxaura marginata*. *Chlorodesmis fastigiata* and *Cheilosporum spectabile* were noted along the random swim survey. As at previous sites, the surgeonfish *Ctenochaetus striatus*, along with small damselfishes (*Pomacentrus*, *Chromis*, and *Plectrophydidon*), was the most abundant fish. Small numbers of large fishes were noted, including the parrotfish *Chlorurus japanensis*, the surgeonfish *Naso literatus*, and the jobfish *Aphareus furca*.

TUT-07
14º18.935′ S, 170º50.239′ W
Depth Range: 17.98–20.12 m
This site was located on the NW tip of Tutuila in Poloa. A total of 21 coral genera were recorded within the belt-transect survey, and *Montipora* was the dominant coral taxon. After comparing results from the 2006 survey, it appears transects were laid in a completely different zone, as 0% coral cover was recorded at this site in 2006. Line-point intercept analysis found 53.9% coral cover, 6 cases of predation (*Montipora*, probable fish bites), 3 cases of subacute tissue loss (*Porites, Montipora*), 2 cases of discoloration (*Pavona varians*), and 2 cases of bleaching (*Porites*) in a survey area of 225 m^2. A large (with a diameter > 2 m) *Porites* colony was observed off-transect with numerous, widespread bleached spots. Overall, noncryptic macroinvertebrates were observed in low abundance. Paguritta crabs were abundant. *Tridacna* and *Linckia multifora* were rare. Sponges and tunicates were abundant. Dominant macroalgae in this site's photoquadrats consisted of turf algae, crustose coralline red algae, cyanophytes, *Peyssonnelia*, *Halimeda*, and *Amphiroa*. The random swim survey yielded *Chlorodesmis fastigiata.* Schools of the small damselfishes *Chromis acares*, *C. margaritifer*, *C. iomelas*, and *Chrysiptera taupou* dominated this site; the surgeonfish *Ctenochaetus striatus* was also observed but in a quantity smaller than that of the damselfishes. Recruits and juvenile fishes were also common, including wrasses (*Macropharyngodon meleagris, Gomphosus various, Halichoeres hortulanis, and Coris gaimard*), butterflyfish (*Chaetodon citrinellus*), goatfish (*Parupeneus*

multifasciatus), parrotfish (*Chlorurus japanensis*), and triggerfish (*Sufflamen bursa*). Of note, 2 large *Chlorurus microrhinos* were observed during the stationary-point count (nSPC).

TUT-06
14º19.684′ S, 170º49.916′ W
Depth Range: 12.80–16.76 m
This site was located within Amanave Bay off the SW tip of Tutuila. A total of 24 coral taxa were recorded within the belt-transect survey, and *Merulina ampliata* and *Echinopora lamelosa* were the dominant coral taxa. Line-point intercept analysis found 58.8% coral cover, 3 cases of bleaching (*Merulina ampliata, Pocillopora eydouxi,* and *Cyphastrea*), and 1 case of skeletal growth anomaly in a survey area of 300 m^2. Overall, noncryptic macroinvertebrates were observed in low abundance. *Tridacna* and *Holothuria whitmaei* were rare. Sponges and tunicates were common. Macroalgae found in this site's photoquadrats included *Halimeda*, crustose coralline red algae, turf algae, cyanophytes, *Peyssonnelia*, and *Chlorodesmis fastigiata*. During the random swim survey, *Cheilosporum spectabile* and *Caulerpa sertularoides* were collected. An interesting feature of this site was the variety of parrotfish observed, including *Chlorurus japanensis*, *C. sordidus*, *Scarus psittacus*, *S. frenatus*, *S. spinus*, *S. forsteni*, and *S. tricolor*. One trevally (*Caranx melampygus*) was seen off transect. The ubiquitous damsels (*Pomacentrus*, *Chromis*, and *Plectrophydidon*) as well as the surgeonfish *Ctenochaetus striatus* again made a showing.

TUT-58
14º18.385′, S 170º49.794′ W
Depth Range: 19–23 m
This site is located on the NW fringing reef of Tutuila near Maloata. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had medium coral cover with high reef complexity (large spur-and-groove formations). Reef fishes were moderately abundant with many large fishes (snappers, scarids, fusiliers). Of note was the presence of large coral groupers (*Plectropomus laevis*).

TUT-59
14º18.004′ S, 170º49.157′ W
Depth Range: 5–6 m
This site is located on the NW fringing reef of Tutuila near Leopard Point. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with medium reef complexity. Reef fishes were mostly small damselfish (*Stegastes*, *Pomacentrus*, *Chrysiptera*) with few large fishes (mostly scarids and acanthurids). This site was very similar to other shallow-depth sites along the north shore.

TUT-60
14º19.964′ S, 170º48.598′ W
Depth Range: 19–21 m
This site is located on the SW fringing reef of Tutuila at the mouth of Fagaone Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had high coral cover with high reef complexity (flat extent). Reef fish abundance and diversity were surprisingly low considering the quality of the reef habitat. This may be related to

the large southern swells present during the dive, which reduced visibility to 6 m and may have caused fish to hide or move elsewhere. Some coral that was overgrown by macroalgae were observed.

February 22, 2008

TUT-21
14º18.682′ S, 170º41.585′ W
Depth Range: 11.28–15.85 m
This site was located on the south central coastline. A total of 25 coral taxa were recorded within the belt-transect survey, and *Montastrea, Porites*, and *Pocillopora* were the dominant coral taxa. Line-point intercept analysis found 26.5% hard coral cover, 9 cases of subacute tissue loss (*Platygyra daedalea*, probably fish bites; *Montastrea*), 3 cases of bleaching (*Pocillopora eydouxi*, *Montastrea*), 3 cases of snail predation (*P. eydouxi, P. meandrina*), 1 case of discoloration (*Fungia*), and 6 cases of coralline lethal orange disease in a survey area of 300 m^2. The echinoid *Echinostephus aciculatis* was extremely abundant and widespread. Hermit crabs and zoanthids (*Palythoa* and *Protopalythoa*) were abundant. Coralliophildae and trapezids were common. The asteroids *Culcita novaguineae, Linckia multifora,* and *Fromia* sp. were rare. Dominant macroalgae in this site's photoquadrats consisted of crustose coralline red algae, turf algae, cyanophytes, *Peyssonnelia*, and *Halimeda.* The random swim survey yielded *Caulerpa sertularoides*, *Amphiroa*, and *Chlorodesmis fastigiata*. Highly site-attached fish species, such as *Plectroglyphidodon dickii* and *Stegastes fasciolatus*, were prominent at this site. Small damsels and *Ctenochatus striatus* were also very abundant.

TUT-10
14º21.068′ S, 170º43.717′ W
Depth Range: 10.36–14.02 m
This site was on the south side of Tutuila in between Pago Pago International Airport and Pago Pago Harbor in the Nu'uuli area. A total of 23 coral taxa were recorded within the belt-transect survey, and monotypic stands of *Lobophyllia hemprici* were the dominant coral at part of this site. Soft corals of the genus *Cladiella or Sinularia* were also quite abundant along the survey area. Line-point intercept analysis found 23.5% hard coral cover. This area was dominated by the soft corals *Sinularia* sp. and *Lobophyllia* sp. Observations included 4 cases of barnacle infestation (*Goniastrea*), 1 case of bleaching (*Montastrea*), and 1 case of coralline lethal orange disease in a survey area of 300 m^2. Overall, noncryptic macroinvertebrates were observed in low abundance. The soft coral *Cladiella* was widespread, and *Sinularia* was common. *Conus* sp. were common. Hermit crabs, *Echinostrephus*, and trapezids were rare. The lace corals *Distichopora* and *Stylaster* were prevalent. Photoquadrat abundances of macroalgae found at this site included crustose coralline red algae, turf algae, cyanphytes, *Cheilosporum, Peyssonnelia, Halimeda, Amphiroa*, and *Gelidiella*. The random swim survey produced *Caulerpa sertularoides*. Pomacentrids were the most abundant fish at this site. *Chromis xanthura* was prevalent in mid-water, and pomacentrids were found in large numbers closer to the substrate*. Ctenochaetus striatus* occurred here in large numbers, making up almost all acanthurid biomass. Of note was an off-transect sighting of one 100-cm *Gymnosarda unicolor*.

TUT-15
14º18.919′ S, 170º39.388′ W
Depth Range: 12.50–14.02 m
This site was at Ta'ema Bank, south of Pago Pago Harbor. This site appeared to be highly impacted with rubble dominating the benthos. Only 11 coral genera were recorded within the survey area, with no observed corals > 20 cm. Line-point intercept analysis found 1.0% coral, 1 case of tissue loss (*Hydnophora exaesa*), and 1 case of coralline lethal orange disease in a survey area of 300 m^2. The echinoid *Echinostephus aciculatis* was extremely abundant. Few other noncryptic invertebrates were present. Dominant macroalgae found in this site's photoquadrats consisted of turf algae, crustose coralline red algae, cyanophytes, and *Peyssonnelia.* At this site, juvenile *Ctenochaetus striatus* were very abundant, having just recruited on the reef. Pomacentrids were also found in large numbers, with *Pomacentrus vaiuli* and *Chrysoptera toupou* being the most common.

TUT-61
14º21.579′ S, 170º44.069′ W
Depth Range: 18–21 m
This site is located on the SW fringing reef of Tutuila just east of Larsen Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. Coral cover at this site was moderate, as was reef complexity. The acanthurid *Ctenochaetus striatus* was observed in large numbers in the belt-transect survey and stationary-point count. A large school comprised primarily of *Acanthurus nigricans* and various parrotfish were seen grazing just off transect. Also seen off transect was a whitetip reef shark, while a large parrotfish (*Cetoscarus bicolor*) was counted during the stationary-point count.

TUT-62
14º20.360′ S, 170º43.135′ W
Depth Range: 5–6 m
This site is located on the SW fringing reef of Tutuila near Pago Pago International Airport. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. Coral cover and complexity were medium. In this surgy environment, the acanthurid *Ctenochaetus striatus* was again present in large numbers, as were the damselfish *Stegastes fasciolatus* and the wrasse *Thalassoma quinquevittatum*. A single jack (*Caranx melampygus*) was seen as the transect line was being deployed; a large parrotfish (*Chlorurus microrhinos*) was counted during the stationary-point count.

TUT-63
14º19.222′ S, 170º41.809′ W
Depth Range: 17–20 m
This site is located on the SW fringing reef of Tutuila just east of Pago Pago International Airport. It was established by the REA fish team as a new sampling location in the forereef deep stratum. Coral cover was medium (large *Porites rus* colonies) and complexity was high. Juvenile acanthurids (*Ctenochaetus striatus*) were dominant, followed by small damselfish (*Pomacentrus vaiuli*). A moderate number of large fishes were seen, including parrots, goatfishes, and snappers, with one whitetip reef shark crossing the belt transect. This site is partially at the base of a large wall.

TUT-64
14º18.536′ S, 170º41.582′ W
Depth Range: 5–6 m
This site is located on the fringing reef of Tutuila between Pago Pago International Airport and the Pago Pago Harbor. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. Coral cover was high with medium complexity. Juvenile acanthurids (*Ctenochaetus striatus*) again were dominant, followed by small damselfishes (*Stegastes, Chrysiptera*). Large fishes were mostly absent, with the exception of a large triggerfish (*Balistoides viridescens*) counted during the stationary-point count. Many large fishes where observed slightly off the survey area.

February 23, 2008

TUT-16
14º16.642′ S, 170º36.426′ W
Depth Range: 13.72–15.54 m
This site was off the east side of Aunu`u Island with high coral cover and diversity. A total of 24 coral taxa were recorded within the belt-transect survey, and *Montipora, Pavona, Porites, Acropora, Montastrea*, and *Pocillopora* were the most abundant genera. Line-point intercept analysis found 77.5% coral cover, 3 cases of bleaching (*Pocillopora verrucosa, P. eydouxi; Acropora* sp.), 1 case of corallivore snail predation (*Acropora abrotanoides*), 1 case of skeletal growth anomaly (*Montipora*), and 1 case of subacute tissue loss (*Acropora nobilis*) in a survey area of 150 m^2. Crinoids were extremely abundant. Coralliophilidae snails, hermit crabs, and trapezoid crabs were common. *Tridacna* and *Linckia multifora* were rare. Halfway through the invertebrate survey the dive was aborted due to computer malfunction. Macroalgae noted were crustose coralline red algae, turf algae, cyanophytes, *Neomeris*, *Halimeda*, and *Caulerpa sertularoides.* Pomacentrids were by far the most abundant fish at this site. Large numbers of *Chromis xanthura*, *Chromis margaritifer*, and *Plectroglyphidodon dickii* were present. Four different species of scarids were also observed.

TUT-03
14º16.056′ S, 170º33.695′ W
Depth Range: 7.32–12.50 m
This site was on the southeast side of the island. High generic richness (25 genera) especially within the Acroporid family was notable. Abundant corals included *Acropora*, *Pocillopora*, *Montipora*, *Porites*, and *Montastrea*. The soft coral *Sinularia or Cladiella* was also common. Line-point intercept analysis found 42.2% coral cover, 3 cases of bleaching (*Porites, Hydnophora exaesa*), 2 cases of subacute tissue loss (*Pocillopora eydouxi*), 1 case of skeletal growth anomaly (*Acropora abrotanoides*), 1 case of barnacle infestation (*Favia stelligera*), and 1 case of coralline algal lethal orange disease in a survey area of 300 m^2. Both hermit crabs and the echinoid *Echinostrephus aciculatis* were abundant. The soft coral *Cladiella* was prevalent. Coralliophilidae snails and trapezoid crabs were common. Macroalgae in this site's photoquadrats consisted of turf algae, crustose coralline red algae, cyanophytes, *Halimeda*, *Peyssonnelia*, *Caulerpa sertularoides,* and *Portieria hornemannii.* The random swim survey yielded *Dictyosphaeria versluysii* and *Amphiroa*. Of note, floating in the water column throughout the survey was what appeared to be kelp, which was also observed by the benthic

towed-diver team; a specimen was collected and pressed. Small damselfishes were abundant, particularly *Chromis margaritifer* and *Chromis xanthura*. *Acanthurus nigricans* replaced the usual *Ctenochaetus striatus* as the most abundant acanthurid.

TUT-02
14º17.133′ S, 170º33.844′ W
Depth Range: 7.62–10.97 m
This site was on the SE forereef of Tutuila. Generic richness was low with only 10 coral genera recorded within the transect area. *Porites* and *Montipora* were the 2 most common corals encountered. Line-point intercept analysis found 26.5% coral cover, 4 cases of subacute tissue loss (*Montipora*), 2 cases of acute tissue loss ("white syndrome," *Montipora*), and 1 case of bleaching (*Montipora*) in a survey area of 300 m^2. Noncryptic macroinvertebrates were observed in low abundance. *Echinostephus aciculatis*, the holothuroid *Bohadschia argus,* and the asteroids *Linckia multifora* and *Fromia* sp. were rare. One *Acanthaster planci* was seen off-transect. Photoquadrat abundances of macroalgae found at this site included crustose coralline red algae, turf algae, *Amphiroa*, *Halimeda*, *Peyssonnelia, Caulerpa serrulata*, and *Gibsmithia.* Noted on the random swim survey were *Galaxaura marginata, Caulerpa serrulata, Portieria hornemannii,* branched crustose coralline red algae, *Titanophora,* and *Predaea.* Again for fishes, *Ctenochaetus striatus* were very abundant, as were *Chromis iomelas*. Also common were midsize sergeant (*Abudefduf sexfasciatus*) and parrotfish (*Chlorurus sordidus*).

TUT-65
14º17.048′ S, 170º35.692′ W
Depth Range: 20–23 m
This site is located on the SE fringing reef of Tutuila east of Fagaitua Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. Overall coral cover was medium, with high reef complexity comprised of a large spur-and-groove formation. The most abundant fishes at this site included small damselfishes (*Chromis*, *Pomacentrus*), with a moderate number of fusiliers (*Pterocaesio*, *Caesio*).

TUT-66
14º16.636′ S, 70º33.452′ W
Depth Range: 4–5 m
This site is located on the fringing reef at the NW corner of Aunu`u Island, which is SE of Tutuila. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. There was high *Acropora* diversity, with overall high coral cover and high reef complexity. Small damselfishes (*Dascyllus*, *Plectroglyphidodon*, *Chromis*) were most common, and few large fishes (mostly scarids and acanthurids) were observed.

<u>February 24, 2008</u>

TUT-11
14º21.625′ S, 170º45.021′ W
Depth Range: 7.32–11.89 m
This site was in Larsen Bay on the S coast of Tutuila. Twenty coral genera were recorded within the survey area, and *Acropora, Galaxea, Porites, Montipora, Montastrea*, and *Pocillopora* were

the most abundant taxa. Soft corals were also abundant. Line-point intercept analysis found 25.5% coral cover, 32 cases of coralline algae lethal orange disease, 3 cases of coralline algae fungal disease, 3 cases of barnacle infestation (*Goniastrea, Favia stelligera*), 1 case of discoloration/subacute tissue loss (*Hydnophora microconos*), and 3 cases of bleaching (*Pocillopora eydouxi, Platygyra dadalea; Montastrea curta*) in a survey area of 300 m^2. The invertebrate survey was incomplete due to autonomous reef monitoring structures (ARMS) deployment. Dominant macroalgae in this site's photoquadrats consisted of crustose coralline red algae, turf algae, cyanophytes, *Peyssonnelia*, *Portieria hornemannii*, *Laurencia*, and *Cheilosporum.* Juvenile *Ctenochaetus striatus* were probably the most abundant fish here. A recruitment event had just occurred and, thus, numerous individuals of the same size class were observed. Small damsels were also prevalent. Of note was an off-transect sighting of *Macolor macularis*.

TUT-22
14º21.968′ S, 170º45.773′ W
Depth Range: 8.53–10.97 m
This site was in Fagatele Bay on the S coast of Tutuila. Nineteen coral genera were recorded within the survey area, and *Porites, Montipora*, and *Acropora* were the most abundant taxa. Soft corals were also common at this site. Line-point intercept analysis found 41.2% coral cover, 30 cases of coralline algal lethal orange disease, 3 cases of bleaching (*Pocillopora eydouxi, Fungia*), 2 cases of subacute tissue loss (*Acropora, Montipora*), and 1 case of skeletal growth anomaly (*Acropora digitifera*) in a survey area of 300 m^2. With the exception of hermit crabs, noncryptic macroinvertebrates were observed in low abundance. *Cladiella* and *Sinularia* were common. Coralliophilidae snails were prevalent in one 5-m segment of the survey. Photoquadrat abundances of macroalgae found at this site included crustose coralline red algae, turf algae, branched crustose coralline red algae, *Cheilosporum, Peyssonnelia*, and *Halimeda.* Scarids were relatively plentiful at this site, particularly *Scarus oviceps*, of which 5 were counted. Midsize acanthurids were also abundant.

TUT-23
14º20.569′ S, 170º47.330′ W
Depth Range: 8.53–13.11 m
This site was on the SW forereef of Tutuila, close to Leone village. Fourteen coral genera were recorded within the survey area, and *Porites, Montipora*, and *Acropora* were the most abundant taxa. Observations: 56.9% coral cover, 5 cases of coralline lethal orange disease, 1 case of coralline algal cyanophyte disease, 3 cases of predation/tissue loss (*Montipora*), 1 case of discoloration (*Pavona*, dark spots), 2 cases of skeletal growth anomalies (*Acropora cytherea, A. abrotanoides*), and 1 case of bleaching (*Astreopora*) in a survey area of 300 m^2. Invertebrate surveyor was not present due to ARMS deployment in Fagatele Bay. Macroalgae in this site's photoquadrats included crustose coralline red algae, turf algae, branched crustose coralline red algae, *Peyssonnelia*, and *Cheilosporum*. *Halimeda* sp. and *Chlorodesmis fastigiata* were noted along the random swim survey. The only fishes seen in appreciable quantities at this site were the surgeonfish *Ctenochaetus striatus* and the damselfishes *Plectrophydidon lacrymatus* and *Chromis margaritifer.* Large fishes were not observed except for a single parrotfish (*Chlorurus japanensis*).

TUT-67
14º21.765′ S, 170º45.926′ W
Depth Range: 19–24 m
This site is located on the SW fringing reef of Tutuila in Fagatele Bay. It was established by the REA fish team as a new sampling location in the forereef deep stratum. The site had high coral cover with medium reef complexity. Acanthurids (*Ctenochatus*, *Acanthurus*) were most common, although in general this site was surprisingly depauperate of large fishes.

TUT-68
14º21.857′ S, 170º45.164′ W
Depth Range: 5–6 m
This site is located on the SW fringing reef of Tutuila in Larsen Bay close to shore. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. Coral cover at this site was medium with low reef complexity. Small wrasses (*Thalassoma*), acanthurids (*Ctenochaetus*) and damsels (*Stegastes*) were the most abundant fishes.

February 25, 2008

TUT-09
14º20.149′ S, 170º42.264′ W
Depth Range: 11.89–15.85 m
This site was on the south side of the island behind Pago Pago International Airport. A total of 22 coral genera were recorded within the survey area, and *Montipora, Montastrea, Galaxea*, and *Leptastrea* were the most abundant taxa. Favid family diversity was high, and a number of large *Astreopora* corals were observed within the survey area. Line-point intercept analysis found 77.5% hard coral cover, 2 cases of skeletal growth anomaly (*Pocillopora meandrina, Astreopora myriophthalma*), 3 cases of bleaching (*Pocillopora meandrina, Astreopora myriophthalma, Porites*), 1 case of subacute tissue loss (*Porites*), 1 case of discoloration/hyperpigmented response (*Porites*), 1 case of predation (*Pocillopora meandrina*), and 2 cases of hyperpigmented response (*Astreopora myriophthalma*) in a survey area of 150 m^2. *Calcinus* hermit crabs and the echinoid *Echinostrephus aciculatis* dominated the macroinvertebrate fauna. *Cladiella* was widespread. *Tridacna*, Coralliophillidae snails, and crinoids were rare. Dominant macroalgae in this site's photoquadrats consisted of turf algae, crustose coralline red algae, cyanophytes, and *Halimeda.* This site was unremarkable for fish diversity and richness. Except for a single adult parrotfish, no large fishes were recorded. Of the fishes present, damselfishes (*Stegastes*, *Plectrophydidon*, *Pomacentrus)* dominated; the wrasse *Thalassoma quinquevittatum* was commonly seen.

TUT-01
14º16.998′ S, 170º38.264′ W
Depth Range: 10.36–15.54 m
This site was on the southern forereef of Tutuila, close to Alega. Fourteen coral genera were recorded within the survey area, and *Porites* and *Montipora* were the most abundant taxa. The soft corals *Sinularia* and *Cladiella* were abundant. Line-point intercept analysis found 25.5% hard coral cover, 3 cases of bleaching (*Porites*), 1 case of subacute tissue loss (*Montipora*), 1

case of barnacle infestation (*Goniastrea*), 2 cases of coralline algal ring syndrome, 2 cases of coralline algal lethal orange disease, and 1 case of coralline algal cyanobacterial disease in a survey area of 300 m^2. Noncryptic macroinvertebrates were observed in low abundance. *Cladiella* and *Sinularia* were widespread. *Echinostrephus aciculatis* and *Calcinus* hermit crabs were common. Photoquadrat abundances of macroalgae found at this site included crustose coralline red algae, turf algae, cyanophytes, branched crustose coralline red algae, *Halimeda*, *Peyssonnelia*, and *Galaxaura marginata.* Noted on the random swim survey was *Halimeda.* The surgeonfish *Ctenochaetus striatus* was by far the most abundant fish, ranging in size from recruit to adult. Damselfish (*Pomacentrus*) were also common, and a variety of parrotfishes were observed, including *Scarus globiceps*, *Chlorurus japanensis*, *C. sordidus*, *C. frontalis*, and *Calatomus carolinus*.

TUT-20
14º16.704′ S, 170º40.182′ W
Depth Range: 10.36–12.50 m
This site was at outer Pago Pago Harbor along the east side. A total of 22 coral genera were recorded within the survey area, and *Pavona*, *Mycedium*, and *Montipora* were the most abundant taxa. Line-point intercept analysis found 4.9% hard coral cover, 1 case of subacute tissue loss (*Acropora*), 1 case of acute tissue loss ("white syndrome," *Mycedium elephantotus*), and 1 case of coralline algal cyanobacterial disease in a survey area of 300 m^2. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis.* Crinoids and hermit crabs were common. Macroalgae found in this site's photoquadrats consisted of turf algae, cyanophytes, *Bryopsis pennata*, and *Peyssonnelia.* The random swim survey yielded *Halymenia durvillei.* For fish, the distinguishing feature of this harbor site was the relatively large number of damselfish (*Pomacentrus* sp.) present. The sergeant *Abudefduf sexfasciatus* was also common. Only a few large fishes were seen, including the goatfish *Parupeneus insularis*, the parrotfish *Chlorurus japanensis*, and the snapper *Lutjanus bojar*.

TUT-69
14º19.323′ S, 170º40.050′ W
Depth Range: 17–20 m
This site is located on the south-central section of Tutuila's fringing reef on Taema Bank. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had high coral cover with medium reef complexity (flat extent) and was dominated by small *Pocillopora* heads. Small fish appeared to be lacking, perhaps, because of low coral structure. Fish biomass at this site was higher than at most other Tutuila sites and was comprised mainly of the acanthurids, *Ctenochaetus striatus* and *Acanthurus nigricans*.

TUT-70
14º17.418′ S, 170º38.940′ W
Depth Range: 3–4 m
This site is located on the south-central section of Tutuila's fringing reef. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had medium coral cover with high reef complexity (deep spur-and-groove formation). Reef fishes were mostly small damselfishes (*Stegastes*, *Plectroglyphididon*, *Chrysiptera*) and wrasses

(*Thalassoma*) with few large fishes (mostly acanthurids) on the top of the spurs. Large fishes were observed mostly at the bottom of grooves, off transect.

B.3. Benthic Environment

B.3.1. Algae

Quantitative algal surveys were conducted at 21 sites around Tutuila and Aunu`u Islands, American Samoa. Five species of macroalgae were recorded along survey transects: 6 species of green algae, 8 species of red algae, and 2 species of brown algae, as well as crustose coralline red algal, turf algal, and cyanophyte functional groups (Table B.3.1.1).

Table B.3.1.1.--Algal genera or functional groups recorded in photoquadrats around Tutuila. Numbers indicate the percentage of photoquadrats in which an alga occurred.

Division	Species/Name	TUT-01	TUT-02	TUT-03	TUT-04	TUT-05	TUT-06	TUT-07	TUT-08	TUT-09	TUT-10	TUT-11
	Cyanophyte	58.33	16.67	8.33	16.67	41.67	16.67	25	58.33	16.67	18.18	8.33
	turf algae	33.33	100	83.33	58.33	50	41.67	83.33	66.67	91.67	72.73	66.67
Chlorophyta	Bryopsis pennata											
Chlorophyta	Caulerpa serrulata		8.33									
Chlorophyta	Chlorodesmis fastigiata					16.67	8.33					
Chlorophyta	Codium sp.					8.33						
Chlorophyta	Halimeda sp.	75	16.67	16.67	16.67	16.67	75	41.67	91.67	33.33	81.82	
Chlorophyta	Ventricaria ventricosa											
Ochrophyta	Dictyota sp.					8.33						
Ochrophyta	Lobophora variegate				41.67	25						
Rhodophyta	Amphiroa sp.		66.67			41.67		16.67	58.33		45.45	
Rhodophyta	Cheilosporum spectabile										81.82	8.33
Rhodophyta	Crustose coralline red algae	50	91.67	83.33	58.33	58.33	75	66.67	100	50	90.91	66.67
Rhodophyta	Galaxaura sp.				16.67	8.33						
Rhodophyta	Gelidiella sp.										9.09	
Rhodophyta	Gibsmithia sp.		8.33									
Rhodophyta	Laurencia sp.											8.33
Rhodophyta	Peyssonnelia sp.	41.67	41.67	41.67	8.33	33.33	8.33	8.33	33.33		63.64	58.33

Division	Species/Name	TUT-01	TUT-02	TUT-03	TUT-04	TUT-05	TUT-06	TUT-07	TUT-08	TUT-09	TUT-10	TUT-11
Rhodophyta	Portieria hornemannii			8.33					8.33			8.33

Division	Species/Name	TUT-13	TUT-14	TUT-15	TUT-17	TUT-18	TUT-19	TUT-20	TUT-21	TUT-22	TUT-23
	Cyanophyte	16.67	50	8.33		41.67	25	58.33	16.67		
	turf algae	91.67	41.67	41.67	25	66.67	100	66.67	83.33	75	91.67
Chlorophyta	Bryopsis pennata							8.33			
Chlorophyta	Caulerpa serrulata										
Chlorophyta	Chlorodesmis fastigiata				8.33	8.33	8.33				
Chlorophyta	Codium sp.										
Chlorophyta	Halimeda sp.	33.33	83.33		8.33		75		16.67	58.33	
Chlorophyta	Ventricaria ventricosa	8.33									
Ochrophyta	Dictyota sp.										
Ochrophyta	Lobophora variegate	8.33	25		66.67	8.33	8.33				
Rhodophyta	Amphiroa sp.		33.33			8.33	91.67				
Rhodophyta	Cheilosporum spectabile								8.33	50	25
Rhodophyta	crustose coralline red algae	33.33	8.33	100	83.33	41.67	100		83.33	83.33	91.67
Rhodophyta	Galaxaura sp.						16.67				
Rhodophyta	Gelidiella sp.										
Rhodophyta	Gibsmithia sp.										
Rhodophyta	Laurencia sp.				25						
Rhodophyta	Peyssonnelia sp.		16.67	25	16.67	8.33	50	100	16.67	16.67	16.67
Rhodophyta	Portieria hornemannii										

B.3.2. Corals

Coral REA surveys were conducted February 18–25, 2008 at 23 forereef sites around Tutuila and Aunu`u Islands (Figs. B.2.1 and B.2.2). All sites surveyed in 2006 were resurveyed in 2008 with the addition of site TUT-03, which was last surveyed in 2004. Survey depths ranged between 11 m and 16 m. Coral population surveys were conducted by Jason Helyer (CRED) and coral disease and health assessments were conducted by Jean Kenyon, PhD (CRED).

B.3.2.1 Percent Benthic Cover

The line-point intercept quantified a total of 2346 points along 1150 m of forereef coral communities. Patterns of intraisland variability in percent benthic cover, derived from the 23 independent REA surveys in 2008, are reflected in Figure B.3.2.1.1. Islandwide, scleractinian corals, turf algae, and crustose coralline algae were the primary benthic components with 34.1% (SE 4.4), 27.7% (SE 4.5), and 21.5% (SE 3.6) of total benthic component cover. The highest values of scleractinian coral cover (76.5%) were found at TUT-09 off Pago Pago International Airport and TUT-16 off Aunu'u Island. The highest values of turf algal cover were found at TUT-15 (82.4%, Ta'ema Bank) and TUT-12 (73.5%, Massacre Bay). The highest value of coralline algal cover (65.7%) was found at TUT-20 in the outer Pago Pago Harbor.

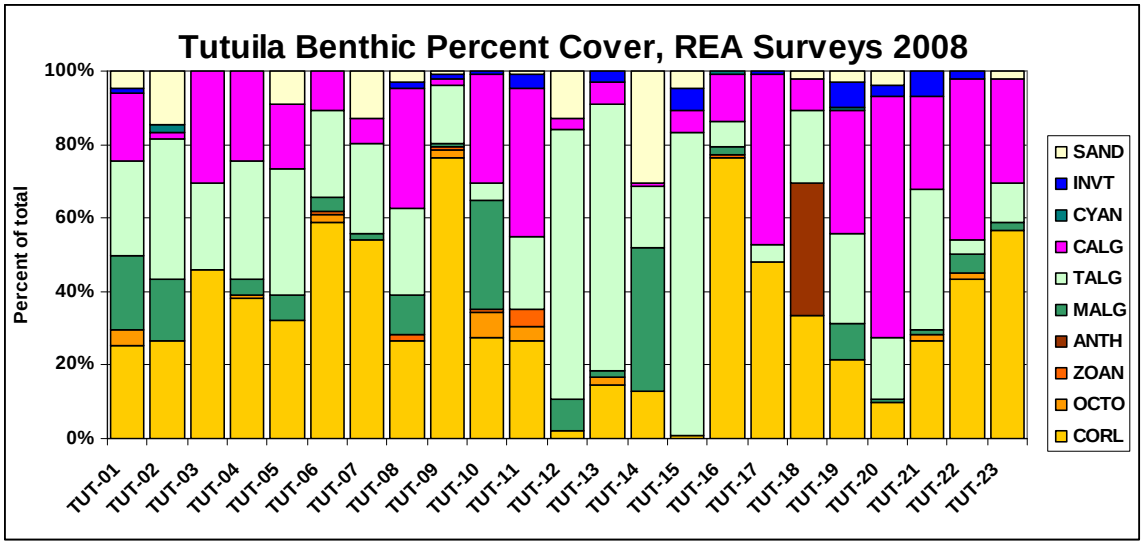


Figure B.3.2.1.1.--Mean percent cover of benthic elements derived from 23 independent REA surveys around Tutuila during the HI-08-02 ASRAMP cruise, February 15–25, 2008. CORL: scleractinian coral; OCTO: octocoral; ZOAN: zoanthid; ANTH: other anthozoans; MALG: macroalgae; TALG: turf algae (on pavement, rubble, and dead coral); CALG: crustose coralline algae (on pavement, rubble, and dead coral); CYAN: cyanobacteria (on pavement, rubble, and dead coral); INVT: non-anthozoan invertebrates; SAND: sand.

Of the 30 scleractinian genera enumerated along the transects, 3 genera, *Montipora*, *Porites*, and *Acropora*, contributed 60.9% of the coral cover, accounting for 26.3%, 19.7%, and 14.8% of the total. The other 27 genera collectively contributed 39.1% of the scleractinian coral cover. Below, Table B.3.2.1.1 provides an itemized analysis of the relative contribution of the different scleractinian genera to the total percent live coral cover.

Table B.3.2.1.1.--Relative contribution of the 30 scleractinian coral genera tallied in the line-intercept method for benthic cover.

Genus	% of Total
Acropora	**14.8**
Astreopora	2.7
Coscinaraea	0.9
Cyphastrea	0.1
Diploastrea	0.1
Echinophyllia	0.1
Echinopora	3.3
Favia	2.3
Favites	0.8
Fungia	1.5
Galaxea	1.6
Gardineroseris	0.1
Goniastrea	0.6
Halomitra	0.3
Hydnophora	1.0
Leptastrea	2.3
Leptoria	0.4
Lobophyllia	2.0
Merulina	1.6
Montastrea	4.4
Montipora	**26.3**
Mycedium	0.1
Pachyseris	0.3
Pavona	4.9
Platygyra	0.6
Pocillopora	6.5
Porites	**19.7**
Psammocora	0.1
Sandalolitha	0.1
Stylophora	0.3

B.3.2.2. Coral Populations

A total of 8777 coral colonies belonging to at least 46 cnidarian taxa (39 scleractinian genera, 6 octocorals, and 1 hydrozoan) were enumerated within the 1033 m^2 of reef surveyed around Tutuila and Aunu`u Islands (Table B.3.2.2.1). Members of the genera *Porites* and *Montipora* were the most abundant coral taxa in terms of number of colonies, contributing 22.7 and 14.9% of the total number of colonies recorded around Tutuila. Density values at individual sites ranged from 1.0 colonies m^{-2} at TUT-12 to 20.9 colonies m^{-2} at TUT-09. Generic richness values ranged from 10 coral genera, recorded at TUT-12, to 27 coral genera, observed at TUT-03. Inspection of coral size histograms show an overwhelming majority of corals had maximum diameters < 20 cm (78%). Only 5% of all colonies measured had diameters > 40 cm. The distribution of coral sizes in 2008 appears similar to coral size distributions observed in 2006 (Fig. B.3.2.2.1).

Table B.3.2.2.1.--Number of corals, by genus, enumerated along belt transects in 2008 coral REA surveys. Genera contributing more than 10% of the total number of colonies are highlighted in bold.

Genus	# of Colonies	% of Total	Genus	# of Colonies	% of Total
Acanthastrea	8	0.3	*Merulina*	46	2.0
Acropora	623	27.1	*Millepora*	11	0.5
Alveopora	57	2.5	*Montastrea*	478	20.8
Astreopora	171	7.4	***Montipora***	**1316**	**57.2**
Cladiella	32	1.4	*Mycedium*	34	1.5
Coscinaraea	29	1.3	Octocoral	1	0.0
Cycloseris	3	0.1	*Pachyseris*	1	0.0
Cyphastrea	45	2.0	*Palythoa*	101	4.4
Diploastrea	8	0.3	*Pavona*	666	29.0
Echinophyllia	9	0.4	*Platygyra*	9	0.4
Echinopora	135	5.9	*Pocillopora*	444	19.3
Favia	122	5.3	***Porites***	**1999**	**86.9**
Favites	60	2.6	*Psammocora*	114	5.0
Fungia	127	5.5	*Rhodactis*	91	4.0
Galaxea	359	15.6	*Sandalolitha*	3	0.1
Gardineroseris	2	0.1	*Sarcophyton*	36	1.6
Goniastrea	27	1.2	**Soft Coral**	**1061**	**46.1**
Goniopora	1	0.0	*Stylocoeniella*	5	0.2
Halomitra	1	0.0	*Stylophora*	14	0.6
Hydnophora	60	2.6	*Turbinaria*	7	0.3
Leptastrea	260	11.3	Unknown	13	0.6
Leptoria	31	1.3	*Zoanthus*	27	1.2
Leptoseris	61	2.7			
Lobophyllia	54	2.3			
Lobophytum	15	0.7	**Total**	**2300**	**100**

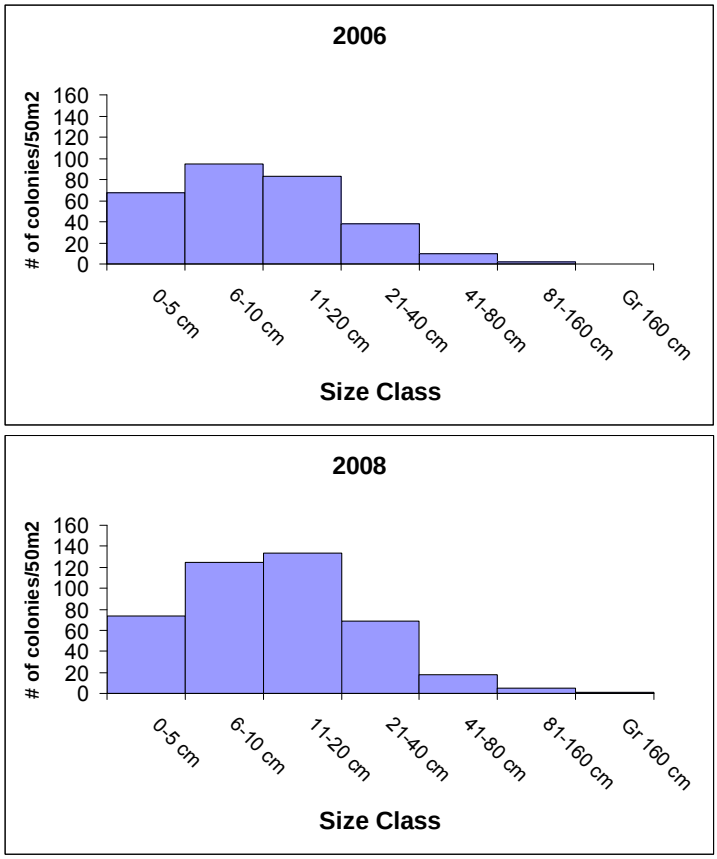


Figure B.3.2.2.1.--Coral size-class distributions for Tutuila in 2006 and 2008.

B.3.2.3 Coral Health and Disease

In 2008, a total area of ~ 6350 m^2 across 23 sites was surveyed for coral and coralline algae disease during REA surveys. Coral disease occurrence and abundance were low; a total of 148 cases of 8 categorized anomalies—barnacle infestation, bleaching, hyperpigmentation response, other discolorations, predation, skeletal growth anomaly, subacute tissue loss, and acute tissue loss "white syndrome"—were tallied. A summary of coral disease occurrence is presented in Figure B.3.2.3.1. The taxa most frequently affected by anomalies were *Montipora, Porites,* and *Acropora* (18.9%, 16.2%, and 10.1% of total cases).

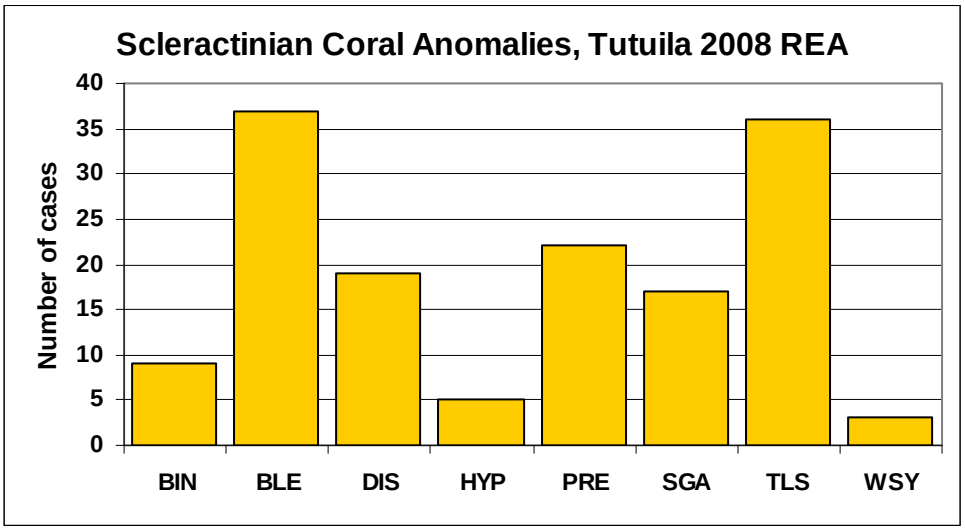


Figure B.3.2.3.1.--Number of cases of scleractinian disease enumerated during REA surveys at Tutuila, American Samoa, in 2008. BIN: barnacle infestation; BLE: bleaching; HYP: hyperpigmentation response; DIS: other discolorations; PRE: predation; SGA: skeletal growth anomaly; TLS: subacute tissue loss; and WSY: acute tissue loss "white syndrome."

A total of 103 cases of 5 coralline algal diseases were also tallied during the REA disease surveys. A summary of coralline algal disease occurrence is presented in Figure B.3.2.3.2, and representative photos are shown in Figure B.3.2.3.3. The most common affliction was coralline lethal orange disease, which accounted for 82.5% of the coralline algal disease cases. Coralline lethal orange disease was particularly abundant at Larsen Bay (TUT-11) and Fagatele Bay (TUT-22): 33 and 30 cases, respectively, in a survey area of 300 m^2 at each site.

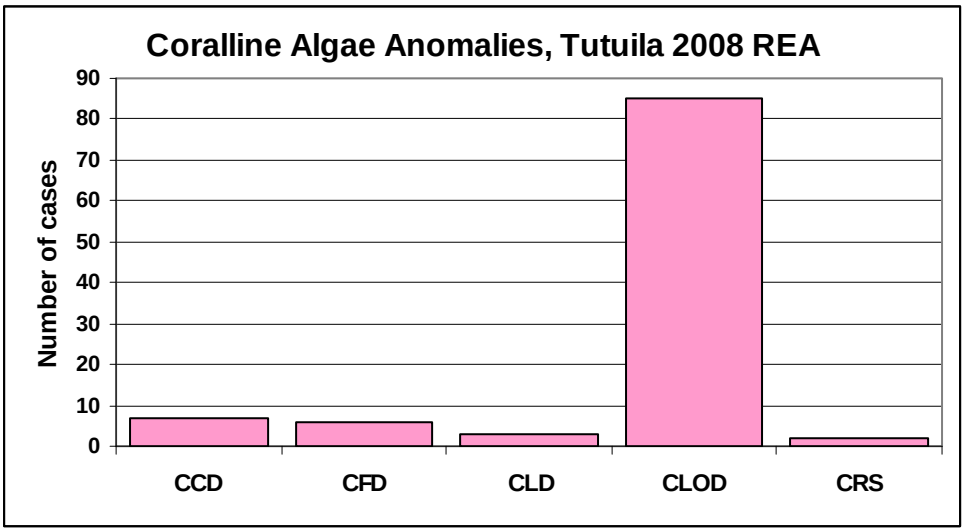
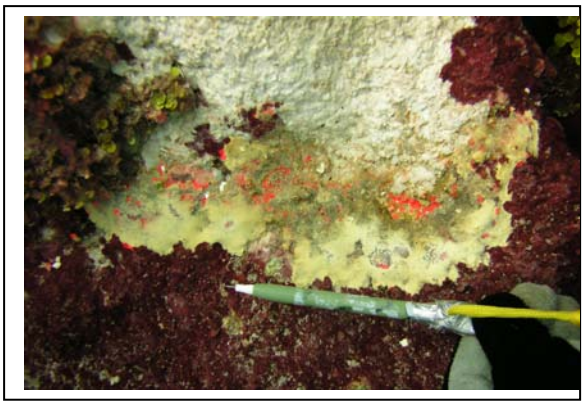


Figure B.3.2.3.2.--Number of cases of coralline algal disease enumerated during REA surveys around Tutuila, American Samoa, during ASRAMP 2008. CCD: coralline cyanophyte disease; CFD: coralline fungal disease; CLD: coralline lethal disease; CLOD: coralline lethal orange disease; CRS: coralline ring syndrome.

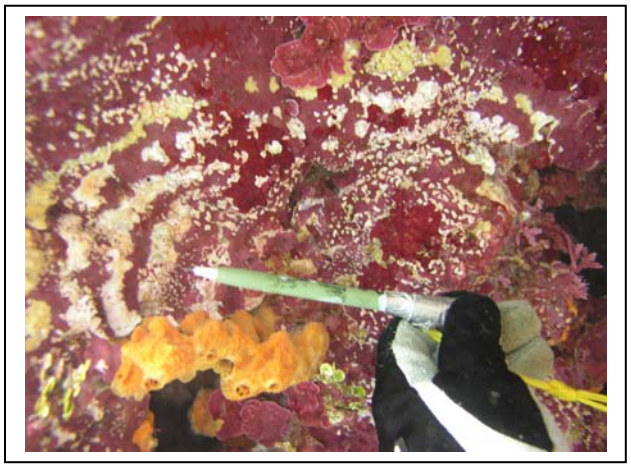


A. Coralline cyanophyte disease

B. Coralline fungal disease

C. Coralline lethal disease

D. Coralline lethal orange disease



E. Coralline ring syndrome

Figure B.3.2.3.3.--REA surveys documented 5 coralline algal diseases around Tutuila, American Samoa, during the ASRAMP 2008 cruise. *Photographs taken by Jean Kenyon, PhD.*

B.3.3. Macroinvertebrates

Noncryptic invertebrates were observed in relatively low abundance around Tutuila and Aunu`u Islands during ASRAMP 2008. *Calcinus* hermit crabs and the rock boring urchin (*Echinostephus aciculatus*) were the most abundant macroinvertebrates. Hermit crab, predominantly *Calcinus minutus*, densities were greatest at TUT-21, TUT-09, and TUT-03 (0.57, 2.85, and 0.58 m²). *Echinostephus aciculatus* densities were greatest at 3 SE sites, TUT-21, TUT-09, and TUT-15 (5.58, 3.65, and 1.68 m²). *Tridacna* clams were rare around Tutuila. They were observed on-transect at 11 REA sites totaling 20 individuals. Of the REA sites with octocoral presence (*Lobophyton*, *Sarcophyton*, *Cladiella*, and *Sinularia*) 62% were located along the south shore between Fagatele Bay and Alega Bay. No octocorals were observed on the north side between Poloa Bay and `Aoa Bay. Qualitatively, tunicates and sponges were more prevalent along the north side, specifically TUT-17, -04, -05, -14, -18, -19, -08, and -06. An unidentified white encrusting sponge was widespread throughout TUT-08 and TUT-19.

With the exception of 1 *Echinothrix calamaris* and 2 *Echinometra mathaei*, all echinoids observed were the rock boring urchin *Echinostephus aciculatus*. Excluding *Echinostephus aciculatus* and crinoids at TUT-16 (densities of 1.42 m^2), echinoderms were extremely rare around Tutuila. Only 1 individual of the following 3 species of holothuroids was observed: *Holothuria whitmaei, Bohadschia argus,* and an unidentified *Holothuria* sp. Five species of asteroids were observed: *Acanthaster planci, Fromia monilis, Linckia multifora, Culcita novaeguineae,* and *Gomophia* sp.*;* with *L. multifora* having the greatest number of overall sightings (10 individuals) and *A. planci* with the fewest (1 individual) sightings.

B.3.3.1. Urchin and Giant Clam Measurements

Figure B.3.3.1.1 below reveals the average test diameter of the urchin, *Echinostrephus aciculatus,* encountered at each site. Only sites where ≥ 5 measurements were recorded for a species are represented. No other species of urchin had more than 5 individuals recorded at an individual site. Measurements were not recorded specifically along the survey transect but rather throughout the site.

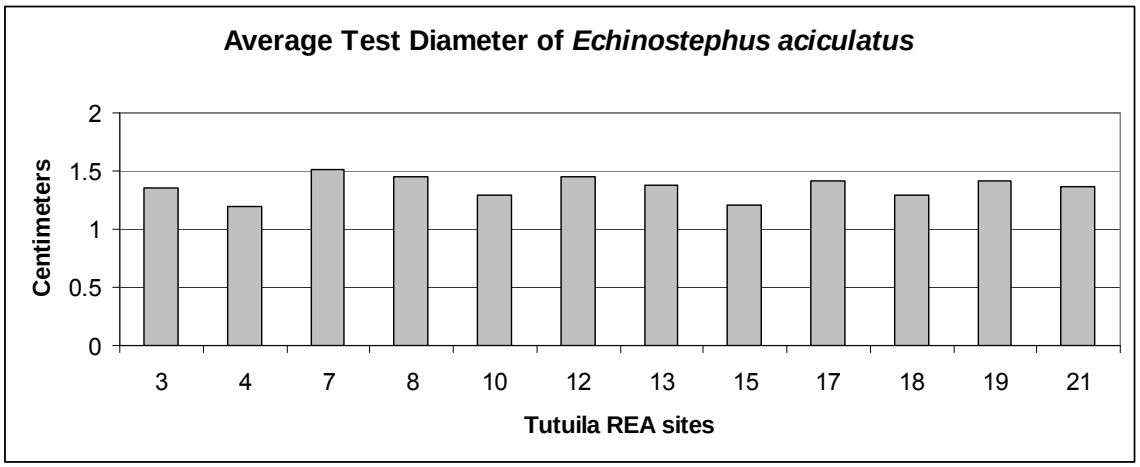


Figure B.3.3.1.1.--Average test diameter of *Echinostephus aciculatus* around Tutuila REA sites.

Figure B.3.3.1.2 below reveals the average maximum shell length of giant clams observed at sites around Tutuila. Only sites where ≥ 5 measurements were recorded are represented. Giant clams were recorded at a total of 13 sites. Measurements were not recorded specifically along the survey transect, rather throughout the site.

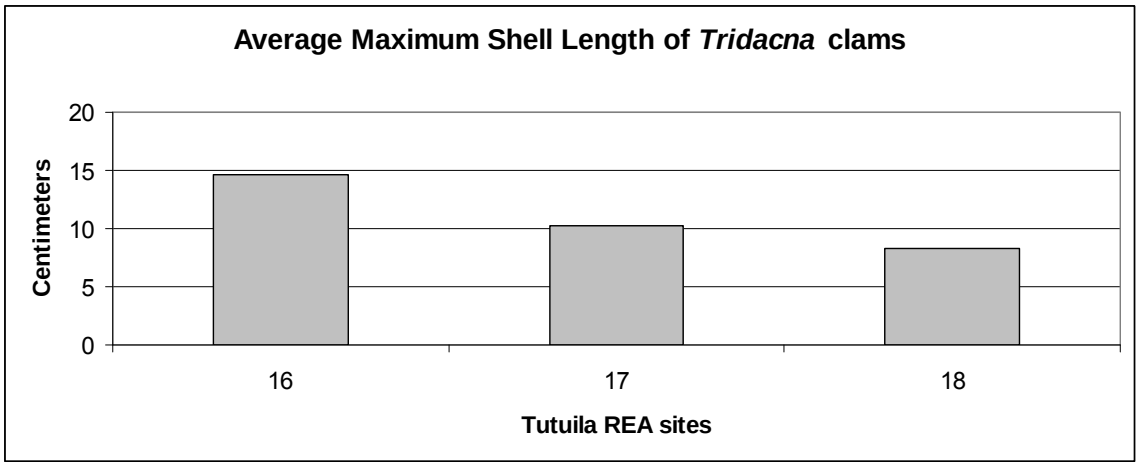


Figure B.3.3.1.2.--Average maximum shell length of *Tridacna* clams around Tutuila REA sites.

B.3.3.2. Autonomous Reef Monitoring Structures (ARMS) Deployment

Two sets of 3 replicate ARMS were deployed in Fagatele Bay, and 1 set of replicates was deployed in Larsen Bay (Table B.3.3.2.1). Each of the 3 sets of 3 ARMS was deployed near each other in the same type of habitat. The table below lists their site locations.

Table B.3.3.2.1.--ARMS deployment locations around Tutuila.

	Latitude and Longitudinal Position	
Fagatele Bay	14º21.968′ S, 170º45.773′ W	14º21.813′ S, 170º45.782′ W
Larsen Bay	14º21.625′ S, 170º45.021′ W	

B.3.3.3. Invertebrate Collections

Nondestructive tissue samples of the following organisms were collected for the Hawai`i Institute of Marine Biology, the University of Hawai`i at Mānoa, for the purpose of genetic analysis.

Table B.3.3.3.1.--Invertebrate tissue collection information for specimens from Tutuila.

Species	Number	REA site	Latitude	Longitude
Linckia multifora	3	TUT-01	14º16.998′ S	170º38.269′ W
Linckia multifora	2	TUT-02	14º16.667′ S	170º36.430′ W
Linckia multifora	2	TUT-21	14º21.073′ S	170º43.717′ W
Calcinus sp.	2	TUT-02	14º16.667′ S	170º36.430′ W
Crinoid *sp.*	3	TUT-03	14º16.051′ S	170º33.690′ W
Crinoid *sp.*	2	TUT-05	14º15.114′ S	170º37.415′ W
Crinoid *sp.*	2	TUT-06	14º19.684′ S	170º49.916′ W
Crinoid *sp.*	1	TUT-10	14º18.666′ S	170º41.578′ W

B.3.4 Towed-diver Benthic Surveys

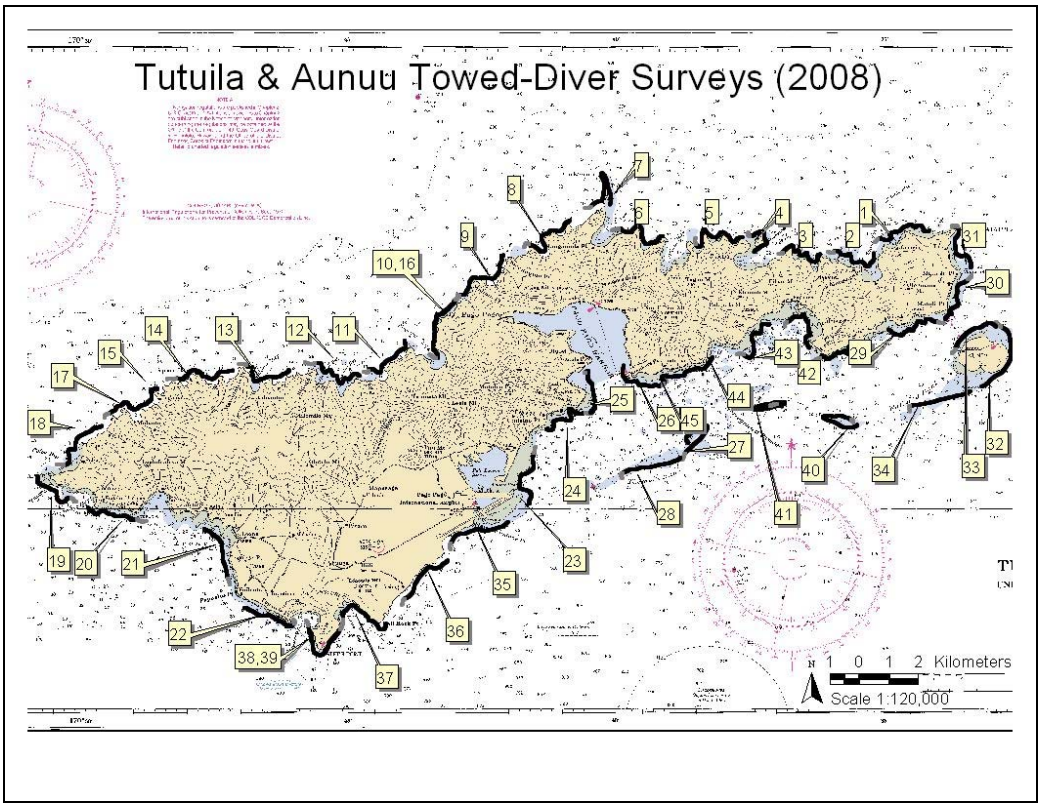


Figure B.3.4.1.--Towed-diver benthic surveys completed around Tutuila and Aunu`u Islands.

A total of 45 towed-diver benthic surveys covering 98.87 km of habitat were completed along the forereefs and banks of Tutuila and Aunu`u Islands. The average total hard coral cover for all pooled surveys was 19.9% (range: 0.1%–75%). The highest average coral cover of 49.25 (range: 20.1%–75%) was recorded off Pago Pago International Airport, past Matautuotafuna Point towing to the SW. The habitat was comprised of mostly continuous reef of medium-low to medium complexity, shifting to spur-and-groove habitat of medium-high to high complexity towards the end of the tow. The initial 5-min segments recorded some of the highest levels, ranging from 50.1% to 75%, of coral cover observed around Tutuila. Coral cover remained high during the entire tow, never dropping below 20.1%. Several large *Porites* colonies were also noted at lat. 14°20.313′ S, long.170°42.979′ W and lat. 14°20.314′ S, long. 170°42.987′ W.

The average total hard coral stress for all pooled surveys was recorded at 3.8% (range: 0%–30%). The highest average coral stress was recorded at 11% (range: 0.1%–30%) during a survey along the northeast side of Taema Bank, rounding the eastmost end and heading along the south side of the bank (Fig. B.3.4.1, survey No. 27). No direct cause of the observed coral stress was noted.

The average total soft coral cover was 4.76% (range: 0%–50%) for all pooled surveys. The highest soft coral cover was recorded on the east side of Pago Pago Harbor (just N of Breakers Point) and heading towards Lauliituai. Habitat consisted of continuous reef, interspersed with

rubble flats in the early portions of the survey. Overall, habitat complexity ranged from medium to high, with sections going as deep as 26 m and as shallow as 6 m. Soft coral cover averaged 17.75% (range: 1.1%–40%) with the last 3 time segments recording 30.1%–40% cover. Soft corals included *Sinularia*, *Cladiella*, *Sarcophyton* and *Lobophyton*, with increases noted especially in the more shallow sections.

The average pooled macroalgal cover was 10.26% (range: 0%–62.5%), while the average pooled coralline algae cover was 25.47% (range: 0%–75%). A survey past Amaua, heading W, recorded the highest macroalgal cover of 32.38% (range: 5.1%–62.5%), and algal flora seen in previous surveys (e.g., *Halimeda*) were prevalent. Habitat consisted of medium to medium-high continuous reef and spur-and-groove habitat with a large sand flat recorded towards the middle of this survey. While native kelp is not known in American Samoa, large algal fronds vaguely resembling kelp was found growing on discarded tires within this sand flat region. A sample was collected for future phycological identification.

An additional and unusual observation was noted for a towed-diver survey completed immediately before Matuli Pt. heading ENE to just past Alao Village (near Maalatele Rocks). Fragments of a different unidentified algae (also resembling kelp) were observed floating through the water column throughout the entire duration of this towed-diver survey (which was longer than 2 km) and was not seen elsewhere, either in the water or rooted to substrate. Note that no frond stems or roots were observed among these floating fragments. *Aspragopsis* was also seen at the end of this survey but was not captured in any still photographic data; nor were any samples collected. A review of videographic data is pending.

Macroinvertebrate populations were generally low around Tutuila and Aunu`u Islands. Only 1 crown-of-thorns seastar (*Acanthaster plancii*) was recorded for all combined surveys. Both sea cucumbers (14, all combined surveys) and free urchins (1, all combined surveys) also appeared to be intrinsically rare. A total of 136 giant clams were recorded for all of Tutuila and Aunu`u Islands, a level that translates to 1.38 clams ha^{-1}. Boring sea urchins, however, were relatively common, and appeared to be primarily *Echinostrephus aciculatus*, which were recorded at a rate of 1084 urchins ha^{-1}. The highest concentration of boring sea urchins (4228 urchins ha^{-1}; 8 time segments recording more than 1001 urchins) was found during a towed-diver survey conducted heading NW past Steps Point into Fagatele Bay.

B.4 Fish

B.4.1 REA Fish Surveys

Stationary-Point Count Data (new methodology)

A total of 90 individual stationary-point count surveys were conducted at 48 sites around Tutuila and Aunu`u Islands (site depths: 10 shallow, 27 mid, 11 deep). Surgeonfishes (Acanthuridae) and fusiliers (Caesionidae) were the largest contributors to biomass with 1.3 kg 100 m^{-2} each. Parrotfishes (Scaridae), with a biomass of ~ 0.50 kg 100 m^{-2}, were the third most abundant family (Fig. B.4.1.1 and Table B.4.1.2).

Belt-transect Data

During the survey period, 90 belt-transect surveys were conducted at 47 sites around Tutuila and Aunu`u Islands. Surgeonfishes were the primary contributors to biomass at 1.2 kg 100 m^{-2}. (Table B.4.1.1). Fusiliers were practically absent from belt-transect counts at 0.1 kg 100 m^{-2}. Parrotfish were also moderately abundant at 0.5 kg 100 m^{-2}.

Overall Observations

A total of 287 species were observed during this survey period by all divers. The average total fish biomass at the sites around Tutuila during the survey period was 0.43 t ha^{-1} for the stationary-point count surveys (Table B.4.1.2), and the average fish biomass was 0.34 t ha^{-1} for the belt-transect surveys (Table B.4.1.1).

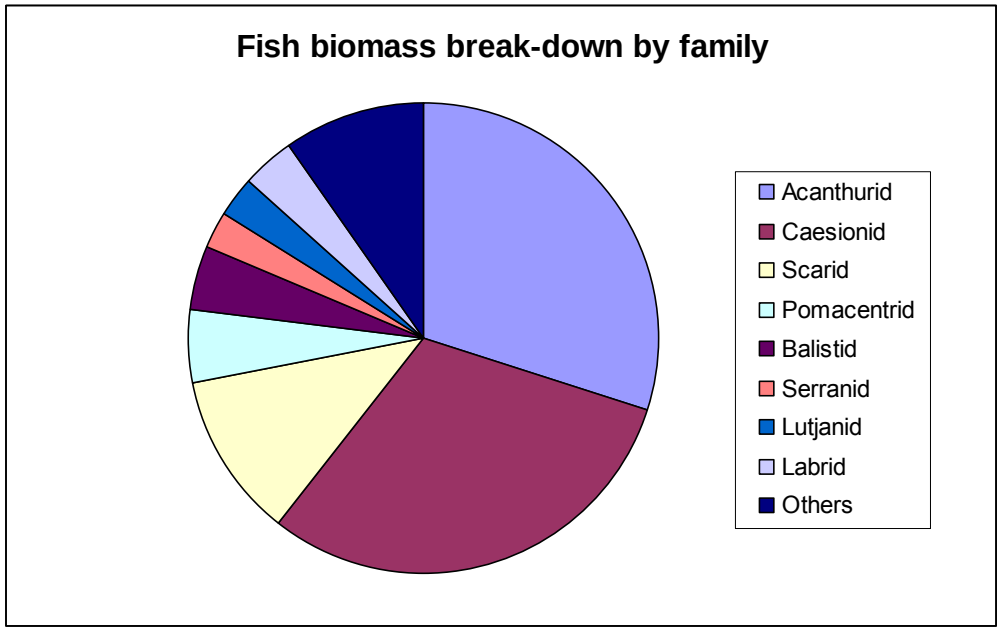


Figure B.4.1.1.--Total fish biomass composition by family, measured by the stationary-point count surveys.

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Table B.4.1.1.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Tutuila as measured by the belt-transect surveys.

Stratum Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
Forereef—Deep	TUT-51	4.7	1.08	0.00	0.26	0.00	0.00	0.51	0.00	0.94	0.00	0.37	1.55
	TUT-52	2.9	1.83	0.00	0.00	0.29	0.00	0.28	0.00	0.00	0.07	0.15	0.23
	TUT-55	2.4	0.58	0.00	1.03	0.15	0.00	0.19	0.00	0.00	0.00	0.14	0.34
	TUT-57	2.6	1.13	0.00	0.00	0.46	0.00	0.13	0.13	0.04	0.09	0.09	0.49
	TUT-58	5.3	0.49	0.00	0.00	2.90	0.00	0.27	0.07	1.11	0.04	0.04	0.38
	TUT-60	1.4	0.57	0.00	0.00	0.64	0.00	0.08	0.00	0.00	0.00	0.10	0.05
	TUT-61	8.8	3.67	0.00	0.18	2.54	0.00	0.22	0.21	0.25	0.00	0.27	1.49
	TUT-63	3.4	1.16	0.00	0.00	0.70	0.00	0.30	0.34	0.13	0.00	0.00	0.80
	TUT-65	2.0	1.37	0.00	0.00	0.00	0.00	0.23	0.08	0.03	0.00	0.14	0.18
	TUT-67	1.6	0.88	0.00	0.27	0.04	0.00	0.14	0.06	0.04	0.00	0.03	0.17
	TUT-69	6.5	5.25	0.00	0.00	0.52	0.00	0.13	0.22	0.00	0.00	0.15	0.23
Forereef—Mid	TUT-01	2.6	0.92	0.00	0.00	1.28	0.00	0.14	0.00	0.00	0.04	0.11	0.07
	TUT-02	1.4	0.43	0.00	0.00	0.35	0.00	0.30	0.00	0.00	0.00	0.08	0.24
	TUT-03	2.6	1.05	0.00	0.00	0.48	0.00	0.28	0.07	0.00	0.00	0.18	0.53
	TUT-04	1.6	0.81	0.00	0.00	0.00	0.00	0.31	0.02	0.04	0.00	0.15	0.22
	TUT-05	2.4	0.91	0.00	0.00	1.14	0.00	0.13	0.00	0.00	0.00	0.04	0.21
	TUT-06	2.9	0.76	0.00	0.00	1.47	0.00	0.25	0.02	0.00	0.15	0.07	0.15
	TUT-07	0.2	0.04	0.00	0.00	0.00	0.00	0.09	0.00	0.01	0.00	0.02	0.01
	TUT-09	0.5	0.08	0.00	0.00	0.00	0.00	0.18	0.05	0.00	0.00	0.04	0.11
	TUT-10	1.3	0.56	0.00	0.00	0.05	0.00	0.27	0.17	0.13	0.00	0.07	0.10
	TUT-11	1.9	1.28	0.00	0.00	0.00	0.00	0.12	0.34	0.00	0.00	0.03	0.17
	TUT-12	4.4	1.33	0.00	0.00	1.31	0.00	0.20	0.15	0.00	0.00	0.03	1.34
	TUT-13	2.1	0.68	0.00	0.00	0.00	0.00	0.38	0.50	0.16	0.00	0.28	0.14
	TUT-14	1.7	0.41	0.00	0.00	0.37	0.00	0.32	0.00	0.09	0.02	0.23	0.24
	TUT-15	1.9	1.08	0.00	0.00	0.16	0.00	0.18	0.00	0.18	0.00	0.09	0.22
	TUT-16	2.5	0.96	0.00	0.00	0.58	0.00	0.52	0.12	0.07	0.00	0.06	0.20
	TUT-17	2.6	0.55	0.00	0.00	1.04	0.00	0.30	0.00	0.09	0.00	0.63	0.02
	TUT-18	5.3	0.30	0.00	0.00	1.84	0.00	0.47	0.09	0.75	0.00	0.12	1.72
	TUT-19	1.7	0.89	0.00	0.00	0.09	0.00	0.14	0.13	0.02	0.17	0.07	0.19
	TUT-20	2.3	0.51	0.00	0.00	0.12	0.00	0.54	0.00	0.00	0.20	0.54	0.41
	TUT-21	3.2	2.07	0.00	0.00	0.04	0.00	0.42	0.02	0.27	0.00	0.16	0.20
	TUT-22	3.0	0.82	0.00	0.00	1.13	0.00	0.09	0.37	0.00	0.00	0.07	0.49
	TUT-23	1.8	1.13	0.00	0.00	0.17	0.00	0.12	0.08	0.00	0.08	0.05	0.14
	TUT-56	2.2	0.71	0.00	0.00	0.00	0.00	0.48	0.00	0.10	0.00	0.39	0.49
	TUT-61	10.6	4.21	0.00	0.00	3.73	0.00	0.16	0.72	0.00	0.49	0.00	1.28

Table B.4.1.1.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Tutuila as measured by the belt-transect surveys.

Stratum Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
	TUT-63	25.8	2.71	0.00	0.00	0.00	21.09	0.52	0.00	0.08	0.00	0.53	0.91
	TUT-69	9.8	4.74	0.00	3.39	0.54	0.00	0.41	0.18	0.27	0.00	0.17	0.15
Forereef—Shallow	TUT-50	1.7	0.66	0.00	0.00	0.02	0.00	0.15	0.53	0.08	0.00	0.13	0.10
	TUT-53	1.6	0.82	0.00	0.00	0.10	0.00	0.21	0.12	0.05	0.01	0.19	0.12
	TUT-54	0.8	0.03	0.00	0.00	0.00	0.00	0.28	0.19	0.02	0.00	0.14	0.11
	TUT-56	1.3	0.41	0.00	0.00	0.00	0.00	0.46	0.24	0.00	0.00	0.17	0.04
	TUT-59	0.8	0.03	0.00	0.00	0.37	0.00	0.16	0.05	0.00	0.00	0.16	0.06
	TUT-62	2.4	1.48	0.00	0.00	0.39	0.00	0.17	0.00	0.00	0.00	0.19	0.17
	TUT-64	1.8	1.22	0.00	0.00	0.03	0.00	0.07	0.00	0.00	0.00	0.19	0.31
	TUT-66	4.5	1.28	0.00	1.14	0.56	0.00	0.53	0.12	0.09	0.08	0.17	0.51
	TUT-68	1.9	0.95	0.00	0.00	0.07	0.00	0.26	0.03	0.10	0.00	0.18	0.35
	TUT-70	1.0	0.32	0.00	0.00	0.10	0.00	0.29	0.00	0.00	0.07	0.11	0.07
Grand average		3.4	1.2	0.0	0.1	0.5	0.4	0.3	0.1	0.1	0.0	0.2	0.4

Table B.4.1.2.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Tutuila as measured by the stationary-point count surveys.

Stratum Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
Forereef—Deep	TUT-51	7.1	0.75	0.00	3.04	0.75	0.00	0.41	0.28	0.12	1.27	0.15	0.29
	TUT-52	5.7	1.99	0.00	0.00	0.49	0.00	0.20	0.14	0.60	1.60	0.25	0.40
	TUT-55	1.8	0.61	0.00	0.00	0.17	0.00	0.38	0.18	0.02	0.00	0.16	0.27
	TUT-57	1.6	0.17	0.00	0.46	0.00	0.00	0.30	0.07	0.05	0.09	0.05	0.36
	TUT-58	2.2	0.67	0.00	0.00	0.11	0.00	0.39	0.20	0.13	0.38	0.06	0.21
	TUT-60	1.5	0.34	0.00	0.00	0.86	0.00	0.07	0.02	0.01	0.00	0.04	0.14
	TUT-61	9.7	3.69	0.00	0.88	0.83	0.00	0.21	0.57	0.44	0.44	0.33	2.28
	TUT-63	8.0	3.37	0.00	0.00	1.69	0.00	0.15	0.23	0.37	0.00	0.43	1.81
	TUT-65	4.9	1.26	0.00	1.92	0.24	0.00	0.48	0.15	0.20	0.13	0.12	0.43
	TUT-67	2.5	1.53	0.00	0.00	0.38	0.00	0.09	0.16	0.01	0.01	0.08	0.22
	TUT-69	12.2	5.16	0.00	3.66	1.67	0.00	0.10	0.25	0.08	0.15	0.32	0.84
Forereef—Mid	TUT-01	1.7	0.92	0.00	0.00	0.17	0.00	0.19	0.02	0.00	0.03	0.06	0.27
	TUT-02	1.8	0.60	0.00	0.00	0.30	0.00	0.36	0.01	0.01	0.02	0.06	0.47
	TUT-03	3.8	1.80	0.00	0.21	0.51	0.00	0.21	0.16	0.02	0.00	0.58	0.29
	TUT-04	1.8	0.97	0.00	0.00	0.14	0.00	0.13	0.03	0.06	0.00	0.09	0.39
	TUT-05	1.3	0.46	0.00	0.00	0.34	0.00	0.10	0.02	0.00	0.00	0.09	0.25
	TUT-06	2.1	0.65	0.00	0.00	0.49	0.00	0.18	0.09	0.01	0.08	0.06	0.56

Table B.4.1.2.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Tutuila as measured by the stationary-point count surveys.

Stratum Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
	TUT-07	2.8	1.09	0.00	0.00	1.06	0.00	0.14	0.13	0.02	0.04	0.17	0.14
	TUT-08	1.5	0.70	0.00	0.00	0.20	0.00	0.12	0.14	0.03	0.03	0.06	0.25
	TUT-09	0.7	0.23	0.00	0.00	0.05	0.00	0.13	0.12	0.01	0.00	0.09	0.10
	TUT-10	0.8	0.22	0.00	0.00	0.10	0.00	0.12	0.02	0.09	0.00	0.04	0.24
	TUT-11	4.1	1.92	0.00	0.67	0.36	0.00	0.09	0.19	0.31	0.02	0.09	0.45
	TUT-12	2.9	0.77	0.00	0.00	1.27	0.00	0.11	0.12	0.05	0.13	0.08	0.41
	TUT-13	1.5	0.38	0.00	0.00	0.01	0.00	0.16	0.21	0.27	0.00	0.27	0.22
	TUT-14	0.9	0.15	0.00	0.00	0.11	0.00	0.21	0.01	0.02	0.04	0.12	0.19
	TUT-15	2.1	1.01	0.00	0.00	0.01	0.00	0.15	0.33	0.29	0.00	0.12	0.24
	TUT-16	3.7	0.73	0.00	0.48	1.06	0.00	0.42	0.34	0.17	0.05	0.11	0.32
	TUT-17	2.2	1.40	0.00	0.00	0.13	0.00	0.14	0.28	0.08	0.00	0.07	0.07
	TUT-18	2.9	0.32	0.00	0.46	0.56	0.00	0.27	0.07	0.22	0.03	0.05	0.92
	TUT-19	1.9	0.32	0.00	0.00	0.77	0.00	0.06	0.24	0.01	0.08	0.19	0.17
	TUT-20	1.8	0.25	0.00	0.00	0.06	0.00	0.43	0.06	0.01	0.18	0.15	0.68
	TUT-21	2.7	1.40	0.00	0.00	0.46	0.00	0.13	0.08	0.18	0.00	0.11	0.33
	TUT-22	3.5	1.22	0.00	0.00	1.30	0.00	0.15	0.17	0.23	0.00	0.23	0.21
	TUT-23	1.6	1.01	0.00	0.00	0.17	0.00	0.15	0.04	0.02	0.02	0.03	0.12
	TUT-56	3.0	1.52	0.00	0.00	0.22	0.00	0.62	0.14	0.00	0.07	0.24	0.17
	TUT-61	8.9	5.54	0.00	0.00	0.76	0.00	0.12	0.49	0.56	0.00	0.20	1.22
	TUT-63	7.2	1.67	0.00	0.00	2.27	0.00	0.29	0.56	0.17	0.30	0.30	1.65
	TUT-69	52.8	1.79	0.00	50.70	0.00	0.00	0.07	0.03	0.02	0.00	0.04	0.12
Forereef—Shallow	TUT-50	1.5	0.58	0.00	0.00	0.05	0.00	0.27	0.27	0.02	0.00	0.06	0.24
	TUT-53	3.5	1.41	0.00	0.00	0.64	0.00	0.20	0.33	0.06	0.00	0.22	0.70
	TUT-54	1.5	0.47	0.00	0.00	0.23	0.00	0.38	0.05	0.03	0.00	0.19	0.11
	TUT-56	2.5	0.48	0.00	0.00	0.00	0.00	0.52	0.77	0.15	0.00	0.51	0.10
	TUT-59	1.8	0.73	0.00	0.00	0.38	0.00	0.17	0.09	0.05	0.00	0.10	0.32
	TUT-62	5.0	3.53	0.00	0.00	0.74	0.00	0.13	0.08	0.06	0.00	0.22	0.21
	TUT-64	3.6	2.21	0.00	0.00	0.37	0.00	0.09	0.58	0.03	0.00	0.14	0.19
	TUT-66	3.6	1.37	0.00	0.80	0.32	0.00	0.44	0.12	0.02	0.15	0.16	0.25
	TUT-68	3.8	2.48	0.00	0.00	0.43	0.00	0.22	0.29	0.08	0.07	0.13	0.13
	TUT-70	1.1	0.51	0.00	0.00	0.00	0.00	0.24	0.00	0.04	0.00	0.10	0.21
Grand Average		**4.3**	**1.3**	**0.0**	**1.3**	**0.5**	**0.0**	**0.2**	**0.2**	**0.1**	**0.1**	**0.2**	**0.4**

B.4.2 Towed-diver Fish Surveys

Table B.4.2.1.--Towed-diver survey report for Tutuila Island.

			Survey Length (km)				Mean Depth
		N	Min	Max	Median	Sum	Average (m)
Tutuila Island	**02/18/2008**	4	1.58	2.38	2.18	8.34	-13.85
	02/19/2008	6	2.12	2.64	2.50	14.67	-15.26
	02/20/2008	6	0.67	2.65	2.14	12.02	-15.56
	02/21/2008	6	1.84	2.29	2.09	12.47	-15.40
	02/22/2008	6	1.99	2.35	2.27	13.35	-14.69
	02/23/2008	6	1.84	2.66	2.13	13.12	-14.49
	02/24/2008	5	2.11	2.46	2.21	11.27	-14.25
	02/25/2008	6	2.05	2.46	2.28	13.63	-14.13
	All	45	0.67	2.66	2.25	98.87	-14.07

N = number of surveys conducted.

Depth readings are taken at 5-s intervals during each 50-min survey and are reported as a mean depth per survey. Mean Depth Average is the median mean depth value for all surveys on a given day.

A total of 39 species of large fishes (> 50 cm in total length) representing 20 families were observed around Tutuila and Aunu`u Islands during the survey period (February 18–25, 2008). The mean number of fishes (all species pooled) observed by divers was 4.00 large fish ha^{-1}. The 8 most frequently recorded species are shown in Figure B.4.2.1. The bigeye jack (*Caranx sexfasciatus*) was the most abundant species observed during the quantitative surveys with a mean number of 0.83 fish ha^{-1} observed. The steephead parrotfish (*Chlorurus microhinus*) was the second most abundant fish species encountered during the survey with 0.82 fish ha^{-1} recorded.

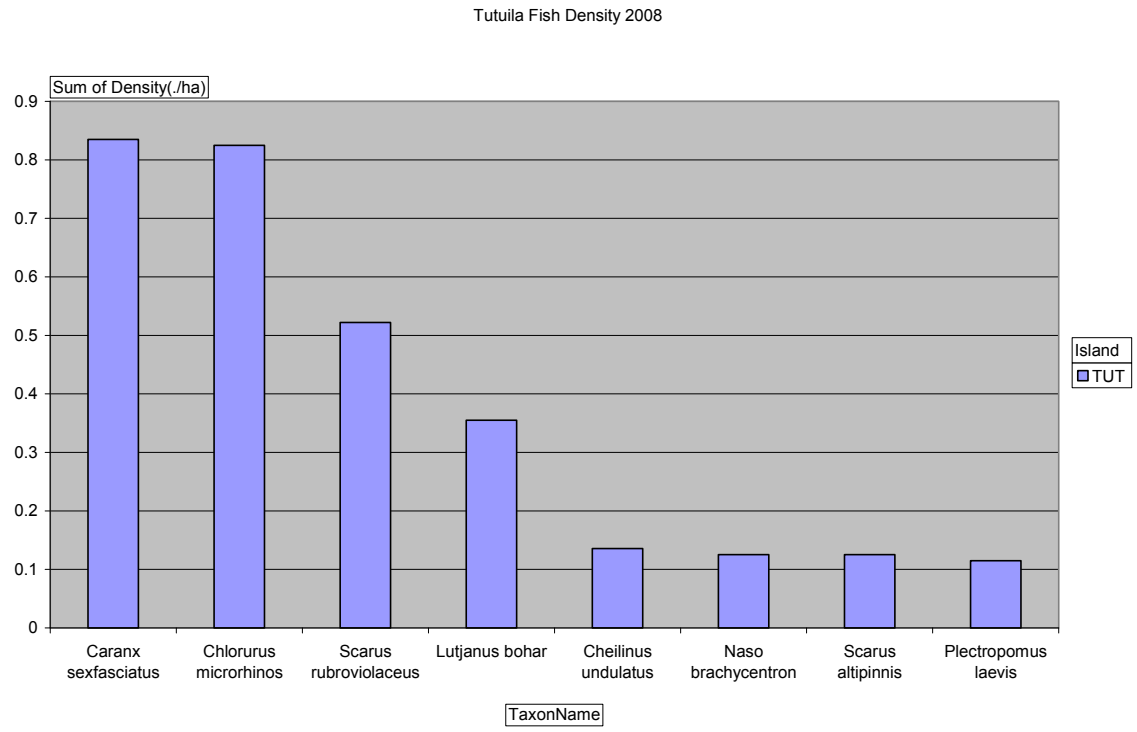

Figure B.4.2.1.--Density of the 8 species most frequently recorded around Tutuila.

The grand mean biomass density of fishes observed on the shallow reefs (< 30 m) around Tutuila and Aunu`u Islands during the survey period was 0.015 t ha^{-1}. The bigeye jack (*Caranx sexfasciatus*) and the steephead parrotfish (*Chlorurs microhinus*) accounted for 35% of the total mean biomass (Fig. B.4.2.2). The total biomass density for the Napolean wrasse (*Chellinus undulatus)* was 0.0015 t ha^{-1}, putting it third in terms of largest biomass around Tutuila.

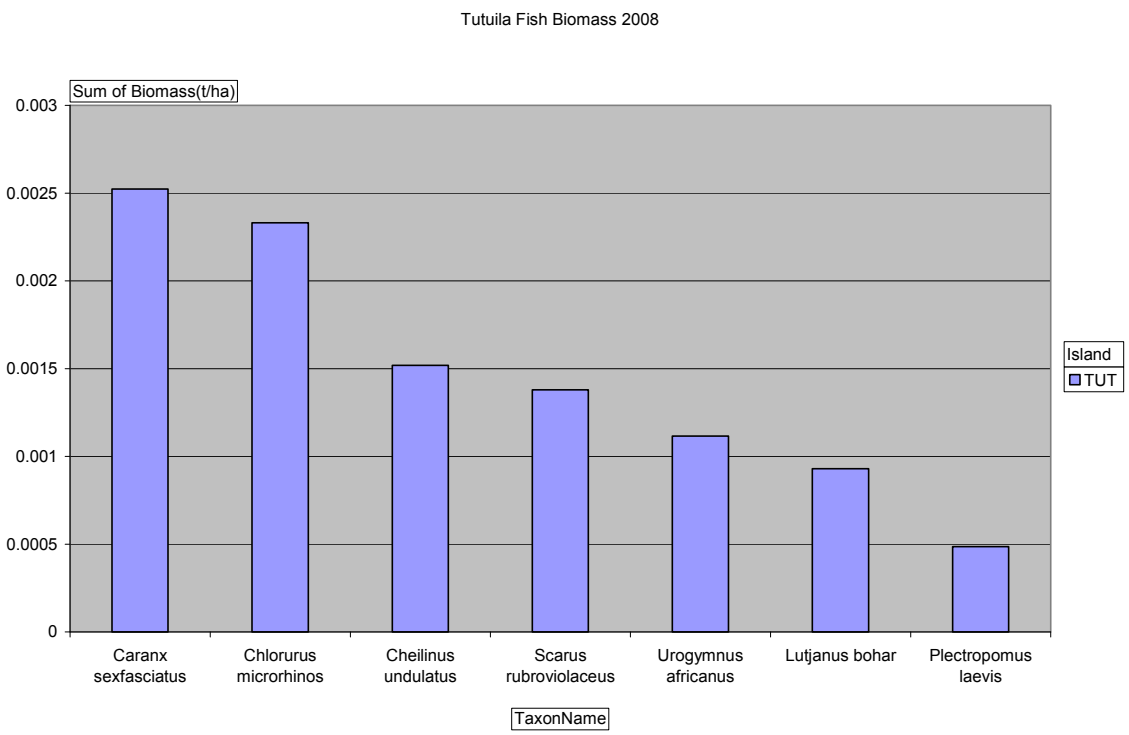

Figure B.4.2.2.--The 7 species with the highest biomass around Tutuila.

Appendix C: Ofu and Olosega

C.1. Oceanography and Water Quality

Moorings

A total of 7 subsurface temperature recorders (STRs) were recovered and replaced at Ofu and Olosega Islands during the HI-08-02 American Samoa Reef Assessment and Monitoring Program (ASRAMP) cruise (Fig. C.1.1 and Table C.1.1).

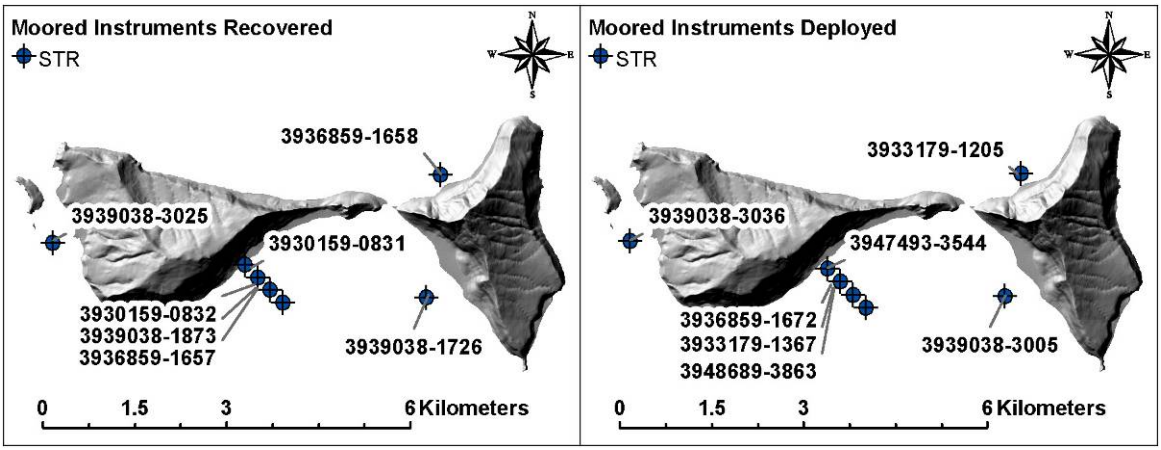

Figure C.1.1.--Moored oceanographic instrumentation map for Ofu and Olosega Islands.

Table C.1.1.--Moored oceanographic instrumentation table for Ofu and Olosega Islands.

Instrument	Serial Number	Latitude	Longitude	Depth (m)	Data Start	Data End
STR	3930159-0832	14 10.81 S	169 39.1316 W	6.10	27-Feb-06	28-Feb-08
STR	3939038-1873	14 10.8373 S	169 39.1159 W	18.90	INSTRUMENT FAILED	
STR	3936859-1657	14 10.8429 S	169 39.1028 W	30.78	27-Feb-06	24-Oct-07
STR	3930159-0831	14 10.6621 S	169 39.1587 W	1.22	1-Mar-06	31-Jan-08
STR	3939038-3025	14 10.4203 S	169 40.8985 W	9.14	1-Mar-06	28-Feb-08
STR	3939038-1726	14 10.901 S	169 37.597 W	10.67	26-Feb-06	16-Dec-07
STR	3936859-1658	14 9.8377 S	169 37.4913 W	6.71	27-Feb-06	30-May-07
STR	3936859-1672	14 10.81 S	169 39.1316 W	6.10	LOGGING DATA	
STR	3933179-1367	14 10.8373 S	169 39.1159 W	18.90	LOGGING DATA	
STR	3948689-3863	14 10.8429 S	169 39.1028 W	30.78	LOGGING DATA	
STR	3947493-3544	14 10.6621 S	169 39.1587 W	1.22	LOGGING DATA	
STR	3939038-3036	14 10.4203 S	169 40.8985 W	9.14	LOGGING DATA	
STR	3939038-3005	14 10.906 S	169 37.5964 W	11.28	LOGGING DATA	
STR	3933179-1205	14 9.8377 S	169 37.4913 W	6.71	LOGGING DATA	

Preliminary Mooring Results

Of the 7 STRs recovered from Ofu and Olosega, 6 yielded good data. Of these 6, however, 3 STRs (Nos. 1657, 1658, and 1726) stopped prematurely due to battery failure (Fig. C.1.2). Between March 2006 and March 2008 subsurface water temperatures around Ofu and Olosega fluctuated with typical seasonal variability for these latitudes with lows (~ 27 °C) occurring July–October and highs between January–April (~ 32 °C). All sensors showed similar temperatures within 1 °C of variability between them. The large diurnal fluctuations

observed in the STR No. 0831 time series, deployed in ~ 1.2 m of water, reflects the effects of heating and cooling in very shallow water.

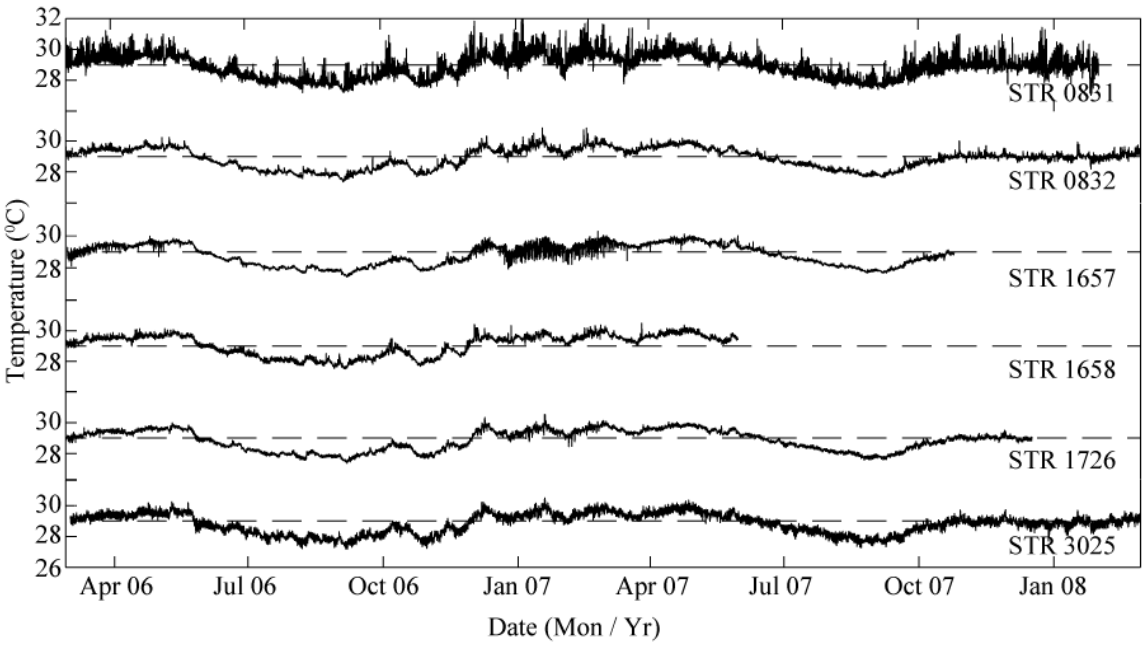

Figure C.1.2.--Temperature data obtained from 6 STR locations around Ofu and Olosega Islands.

Water Quality

At the 30-m bathymetric contour around both islands, 25 shallow-water conductivity, temperature, and depth (CTD) casts were conducted. Discrete water samples from a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m were collected concurrently with shallow-water CTD casts at 6 of the 25 CTD sites, yielding a total of 26 chlorophyll-*a* and 26 nutrient samples. All casts were performed on the same day (Fig. C.1.3).

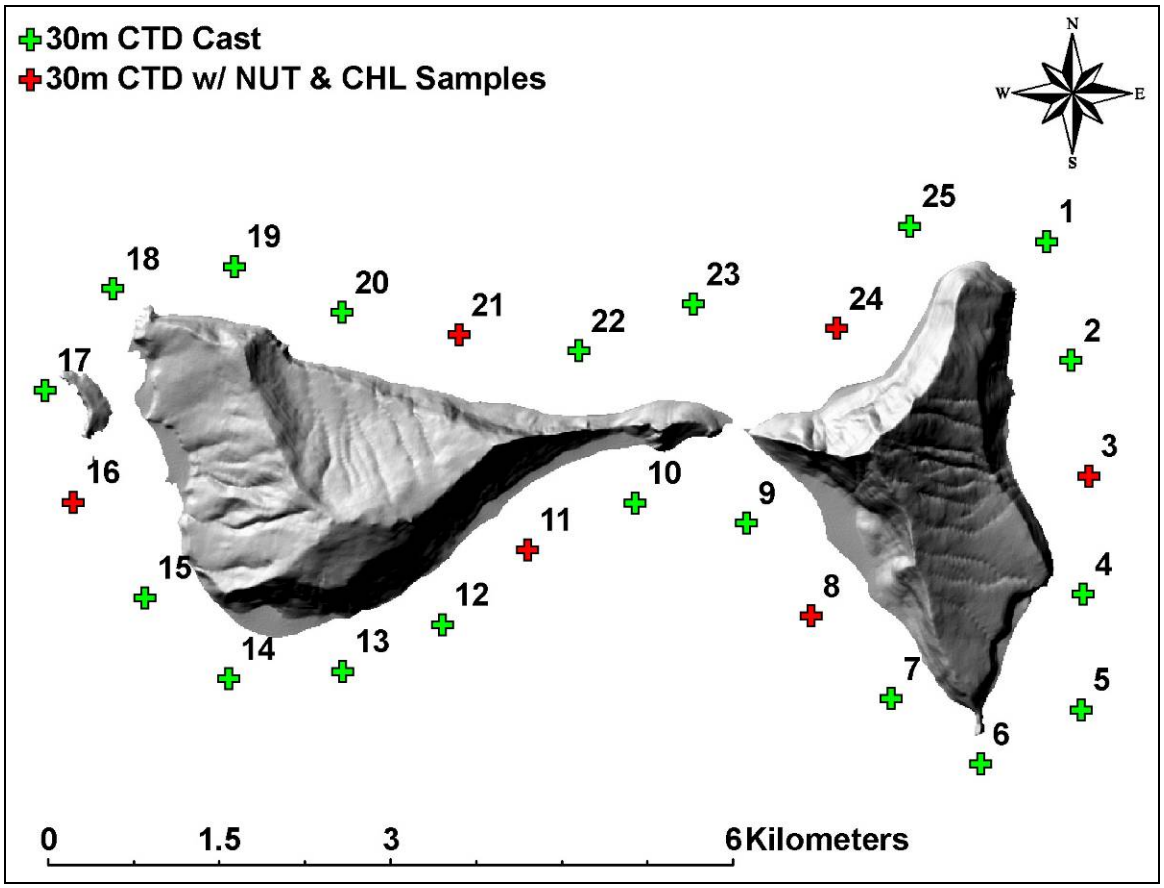

Figure C.1.3.--Shallow-water CTD casts and water sampling locations around Ofu and Olosega Islands, labeled by cast number.

Around the Manua Group—Ofu, Olosega, and Ta`u—6 shipboard CTD casts were conducted (Fig. C.1.4). All casts were made to a depth of 500 m, and water samples were collected at depths of 3 m, 80 m, 100 m, 125 m, and 150 m for nutrient and chlorophyll-*a* (Chl-*a*) analysis. Nutrient and Chl-*a* samples were processed and stored according to protocols provided by Pacific Marine Environmental Laboratory (PMEL) scientists. Samples were sent to PMEL and the University of Hawai`i when the cruise returned. CTD casts were conducted February 29–March 5, 2008, using the Coordinated Universal Time (UTC) standard, based on the schedule below.

Day 1: MAN15–MAN17
Day 2: MAN18
Day 6: MAN19–MAN20

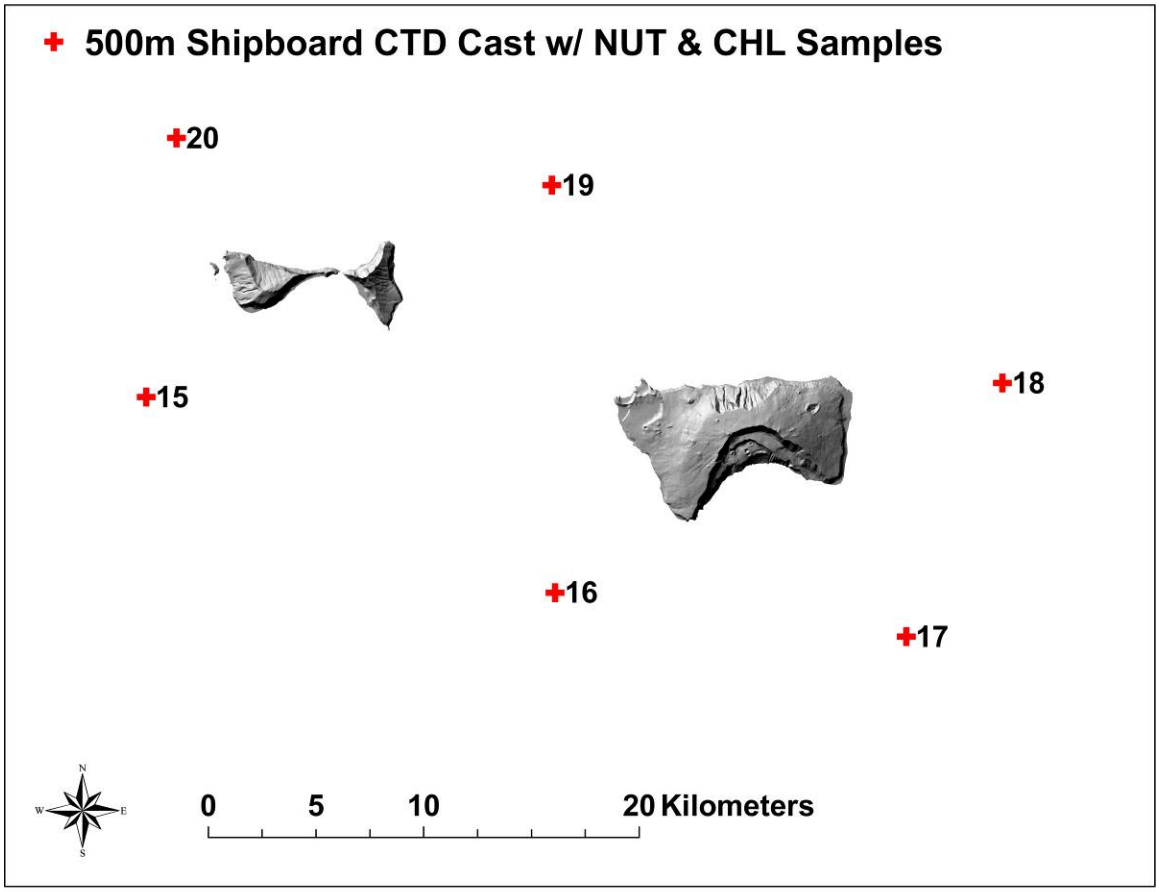

Figure C.1.4.--Shipboard CTD, nutrient, and Chl-*a* sites in the Manu'a Group (Ofu, Olosega, and Ta`u Island) during the HI-08-02 ASRAMP cruise, labeled by cast number.

Preliminary Water Quality Results

Temperature, salinity, density, and beam transmittance throughout the 30-m water column showed some variability with depth around Ofu and Olosega Islands during the sampling period (Fig. C.1.5). In general, surface waters (< 10 m deep) were cooler (by ~ 0.5 °C), had less saline, and were less dense than deep waters. This difference is likely the result of the heavy rains experienced during this sampling period, which caused a surface lens of freshwater both from direct rainfall to the surface and from terrestrial freshwater runoff. Beam transmission was generally high (> 90%) around Ofu and Olosega. One exception to these clear waters occurred around the northeast point of Olosega (casts 1–3) where large plumes of heavy terrestrial runoff (including mud and debris) were observed during the sampling period, likely accounting for the relatively low beam transmission (< 75%) in that region.

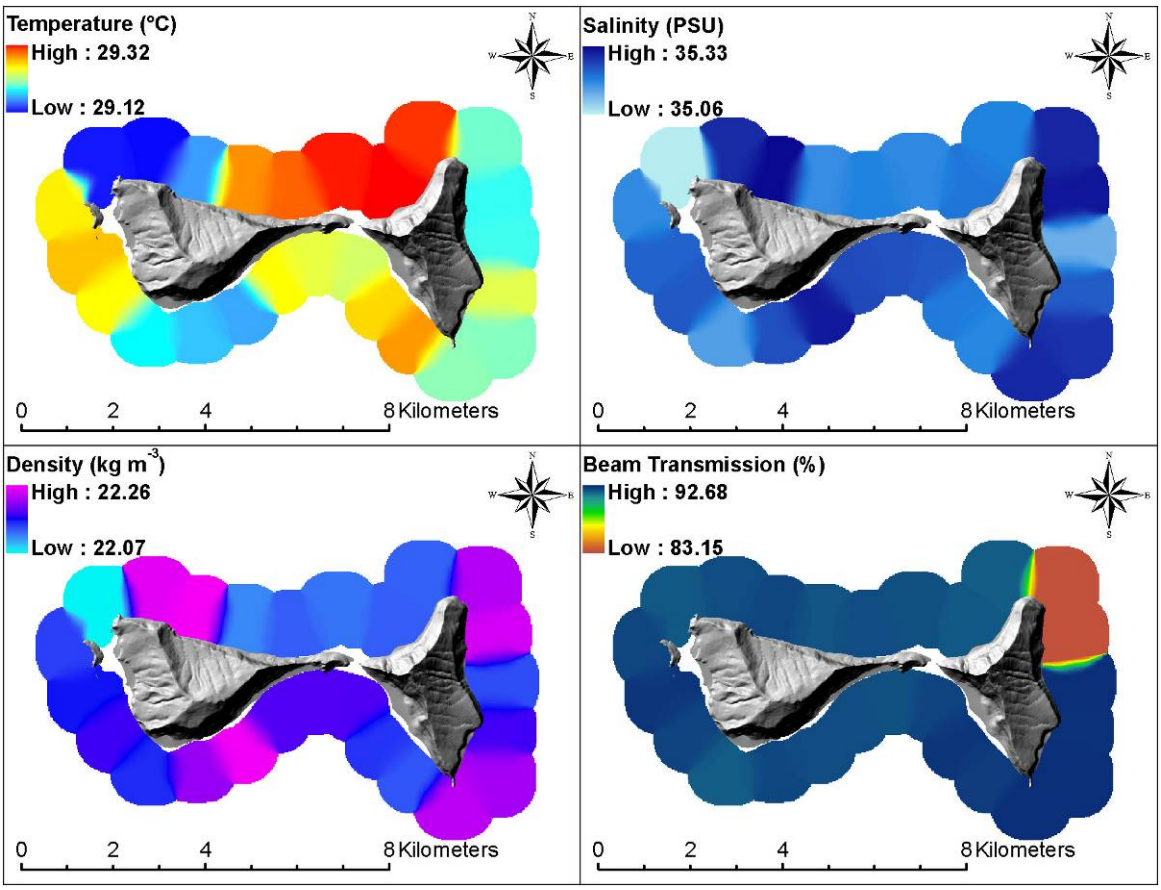

Figure C.1.5.--Interpolated shallow-water CTD cast data at a depth of 20 m around Ofu and Olosega Islands during the HI-08-02 ASRAMP cruise: temperature (upper left), salinity (upper right), density (bottom left) and beam transmission (bottom right).

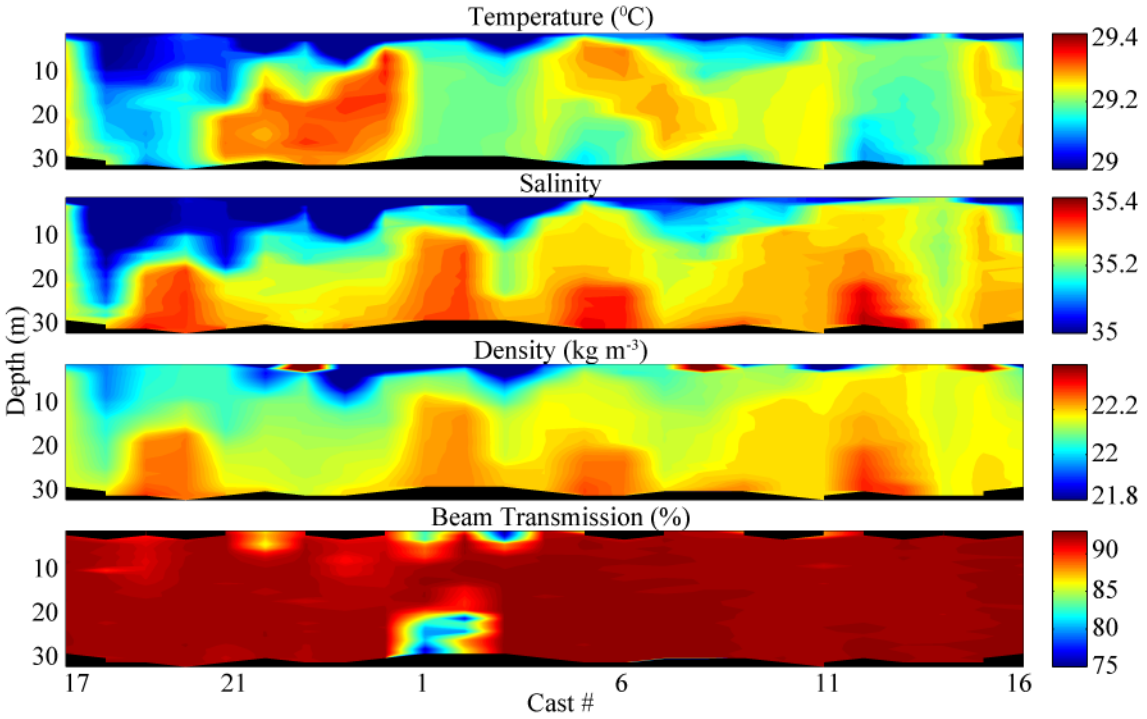

Figure C.1.6.--Cross-section plot of shallow-water CTD data (temperature, salinity, density, and beam transmission) collected at Ofu and Olosega Islands during the HI-08-02 ASRAMP cruise. Refer to Figure C.1.3 for CTD cast locations.

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

Thirteen Rapid Ecological Assessment (REA) sites were visited by a team of up to 8 scientists around Ofu and Olosega Islands between February 18 and 25, 2008. At 3 of those sites, only fish surveys were conducted over differing depth ranges. Site locations are shown in Figure C.2.1, and survey dates and efforts are shown in Tables C.2.1 (benthic surveys) and C.2.2 (fish surveys). Individual site descriptions are included for the following discipline communities: coral, coral and coralline disease, macroinvertebrates, algae, and fish.

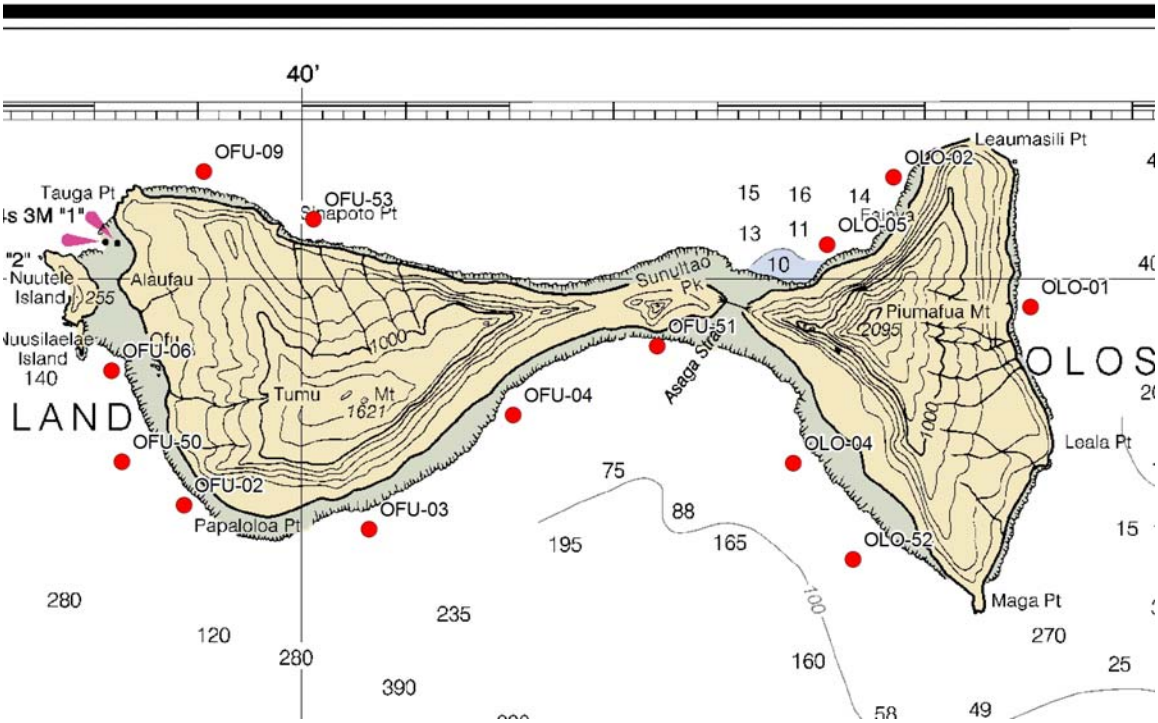

Figure C.2.1.--Benthic REA survey site locations around Ofu and Olosega Islands during the HI-08-02 ASRAMP cruise.

Table C.2.1.--Ofu and Olosega Islands 2008 benthic REA site survey dates, teams present, and additional comments. All dives were conducted in the forereef stratum.

Site ID	Date	Teams Present	Comments
OFU-02	2/28/2008	Coral, Disease, Algae, Invertebrates	
OFU-03	2/28/2008	Coral, Disease, Algae, Invertebrates	
OFU-04	2/28/2008	Coral, Disease, Algae, Invertebrates	
OFU-06	3/4/2008	Coral, Algae, Invertebrates	*
OFU-09	3/4/2008	Coral, Algae, Invertebrates	*
OLO-01	3/4/2008	Coral, Algae, Invertebrates	*
OLO-02	2/29/2008	Coral, Disease, Algae, Invertebrates	
OLO-04	2/29/2008	Coral, Disease, Algae, Invertebrates	
OLO-05	2/29/2008	Coral, Disease, Algae, Invertebrates	
OLO-06	2/29/2008	Coral, Disease, Algae, Invertebrates	Incomplete coral and invertebrate survey due to sediment plume

*Because the disease specialist was injured, a secondary scientist gathered health and disease data at these sites. This data will be processed after the cruise and entered into the database upon the discretion of Bernardo Vargas-Ángel.

Table C.2.2.--Ofu and Olosega Islands fish 2008 REA survey sites. At each site, 2 belt-transect (25 × 4 m) surveys and a stationary-point count survey (over a circular plot with a 7.5-m radius) were performed, unless otherwise noted. All dives were done in the forereef stratum.

Site ID	Date	Depth (m)	Comments
OFU-02	2/28/2008	12	**
OFU-03	2/28/2008	13	**
OFU-04	2/28/2008	10	**
OFU-06	3/4/2008	13	**
OFU-09	3/4/2008	10	**
OFU-50	2/28/2008	23	**
OFU-51	2/28/2008	5	**
OFU-52	3/4/2008	20	**
OLO-01	3/4/2008	15	**
OLO-02	2/29/2008	11	**
OLO-04	2/29/2008	11	**
OLO-05	2/29/2008	10	**
OLO-52	2/29/2008	21	**

** Since 1 fish team member was ill and unable to participate in dives, the protocol for fish surveys was modified slightly: the 3 remaining fish team members were deployed on a boat separate from the benthic REA team; during each dive, 2 team members conducted 2 belt-transect surveys and 1 stationary-point count survey while the third member conducted 2 stationary-point count surveys in an area close to the original transect.

Site Descriptions

February 28, 2008

OFU-02

14°11.092′ S, 169°40.438′ W

Depth Range: 8.53–14.33 m

This site was off the south coast of Ofu. Hard coral cover was 32.4%. A total of 29 coral genera were recorded within belt transects, and *Porites, Acropora, Galaxea, Goniastrea, Pocillopora,* and *Montastrea* were the most abundant taxa. Coral disease and health assessment revealed 16 cases of barnacle infestation (*Goniastrea*), 2 cases of predation (*Porites*), and 3 cases of coralline lethal orange disease in a survey area of 222 m^2. Line-point intercept analysis found 32.4% hard coral cover, strong surge, 16 cases of barnacle infestation (*Goniastrea*), 2 cases of predation (*Porites*), and 3 cases of coralline lethal orange disease in a survey area of 222 m^2. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis*, followed by *Calcinus* hermit crabs. *Tridacna* and trapezid crabs were rare. An unidentified ruffled gray sponge was prevalent throughout the site. Macroalgae identified in the photoquadrats included cyanophytes, crustose coralline red algae, turf algae, *Chlorodesmis fastigiata*, and *Peyssonnelia*. *Halimeda* and *Titanophora* were noted along the random swim survey. Schools of small damselfishes were observed at this site, and *Chromis iomelas* and *Chromis acares* were the most abundant. The surgeonfish *Ctenochaetus striatus* were often seen as adults, while *Ctenochaetus cyanocheilus* was

observed in all size classes. A variety of large fishes were fairly abundant, including several species of parrotfishes, the grouper *Cephalopholis argus*, the snapper *Lutjanus bohar*, and the surgeonfish *Naso brevirostris*. The surgeonfish *Acanthurus nigricans* was commonly seen individually within the transect area, and off transect they were observed in large schools, accompanied by *Acanthurus guttatus*. A large school of *Acanthurus blochii* was also seen off transect.

OFU-03
14°11.177′ S, 169°39.594′ W
Depth Range: 10.97–13.11 m
This site was off the south coast of Ofu. Coral cover was high, accounting for 50% of the benthos. A total of 26 coral genera were recorded within this site's belt transects, and *Montipora, Montastrea, Astreopora, Porites, Goniastrea,* and *Pocillopora* were the most abundant taxa. Coral disease and health assessment revealed 6 cases of barnacle infestion (*Goniastrea*), 2 cases of skeletal growth anomaly (*Acropora hyacinthus, A. samoensis*), 2 cases of subacute tissue loss (*Goniastrea, Montipora*) and 2 cases of bleaching (*Montastrea curta, Pocillopora eydouxi*) in a survey area of 192 m^2. Line-point intercept analysis found 50.0% hard coral cover, moderate surge, 6 cases of barnacle infestion (*Goniastrea*), 2 cases of skeletal growth anomaly (*Acropora hyacinthus, A. samoensis*), 2 cases of subacute tissue loss (*Goniastrea, Montipora*), and 2 cases of bleaching (*Montastrea curta, Pocillopora eydouxi*) in a survey area of 192 m^2. Only one belt-transect survey was completed due to autonomous reef monitoring structures (ARMS) installation. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis*, followed by *Calcinus* hermit crabs. *Tridacna* and trapezid crabs were rare. The Serpulidae worm *Spirobranchus gigantus* was widespread. A leathery, plated gray sponge was abundant. An unidentified ruffled gray sponge was widespread throughout the site. Dominant macroalgae in the photoquadrats consisted of turf algae, crustose coralline red algae, cyanophytes, *Halimeda*, *Lobophora variegata*, and *Jania. Chlorodesmis fastigiata* and *Turbinaria* were recorded on the random swim survey. The surgeonfish *Ctenochaetus striatus* were commonly seen in all size ranges, and small damselfishes (*Chromis, Pomacentrus*) comprised the most abundant fishes observed. Large fish were seen in smaller numbers, including the grouper *Cephalopholis argus*, the snappers *Aphareus furca* and *Lutjanus kasmira*, soldierfish *Myripristis berndti*, and the squirrelfish *Sargocentron tierre*. Interestingly, only 3 individual butterflyfishes representing 3 species were seen.

OFU-04
14°10.671′ S, 169°38.969′ W
Depth Range: 13.11–16.76 m
This site was off the south coast of Ofu. Coral cover was 36.3%. A total of 33 coral genera were recorded within this site's belt transects, and *Goniastrea, Montipora,* and *Pocillopora* were the most abundant taxa. Coral disease and health assessment revealed 5 cases of crown-of-thorns seastar (COTS) predation (*Pocillopora meandrina, Goniastrea retiformis*), 2 cases of subacute tissue loss (*Porites*), 3 cases of barnacle infestation (*Goniastrea*), 1 case of skeletal growth anomaly (*Fungia*), and 4 cases of coralline lethal orange disease in a survey area of 234 m^2. Line-point intercept analysis found 36.3% hard coral cover, 5 cases of COTS predation (*Pocillopora meandrina, Goniastrea retiformis*), 2 cases of subacute tissue loss

(*Porites*), 3 cases of barnacle infestation (*Goniastrea*), 1 case skeletal growth anomaly (Fungia), and 4 cases of coralline lethal orange disease in a survey area of 234 m^2. *Calcinus* hermit crabs and vermetid mollucs were common. Few other noncryptic invertebrates were present. An unidentified ruffled gray sponge was prevalent. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes, *Halimeda*, *Lobophora variegate*, and *Gelidiella.* Noted on the random swim survey were *Valonia* and *Amphiroa.* A recruitment of *Ctenochaetus striatus* juveniles was an obvious characteristic of this site. High numbers of these fishes were observed feeding on the substrate. Also observed were unusually high numbers of *Acanthurus pyroferus*. *Scarus psittacus* was also abundant, as were the usual small pomacentrids.

OFU-50
14º10.867′ S, 169º40.859′ W
Depth Range: 20–26 m
This site is located on the west side of Ofu Island. It was established by the REA fish team as a new sampling location in the forereef deep stratum. The site had medium coral cover with medium reef complexity. Many large fishes were observed (*Scarus rubroviolaceus*, *Gymnosarda unicolor*); approximately 30 blackfin barracuda (*Sphyraena qeni*) were observed.

OFU-51
14º10.311′ S, 169º38.280′ W
Depth Range: 4–5 m
This site is located in the central section of south Ofu. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with medium reef complexity. Reef fishes were mostly small damselfishes (*Stegastes*, *Pomacentrus*, *Chrysiptera*) with few large fish (mostly scarids).

<u>February 29, 2008</u>

OLO-04
14°10.887′ S, 169°37.606′ W
Depth Range: 13.11–16.76 m
Coral cover was high (43.1%). Coral disease and health assessment revealed 6 cases of subacute tissue loss (*Montipora, Goniastrea retiformis, Favia stelligera, Montastrea curta*), 1 case bleaching (*Pocillopora meandrina*), 1 case predation (*Pocillopora meandrina*, likely COTS), 1 case white syndrome (*Goniastrea edwardsi*), and 3 cases of coralline lethal orange disease in a survey area of 150 m^2. Line-point intercept analysis found 43.1% hard coral cover, 6 cases of subacute tissue loss (*Montipora, Goniastrea retiformis, Favia stelligera, Montastrea curta*), 1 case bleaching (*Pocillopora meandrina*), 1 case predation (*Pocillopora meandrina*, likely COTS), 1 case white syndrome (*Goniastrea edwardsi*), and 3 cases of coralline lethal orange disease in a survey area of 150 m^2. Only one belt-transect survey was completed due to ARMS installation. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis*, followed by *Calcinus* hermit crabs. *Tridacna* and trapezid crabs were rare. An unidentified ruffled gray sponge was prevalent. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes,

Lobophora variegata, *Jania*, and *Halimeda. Chlorodesmis fastigiata* was noted on the random swim survey. *Ctenochaetus striatus* juveniles were very abundant at this site, having just recruited on the reef. Small pomacentrids were very abundant here, with *Chromis acares* and *Chromis iomelas* hovering in large clouds just above the substrate. Of note was a detection of 1 *Variola louti* that was 55 cm long.

OLO-06
14°11.233′ S, 169°36.460′ W
Depth Range: 11.58–14.63 m
Coral cover was high (40.2%). Coral disease and health assessment revealed 1 case of white syndrome (*Montipora*) disease in a survey area of 30 m^2. This dive was cut short due to approaching heavy turbidity plume, which was likely from landslide activity. Line-point intercept analysis found 40.2% hard coral cover, and 1 case white syndrome (*Montipora*) disease in a survey area of 30 m^2. These divers were also recalled because of approaching heavy turbidity plume, which was likely from landslide activity. The dive was cut short as a result of this diver recall. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis. Calcinus* sp. hermit crabs were rare. The Serpulidae worm *Spirobranchus gigantus* was widespread. Macroalgae identified in the photoquadrats included cyanophytes, crustose coralline red algae, turf algae, *Peyssonnelia*, *Jania*, and *Lobophora variegata. Chlorodesmis fastigiata* was recorded along the random swim survey.

OLO-02
14°9.478′ S, 169°37.134′ W
Depth Range: 7.92–12.19 m
Coral cover was 22.5%. Coral disease and health assessment revealed 1 case barnacle infestation (*Goniastrea*), 1 case white syndrome (*Montipora*), 1 case subacute tissue loss (*Montipora*), 2 cases of coralline lethal orange disease, and 1 case coralline cyanophyte disease in a survey area of 252 m^2. Line-point intercept analysis found 22.5% hard coral cover, 1 case barnacle infestation (*Goniastrea*), 1 case white syndrome (*Montipora*), 1 case subacute tissue loss (*Montipora*), 2 cases of coralline lethal orange disease, and 1 case coralline cyanophyte disease in a survey area of 252 m^2. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis*, followed by *Tridacna* sp. All *Tridacna* sp. were new recruits for they were ≤ 2–3 cm long. An unidentified ruffled gray sponge was prevalent. Photoquadrat abundances of macroalgae consisted of crustose coralline red algae, turf algae, cyanophytes, *Lobophora variegata*, and *Peyssonnelia.* Algal species found along the random swim survey included *Chlorodesmis fastigiata*, *Haloplegma duperreyi*, and *Tydemania expeditionis.* In terms of fishes, this site was typified by huge numbers of *Chromis iomelas*. This abundance of *C. iomelas* was perhaps the most dominant characteristic of the site, and a relatively large school of the snapper *Lutjanus kasmira* roaming throughout the stationary-point count survey area was also an interesting feature. Also abundant were *Ctenochatus striatus* juvenile recruits, feeding continuously on the substrate.

OLO-05
14°9.809′ S, 169°37.449′ W
Depth Range: 13.11–15.82 m
Coral cover was 38.2%. Coral disease and health assessment revealed 2 cases of white syndrome (*Pavona varians*), 2 cases of subacute tissue loss (*Pavona varians, Psammocora*), 1 case coralline lethal orange disease, and 4 cases of coralline ring syndrome (all in shaded crevices) in a survey area of 252 m^2. Line-point intercept analysis found 38.2% hard coral cover, 2 cases of white syndrome (*Pavona varians*), 2 cases of subacute tissue loss (*Pavona varians, Psammocora*), 1 case coralline lethal orange disease, and 4 cases of coralline ring syndrome (all in shaded crevices) in a survey area of 252 m^2. With the exception of hermit crabs, macroinvertebrates were observed in low abundance. *Coralliophilidae* snails, trapezid crabs, and *Tridacna* clams were rare. An unidentified ruffled gray sponge was prevalent. Macroalgae in the photoquadrats included crustose coralline red algae, turf algae, cyanophytes, *Peyssonnelia*, *Halimeda*, *Chlorodesmis fastigiata*, and *Lobophora variegata. Chlorodesmis fastigiata* were noted along the random swim survey. Recruitment of the surgeonfish *Ctenochaetus striatus* at this site was high, as it was for damselfish populations, especially *Chromis acares* and *C. iomelas*. Parrotfish and grouper were the large fishes recorded, though not commonly. Several soldierfish (*Myripristis berndti*) were observed under ledges. Of note, a large turkeyfish (*Pterois volitans*) was counted in the stationary-point count survey.

OLO-52
14º11.336′ S, 169º37.336′ W
Depth Range: 20–23 m
This site is located on the west section of Olosega. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had high coral cover with medium reef complexity, including occasional soft corals. A school of 11 *Sphyraena qenie* was observed upon descent; other large fish observed included groupers (*Cephalopholus argus*, *Variola louti*), parrots (*Chlorurus, Scarus*), and wrasse (*Bodianus*). High abundances of smaller fishes included damselfishes (*Pomacentrus, Chromis*), anthia (*Pseudanthias*), and surgeon (*Ctenochatus*).

March 4, 2008

OFU-09
14°9.475′ S, 169°40.465′ W
Depth Range: 10.67–13.72 m
This site was located on the north forereef of Ofu. Coral and turf algae dominated the benthos, accounting for 46.1% and 31.4% of the benthos, respectively. A total of 22 coral genera were recorded within this site's belt transects, and *Montipora, Astreopora,* and *Leptastrea* were the most abundant taxa. No coral disease and health assessment survey was conducted. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis. Calcinus* hermit crabs were common. *Tridacna* clams and coralliophilidae snails were rare. Tunicates were widespread and abundant, specifically an unidentified green didemid. Macroalgae identified in the photoquadrats included cyanophytes, crustose coralline red algae, turf algae, *Lobophora variegate*, and *Dictyosphaeria versluysii.* Algal genera

found along the random swim survey included *Chlorodesmis fastigiata, Halimeda*, *Amansia rhodantha, Caulerpa sertularoides*, and *Halymenia durvillei.* For fish diversity and abundance, this site was relatively disparate. The only species with high abundance were the surgeonfish *Acanthurus nigrofuscus* and the wrasse *Thalassoma quinquevittatum*. A single large *Caranx melampygus* was seen off transect, as was the large triggerfish *Pseudobalistes flavimarginatus*.

OLO-01
14°10.117′ S, 169°39.491′ W
Depth Range: 12.19–15.85 m
This site was located on the east side of Olosega. Coral cover was high accounting for 47.1% of the benthos. A total of 21 coral genera were recorded within this site's belt transects, and *Porites* and *Turbinaria* were the most abundant taxa. No coral disease and health assessment survey was conducted. Overall, noncryptic macroinvertebrates were observed in low abundance. *Calcinus* hermit crabs were common. Trapezid crabs, coralliophilidae snails, and *Tridacna* clams were rare. An unidentified gray sponge was widespread. Live coral dominanted the belt transects at this site. Macroalgae in the photoquadrats included crustose coralline red algae, turf algae, cyanophytes, *Peyssonnelia*, and *Lobophora variegata.* The random swim survey produced *Halimeda*, *Chlorodesmis fastigiata, Dictyosphaeria versluysii, Caulerpa sertularoides*, and *Halymenia.* In terms of fishes, this site was typified by large numbers of *Ctenochaetus striatus*. *Chromis margaritifer, Pomacentrus vaiuli*, and *Chromis acares* were the most numerous pomacentrid species.

OFU-06
14°10.457′ S, 169°40.915′ W
Depth Range: 11.58–15.24 m
This site was located on the southwest forereef of Ofu. Coralline algae dominated the benthic substrate; coral cover was 14.7%. A total of 29 coral genera were recorded within the belt transects at this site, and *Galaxea* and *Montipora* were the most abundant taxa. No coral disease and health assessment survey was conducted. Overall, noncryptic macroinvertebrates were observed in low abundance. Only *Calcinus* hermit crabs and trapezid crabs were observed along this site's belt transects. An unidentified gray sponge was widespread. Macroalgae identified in the photoquadrats included cyanophytes, crustose coralline red algae, turf algae, *Jania, Lobophora variegate*, and *Peyssonnelia. Chlorodesmis fastigiata Halimeda, Caulerpa sertularoides*, and *Haloplegma duperreyi* were noted on the random swim survey. This site was notable for schools of large snappers (*Lutjanus bohar* and *Macolor niger*) hovering off transect. The rare humphead wrasse (*Cheilinus undulates*) was also seen briefly off transect. Observed on transect were the ubiquitous *Ctenochaetus striatus*, both juveniles and adults. Fair numbers of *Acanthurus nigricans* and the damsel *Chrystiptera taupou* were also recorded. A large parrotfish of the species *Scarus altipinnis*—not commonly observed—was seen within the stationary-point count survey.

OFU-53
14º09.701′ S, 169º39.935′ W
Depth Range: 20–25 m
This site is located on the north shore of Ofu Island. It was established by the REA fish team as a new sampling location in the forereef deep stratum. The site is a gently sloping spur-and-groove formation ending over a sandy area at ~ 27 m. The reef had high complexity and medium coral cover. Many large fishes where observed here, including many *Macolor* snappers, many large parrotfish, and a dogtooth tuna.

C.3. Benthic Environment

C.3.1. Algae

Quantitative algal surveys were conducted at 10 sites around Ofu and Olosega Islands, American Samoa. Ten species of macroalgae were recorded along survey transects: 3 species of green algae, 6 species of red algae, and 1 species of brown algae, as well as crustose coralline red algal, turf algal, and cyanophyte functional groups (Table C.3.1.1).

Table C.3.1.1.--Algal genera or functional groups recorded in photoquadrats at Tutuila Island. Numbers indicate the percentage of photoquadrats in which an alga occurred.

Division	Species/Name	OFU-02	OFU-03	OFU-04	OFU-06	OFU-09	OLO-01	OLO-02	OLO-04	OLO-05	OLO-06
	Cyanophyte	8.33	50	83.33	8.33	58.33	8.33	27.27	41.67	33.33	75
	turf algae	83.33	58.33	33.33	100	100	100	72.73	50	58.33	91.67
Chlorophyta	*Chlorodesmis fastigiata*	8.33								16.67	
Chlorophyta	*Dictyosphaeria versluysii*					50					
Chlorophyta	*Halimeda sp.*		50	100					50	75	
Ochrophyta	*Lobophora variegata*					8.33				33.33	33.33
Rhodophyta	*Amphiroa sp.*										
Rhodophyta	*crustose coralline red algae*	100	100	100	100	100	91.67	90.91	100	91.67	100
Rhodophyta	*Gelidiella sp.*			8.33							
Rhodophyta	*Gibsmithia sp.*										
Rhodophyta	*Jania sp.*		16.67		8.33				8.33		8.33
Rhodophyta	*Peyssonnelia sp.*	58.33			91.67		8.33	18.18		66.67	8.33

C.3.2. Corals

Coral REA surveys were conducted at 10 forereef sites around Ofu and Olosega Islands February 28–March 5, 2008 (Fig. C.2.1). Ten of 11 sites surveyed in 2006 were resurveyed in 2008. Survey depths ranged between 11 and 16 m. Coral population surveys were conducted by Jason Helyer (CRED) and coral disease and health assessments were conducted by Jean Kenyon, PhD (CRED).

C.3.2.1. Percent Benthic Cover

The line-point intercept method resulted in a total of 1938 points along 950 m of forereef coral communities. Patterns of intraisland variability in percent benthic cover, derived from the 19 independent REA surveys conducted in 2008, are reflected in Figure C.3.2.1.1.

Scleractinian coral, crustose coralline algae, and turf algae were the primary benthic components, accounting for 37.7% (SE 3.1), 34.6% (SE 5.6), and 17.2% (SE 3.6) of total cover. The highest values of coral cover (50.0% and 47.1%) were found at sites OFU-03 on the south side of Ofu and OLO-01 on the east side of Olosega. The highest value of coralline algal cover (65.7%) was found at OFU-06 on the west side of Ofu. High values (31.4%, 30.4%, and 29.4%) of turf algal cover were found at OFU-09, OLO-01, and OLO-06.

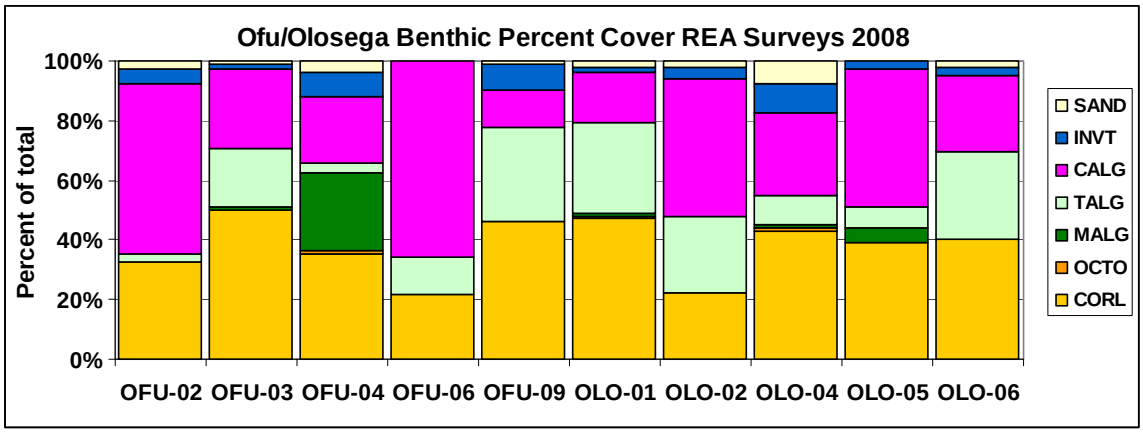

Figure C.3.2.1.1.--Mean percent cover of benthic elements derived from 10 sites at Ta`u, HI-08-02 ASRAMP cruise (February 28–March 5, 2008). CORL: scleractinian and hydrozoan coral; OCTO: octocoral; ZOAN: zoanthids; MALG: macroalgae; TALG: turf algae (on pavement, rubble, and dead coral); CALG: crustose coralline algae (on pavement, rubble, and dead coral); INVT: non-anthozoan invertebrates; SAND: sand.

C.3.2.2. Coral Populations

A total of 5314 coral colonies belonging to at least 46 cnidarian taxa (36 scleractinian genera, 8 octocorals, and 2 hydrozoan) were enumerated within 358 m^2 of reef surveyed at Ofu and Olosega Islands (Table C.3.2.2.1). Members of the genera *Montipora, Porites*, and *Goniastrea* were the most abundant coral taxa in terms of number of colonies, with each genus contributing 16%, 12.2% and 10.4%, respectively, of the total number of colonies

recorded around Ofu and Olesega Islands. Density values at individual sites ranged from 10 colonies m^{-2} at OLO-01 to 23.2 colonies m^{-2} at TUT-04. Generic richness values ranged from 21 coral genera recorded at OLO-01 to 33 coral genera observed at OFU-04. Inspection of coral size histograms that showed an overwhelming majority of corals had maximum diameters < 20 cm (78%). Only 5% of all colonies measured had diameters > 40 cm.

Table C.3.2.2.1.--Number of corals, by genus, enumerated along belt transects in 2008 coral REA surveys. Genera contributing more than 10% of the total number of colonies are highlighted in bold.

Coral Taxon	# of Colonies	% of Total	Coral Taxon	# of Colonies	% of Total
Acanthastrea	30	0.6	Lobophytum	8	0.2
Acropora	168	3.2	Merulina	1	0.0
Alveopora	1	0.0	Millepora	9	0.2
Astreopora	265	5.0	Montastrea	274	5.2
Cladiella	36	0.7	**Montipora**	**852**	**16.0**
Coscinaraea	7	0.1	Mycedium	1	0.0
Cyphastrea	41	0.8	Palythoa.	18	0.3
Diploastrea	2	0.0	Pavona	282	5.3
Echinophyllia	21	0.4	Platygyra	124	2.3
Echinopora	23	0.4	Pocillopora	349	6.6
Favia	270	5.1	**Porites**	**646**	**12.2**
Favites	149	2.8	Protopalythoa	1	0.0
Fungia	106	2.0	Psammocora	132	2.5
Galaxea	325	6.1	Sandalolitha	3	0.1
Gardineroseris	1	0.0	Sarcophyton	12	0.2
Goniastrea	**552**	**10.4**	Sinularia	24	0.5
Goniopora	7	0.1	Stylocoeniella	61	1.1
Halomitra	2	0.0	Stylophora	5	0.1
Heliopora	2	0.0	Symphyllia	7	0.1
Herpolitha	5	0.1	Turbinaria	122	2.3
Hydnophora	14	0.3	Xenia	1	0.0
Leptastrea	172	3.2	Zoanthus	22	0.4
Leptoria	136	2.6			
Leptoseris	25	0.5	Total	5314	100

C.3.2.3. Coral Health and Disease

In 2008, surveys for coral and coralline algal disease were conducted at 7 sites covering 1332 m^2 of reef around Ofu and Olosega Islands. Overall, coral disease/anomaly occurrence and abundance were low; a total of 59 cases of 7 categorized anomalies (barnacle infestation, bleaching, other discolorations, predation, skeletal growth anomaly, subacute tissue loss, and acute tissue loss "white syndrome") were tallied. A summary of coral disease occurrence is presented in Figure C.3.2.3.1. The commensal relationship between barnacles and *Goniastrea* was the most frequently tallied condition and accounted for 45.8% of cases at Ofu and Olosega Islands. Although it is arguable if this condition can be considered a disease, it was included in survey observations because it is noted on diagnostic cards produced by Thierry Work and Greta Aeby (Diseases of American Samoan Corals) and because a large proportion (≥ 50%) of corallites in affected colonies were frequently inhabited by barnacles. Other than barnacle infestation, the taxa most frequently affected by anomalies were *Montipora* and *Pocillopora*.

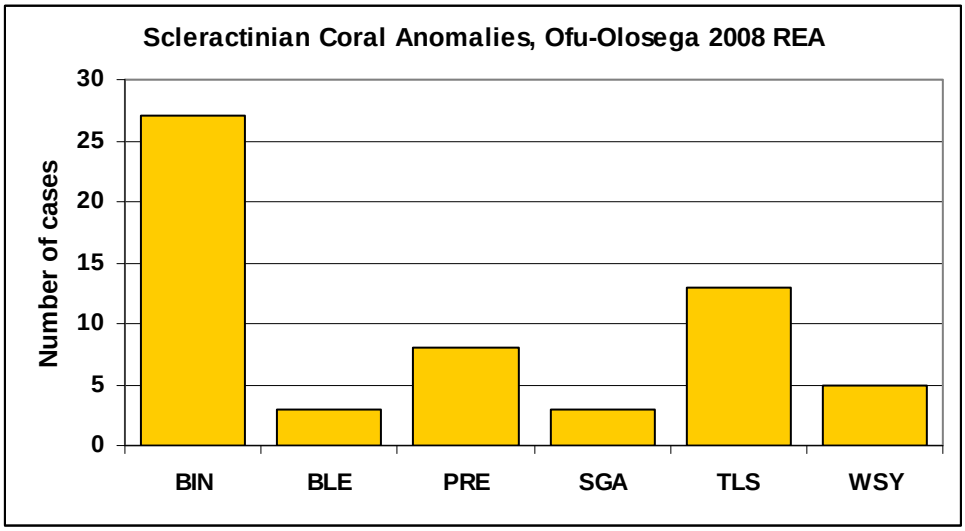

Figure C.3.2.3.1.--Number of cases of scleractinian disease enumerated during REA surveys, Ofu and Olosega Islands, American Samoa, 2008. BIN: barnacle infestation; BLE: bleaching; DIS: other discolorations; PRE: predation; SGA: skeletal growth anomaly; TLS: subacute tissue loss; and WSY: acute tissue loss, "white syndrome."

Eighteen cases were observed at the 7 sites surveyed at Ofu and Olosega Islands, including coralline cyanophyte disease, coralline lethal orange disease, and coralline ring syndrome. A summary of coralline algal disease occurrence is presented in Figure C.3.2.3.2. The most common affliction was coralline lethal orange disease (CLOD), which accounted for 72.2% of the coralline algal disease cases.

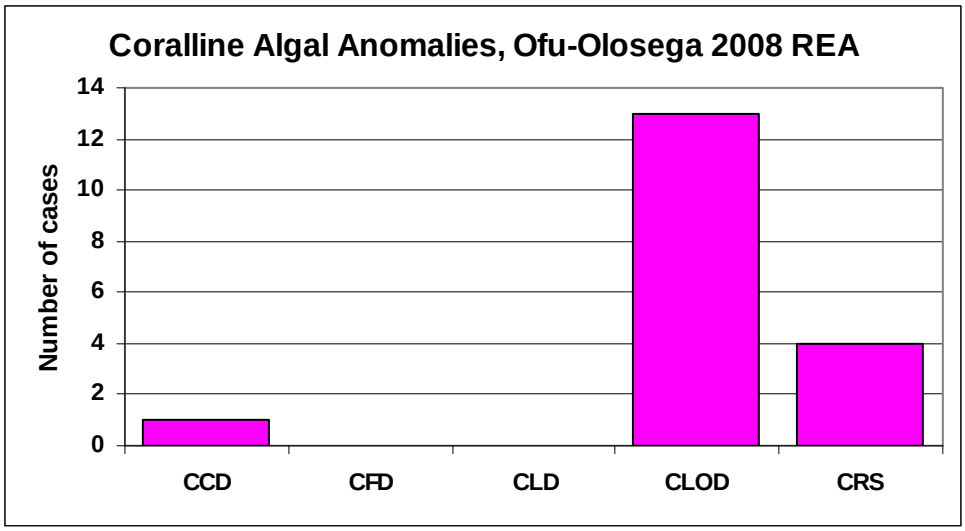

Figure C.3.2.3.2.--Number of cases of coralline algal disease enumerated during REA surveys, Ofu and Olosega Islands, American Samoa, 2008. CCD: coralline cyanophyte disease; CFD: coralline fungal disease; CLD: coralline lethal disease; CLOD: coralline lethal orange disease; CRS: coralline ring syndrome.

C.3.3. Macroinvertebrates

Noncryptic invertebrates were observed in extremely low abundance around Ofu and Olosega Islands during ASRAMP 2008. *Calcinus* hermit crabs and the rock boring urchin, *Echinostrephus aciculatus,* were the most abundant macroinvertebrates. Hermit crab, predominantly *Calcinus minutus*, densities were greatest at sites OLO-05, OFU-04, and OFU-02 (0.61, 0.44, and 0.34 m²). *Echinostephus aciculatus* densities were greatest at OFU-09, OFU-03, and OLO-06 (1.63 1.13, and 1.04 m²). Excluding *Echinostrephus aciculatus*, echinoderms were extremely rare. No asteroids or holothuroids were recorded. Only 3 crinoids were observed. *Tridacna* clams were rare with the exception of site OLO-02, which had a density of 0.12 m². Clams at this site were ≤ 7 cm in shell length. An unidentified gray sponge was widespread throughout both islands.

C.3.3.1. Urchin and Giant Clam Measurements

Figure C.3.3.1.1 below reveals the average test diameter of the urchin, *Echinostrephus aciculatus,* encountered at each site. No other urchins were recorded. Only sites where ≥ 5 measurements were recorded for a species are represented. Measurements were not recorded specifically along the survey transect but rather throughout the site.

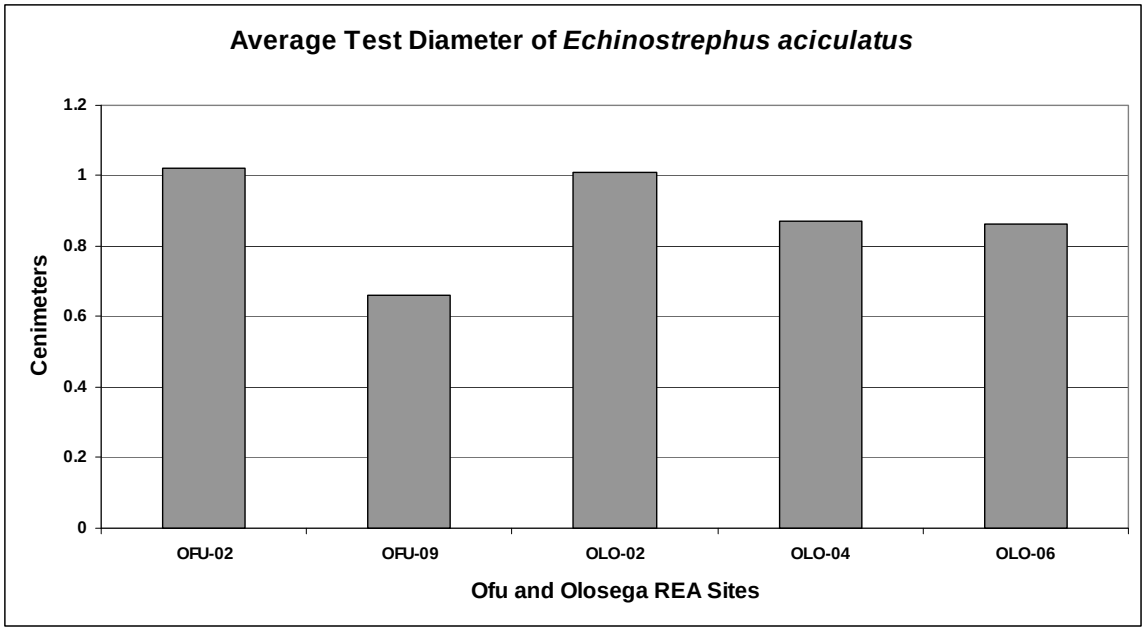

Figure C.3.3.1.1.--Average test diameter of *Echinostrephus aciculatus* at REA survey sites around the Ofu and Olosega Islands during the HI-08-02 ASRAMP 2008 cruise.

Figure C.3.3.1.2 below reveals the average maximum shell length of giant clams observed from sites around Ofu and Olosega. Only sites where ≥ 5 measurements were recorded are represented. Measurements were not recorded specifically along the survey transect but rather throughout the site.

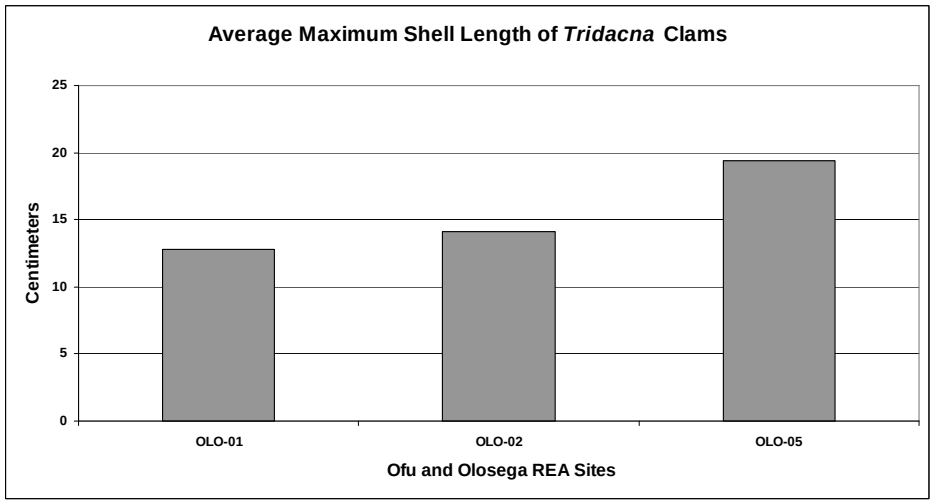

Figure C.3.3.1.2.--Average maximum shell length of *Tridacna* clams at REA survey sites around Ofu and Olosega Islands during the HI-08-02 ASRAMP 2008 cruise.

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

Four ARMS were deployed around Ofu and Olosega Islands. Table C.3.3.2.1 below lists the site locations for these deployments.

Table C.3.3.2.1.--ARMS deployment locations around Ofu and Olosega Islands.

	Latitude and Longitude
OFU-03	14º11.177′ S, 169º45.594′ W
OFU-04	14º10.671′ S, 168º38.969′ W
OFU-06	14º10.457′ S, 169º40.915′ W
OLO-04	14º10.887′ S, 169º39.606′ W

C.3.3.3. Invertebrate Collections

Nondestructive tissue samples of the following organisms were collected for the Hawai`i Institute of Marine Biology, the University of Hawai`i at Mānoa, for the purpose of genetic analysis.

Table B.3.3.3.1.--Invertebrate tissue collection information for specimens from Ofu and Olosega Islands.

Species	Number	REA site	Latitude	Longitude
Crinoid sp.	1	OLO-02	14º09.478′ S	169º32.134′ W
Crinoid sp.	2	OLO-05	14º09.809′ S	169º37.449′ W
Unidentified gray sponge		OLO-05	14º09.809′ S	169º37.449′ W

C.3.4. Towed-diver Benthic Surveys

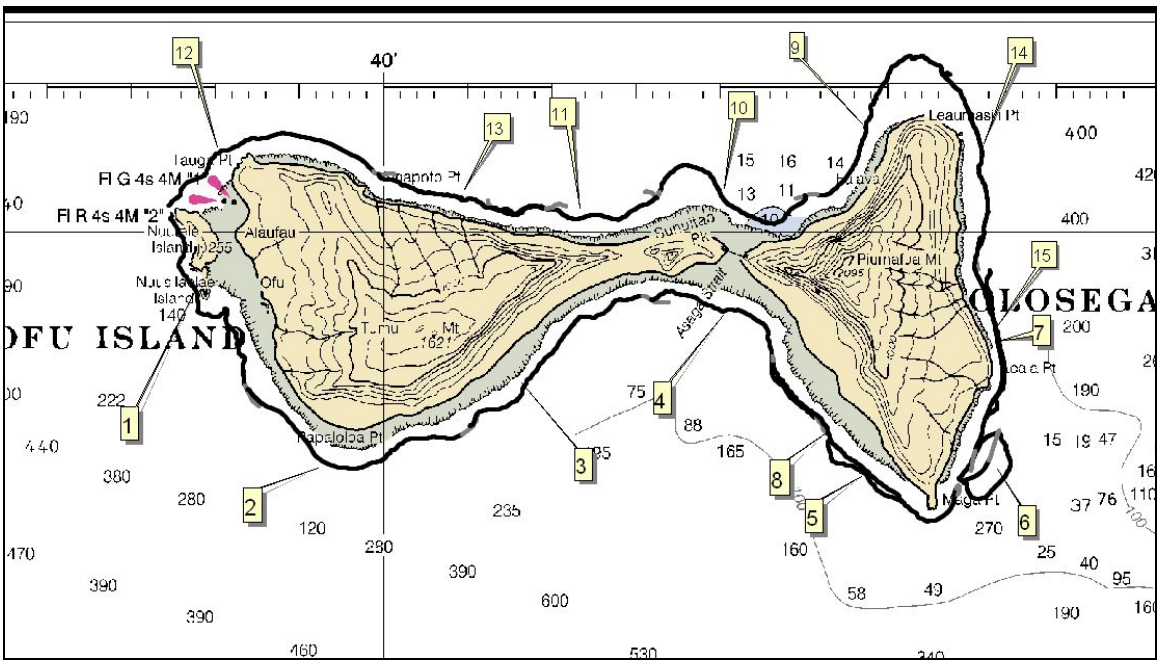

Figure C.3.4.1.--Towed-diver benthic surveys completed around Ofu and Olosega Islands during the HI-08-02 ASRAMP cruise.

A total of 15 towed-diver benthic surveys covering 35.86 km of habitat were completed along the forereefs of Ofu and Olosega Islands. The average total hard coral cover for both islands was 20.2% (within a range of 0.1%–62.5%). The highest average coral cover (36.0%, given a range of 10.1%–62.5%) was recorded along the southeast reef of Ofu working east along the southwest reef of Olosega. The habitat was composed mostly of continuous reef of medium-high complexity with intermittent areas of spur-and-groove formations and one large area of sand. The final 5-min segments recorded the highest levels of coral cover at a range of 50.1%–62.5%.

The average total hard coral stress was 2.3% (within a range of 0%–20%) for all surveys. The highest coral stress was recorded at 5.3% (within a range of 1.1%–10%), which was recorded during a survey along the northwest reef of Ofu. No direct cause of the observed coral stress was recognized.

The average total soft coral cover was 0.5% (within a range of 0%–20%) for all surveys. The highest soft coral cover was recorded along the southeast reef of Ofu working east to the southwest reefs of Olosega—the same survey site of the highest hard coral cover. Soft coral cover averaged 5.3% (within a range of 1.1%–10%). The soft corals present included *Sinularia*, *Sarcophyton*, and *Lobophyton* with increases noted in the shallow sections.

The average pooled macroalgal cover was 5.7% (within a range of 0%–40%), while the average pooled coralline algae cover was 21% (within a range of 0%–75%). The highest average macroalgal cover (22%, given a range of 5.1%–40%) occurred along the south tip of

Ofu Island working ESE, an area that corresponds to the Ofu area of the National Park of American Samoa. Habitat consisted of medium to medium-low continuous reef habitat, which was recorded as being relatively compact. The highest average coralline algae cover (44%, given a range of 20.1%–62.5%) occurred along the north reef of Ofu.

Macroinvertebrate populations around Ofu and Olosega Islands varied greatly per species and habitat type. The boring sea urchin, *Echinostrephus aciculatus,* was the most abundant macroinvertebrate and overall averaged 293.3 urchin ha^{-1}. The highest densities of urchin were found along the southeast pavement reefs of Olosega, where the average was 1307.5 individuals ha^{-1}. A total of 76 giant clams were recorded in all surveys (2.12 clams ha^{-1}), and they were most abundant on the south end of Olosega where numbers as high as 6.3 urchin ha^{-1} were recorded along the continuous reef habitat. A total of 35 sea cucumbers (0.97 sea cucumbers ha^{-1}) were recorded in all surveys, and they were most abundant along the northwest pavement and spur-and-groove reefs of Olosega (6.3 sea cucumbers ha^{-1}). No crown-of-thorns seastar (*Acanthaster planci*) were observed.

C.4. Fish

C.4.1 REA Fish Surveys

Stationary-Point Count Data (new methodology)

A total of 26 individual stationary-point count surveys were conducted at 13 sites around Ofu and Olosega Islands (site depths: 3 deep, 9 mid, and 1 shallow). Surgeonfishes (Acanthuridae) were the largest contributor to biomass with 1.4 kg 100 m^{-2}. Parrotfishes (Scaridae) were the second most abundant family with a biomass of ~ 0.5 kg 100 m^{-2} (Fig. C.4.1.1 and Table C.4.1.1). A shark sighting was responsible for elevated shark biomass around these islands (3.1 kg 100 m^{-2}).

Belt-transect Data

During the survey period, 26 belt-transect surveys were conducted at 13 sites around Ofu and Olosega Islands. Surgeonfish were the primary contributors to biomass with 1.5 kg 100 m^{-2}. (Table C.4.1.1). Parrotfish were also moderately abundant at 0.5 kg 100 m^{-2}. A large school of blackfin barracudas were observed at a single site and accounted for a substantial portion of the overall average for Ofu and Olosega Islands (6.3 kg 100 m^{-2}).

Overall Observations

A total of 186 species were observed during the survey period by all divers. The average total fish biomass at the sites around Ofu and Olosega during the survey period was 0.80 t ha^{-1} for the stationary-point count surveys (Table C.4.1.2), and the average fish biomass was 0.94 t ha^{-1} for the belt-transect surveys (Table C.4.1.1).

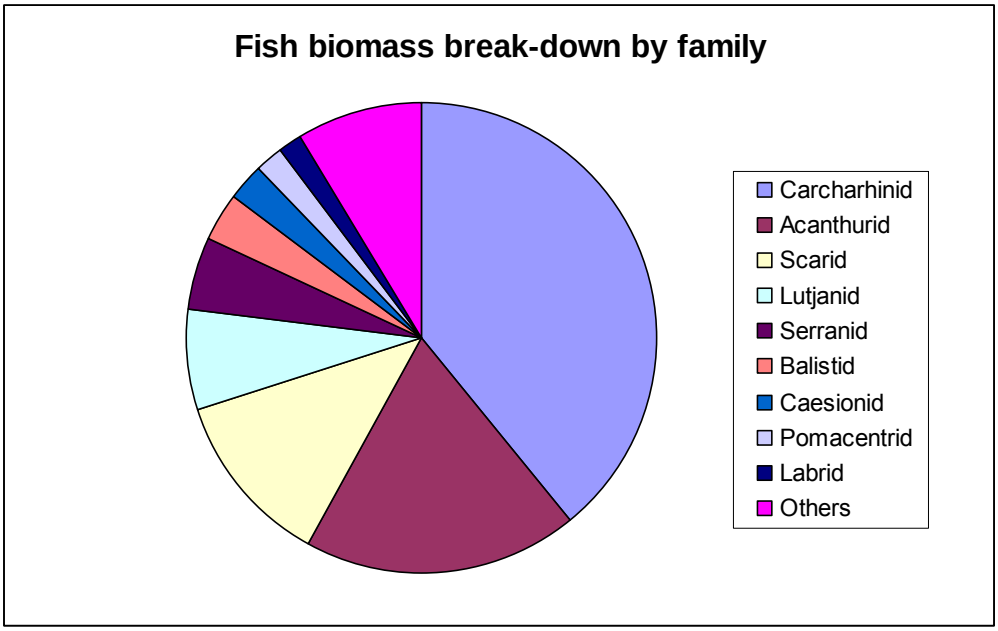

Figure C.4.1.1.--Total fish biomass composition by family, measured by stationary-point count method.

Table C.4.1.1.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Ofu and Olosega Islands as measured by belt transects.

Stratum Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
Forereef—Deep	OFU-50	84.4	1.01	81.65	0.00	0.72	0.00	0.22	0.05	0.23	0.00	0.01	0.55
	OFU-53	4.4	0.72	0.00	0.00	0.24	0.00	0.14	0.07	0.44	1.70	0.06	1.06
	OLO-52	1.8	0.41	0.00	0.00	0.69	0.00	0.18	0.23	0.21	0.00	0.05	0.04
Forereef—Mid	OFU-02	2.8	1.22	0.00	0.00	0.00	0.00	0.18	0.12	0.35	0.00	0.08	0.85
	OFU-03	2.3	1.27	0.00	0.00	0.00	0.00	0.07	0.34	0.22	0.19	0.07	0.14
	OFU-04	2.5	1.54	0.00	0.00	0.16	0.00	0.04	0.22	0.20	0.00	0.18	0.21
	OFU-06	5.3	4.06	0.00	0.00	0.42	0.00	0.10	0.29	0.07	0.05	0.06	0.21
	OFU-09	1.6	1.16	0.00	0.00	0.00	0.00	0.02	0.09	0.15	0.00	0.16	0.07
	OLO-01	4.6	0.80	0.00	0.00	1.16	0.00	0.20	0.52	0.44	0.49	0.12	0.89
	OLO-02	3.8	1.20	0.00	0.00	1.32	0.00	0.27	0.00	0.21	0.31	0.21	0.26
	OLO-04	2.3	1.31	0.00	0.00	0.08	0.00	0.18	0.15	0.31	0.00	0.15	0.09
	OLO-05	3.1	1.15	0.00	0.00	0.79	0.00	0.16	0.03	0.16	0.27	0.06	0.41
Forereef—Shallow	OFU-51	3.0	1.77	0.00	0.00	0.54	0.00	0.08	0.26	0.10	0.07	0.09	0.09
Grand average		**9.4**	**1.4**	**6.3**	**0.0**	**0.5**	**0.0**	**0.1**	**0.2**	**0.2**	**0.2**	**0.1**	**0.4**

Table C.4.1.2.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Ofu and Olosega Islands as measured by stationary-point counts.

Stratum-Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
Forereef—Deep	OFU-50	49.5	1.65	0.00	2.45	1.88	40.65	0.44	0.36	0.70	0.01	0.12	1.20
	OFU-53	9.7	0.64	0.00	0.00	0.97	0.00	0.15	0.38	0.57	2.94	0.28	3.79
	OLO-52	3.4	0.70	0.00	0.00	1.32	0.00	0.21	0.15	0.58	0.00	0.29	0.14
Forereef—Mid	OFU-02	6.3	1.63	0.00	0.00	3.17	0.00	0.13	0.22	0.35	0.34	0.04	0.39
	OFU-03	3.6	2.15	0.00	0.00	0.11	0.00	0.11	0.19	0.27	0.24	0.11	0.41
	OFU-04	4.4	1.36	0.00	0.16	1.65	0.00	0.04	0.47	0.35	0.09	0.13	0.17
	OFU-06	5.7	2.59	0.00	0.00	0.85	0.00	0.10	0.04	0.32	1.10	0.21	0.52
	OFU-09	2.7	1.56	0.00	0.00	0.37	0.00	0.04	0.17	0.20	0.00	0.14	0.20
	OLO-01	2.5	1.11	0.00	0.00	0.29	0.00	0.14	0.18	0.27	0.01	0.11	0.39
	OLO-02	5.6	1.30	0.00	0.00	0.52	0.00	0.30	0.11	0.48	2.36	0.04	0.54
	OLO-04	4.1	1.19	0.00	0.00	0.95	0.00	0.34	0.56	0.63	0.04	0.08	0.25
	OLO-05	3.2	1.82	0.00	0.00	0.27	0.00	0.17	0.08	0.22	0.05	0.03	0.59
Forereef—Shallow	OFU-51	2.7	1.61	0.00	0.00	0.21	0.00	0.06	0.34	0.15	0.00	0.06	0.25
Grand average		**8.0**	**1.5**	**0.0**	**0.2**	**1.0**	**3.1**	**0.2**	**0.3**	**0.4**	**0.6**	**0.1**	**0.7**

C.4.2. Towed-diver Fish Surveys

Table C.4.2.1.--HI-08-02 Towed-diver survey report for Ofu and Olosega Islands.

			Survey Length (km)				Mean Depth
		N	Min	Max	Median	Sum	Average (m)
Ofu and Olosega Islands	**02/28/2008**	5	2.12	2.85	2.63	12.90	-14.98
	02/29/2008	6	1.76	2.69	2.21	13.26	-14.15
	03/04/2008	4	2.23	2.76	2.35	9.70	-14.78
	All	15	1.76	2.85	2.42	35.86	-14.64

N = number of surveys conducted.

Depth readings are taken at 5-s intervals during each 50-min survey and are reported as a mean depth per survey. Mean Depth Average is the median mean depth value for all surveys on a given day.

A total of 28 species of large fishes (> 50 cm in total length) representing 16 families were observed around the islands of Ofu and Olosega during the survey period, February 28–March 5, 2008. The mean number of fishes (all species pooled) observed by divers was 5.64 fish ha^{-1}. The 10 most frequently recorded species are shown in Figure C.4.2.1. The Scaridae family had the greatest density of large fish observed with 4 species accounting for a total density of 2.21 fish ha^{-1}. The steephead parrotfish (*Chlorurus microrhinos*) was the most abundant species observed during the quantitative surveys with a mean number of 1.19 fish ha^{-1} observed. The red snapper (*Lutjanus bohar*) was the second most abundant fish species encountered during the survey with 0.93 fish ha^{-1} recorded. The redlip parrotfish (*Scarus rubroviolaceus*) was the third most abundant fish species encountered during the survey with 0.77 fish ha^{-1} recorded.

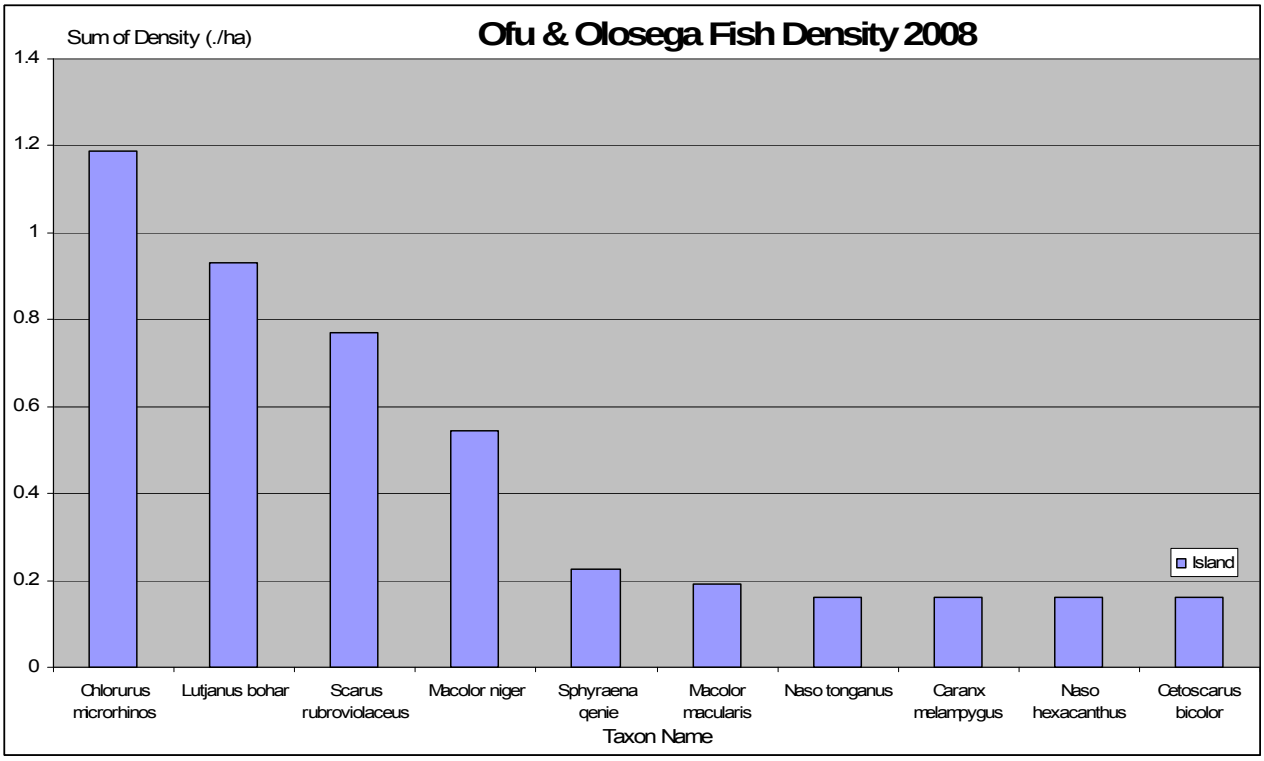

Figure C.4.2.1.--Density of 10 species most frequently recorded around the Ofu and Olosega Islands during the HI-08-02 ASRAMP cruise.

The grand mean biomass density of large fishes (> 50 cm in total length) observed on the shallow forereefs (< 30 m) around Ofu and Olosega Islands during the survey period of February28–March 5, 2008, was 0.017 t ha^{-1}. The 8 greatest biomasses of species encountered are shown in Figure C.4.2.2. The steephead parrotfish (*Chlorurs microhinus*) accounted for 20% (0.0033 t ha^{-1}) of the total mean biomass. The red snapper (*Lutjanus bohar*) accounted for 18% (0.003 t ha^{-1}), and the redlip parrotfish (*Scarus rubroviolaceus*) accounted for 12% (0.002 t ha^{-1}). The total biomass density for the rare, ICUN red-listed Napolean wrasse (*Chellinus undulatus)* was 0.0005 t ha^{-1}, putting it eighth in terms of largest biomass around Ofu and Olosega Islands.

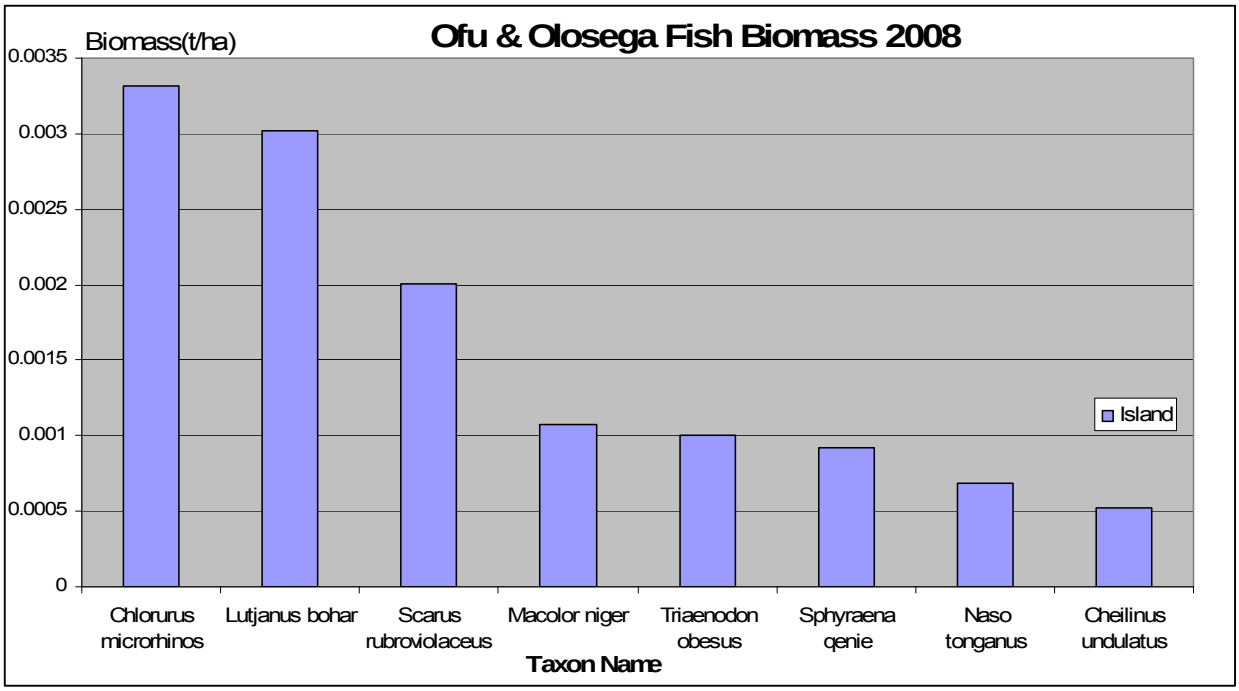

Figure C.4.2.2.--The 8 species with the highest biomass around Ofu and Olosega Islands during the HI-08-02 ASRAMP cruise.

Appendix D: Ta`u

D.1. Oceanography and Water Quality

Moorings

A total of 3 subsurface temperature recorders (STRs) were recovered and replaced at sites around the island of Ta`u during the HI-08-02 American Samoa Reef Assesment and Monitoring Program (ASRAMP) cruise, and a new STR (No. 3933179-1204) was deployed on the northeast shore of Ta`u. Additionally, a sea surface temperature (SST) buoy was recovered and replaced on the west side of Ta`u (Fig. D.1.1 and Table D.1.1).

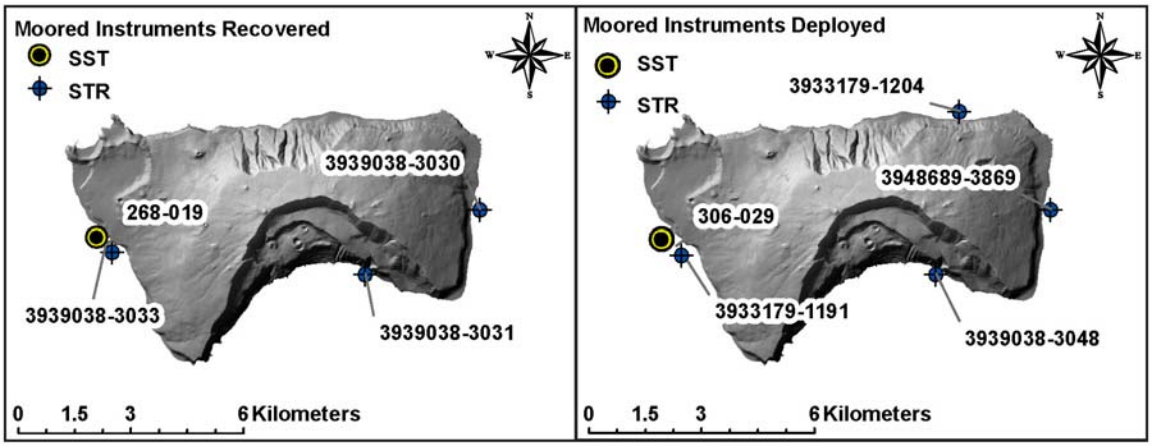

Figure D.1.1.--Moored oceanographic instrumentation map for Ta`u.

Table D.1.1.--Moored oceanographic instrumentation table for Ta`u. For instruments recovered and deployed around Tutuila during the HI-08-02 ASRAMP cruise, this table provides instrument type, serial number, sensor depth, and data start and end dates (UTC).

Instrument	Serial Number	Latitude	Longitude	Depth (m)	Data Start	Data End
SST	268-019	14 14.6453 S	169 30.5341 W	0.00	4-Mar-06	1-Mar-08
STR	3939038-3033	14 14.6453 S	169 30.5341 W	14.94	4-Mar-06	1-Mar-08
STR	3939038-3031	14 15.0464 S	169 26.7944 W	6.40	3-Mar-06	2-Mar-08
STR	3939038-3030	14 14.127 S	169 25.145 W	9.75	3-Mar-06	2-Mar-08
SST	306-029	14 14.6413 S	169 30.5344 W	0.00	LOGGING DATA	
STR	3933179-1191	14 14.6413 S	169 30.5344 W	14.33	LOGGING DATA	
STR	3939038-3048	14 15.0464 S	169 26.7944 W	6.40	LOGGING DATA	
STR	3948689-3869	14 14.127 S	169 25.145 W	9.75	LOGGING DATA	
STR	3933179-1204	14 12.715 S	169 26.462 W	12.80	LOGGING DATA	

Preliminary Mooring Results

All 3 STRs and the 1 SST buoy recovered from around Ta`u yielded full-length, quality data sets (Fig. D.1.2). Between March 2006 and March 2008 subsurface water temperatures around the island and surface temperature on the west side of Ta`u fluctuated seasonally with lows (~ 27 °C) occurring during July–October and highs between January–April (~ 30 °C). All sensors showed similar temperatures with 1° C of variability between them. The large diurnal fluctuations seen in the SST buoy No. 268-019 time series reflect the effects of heating and cooling of the surface waters.

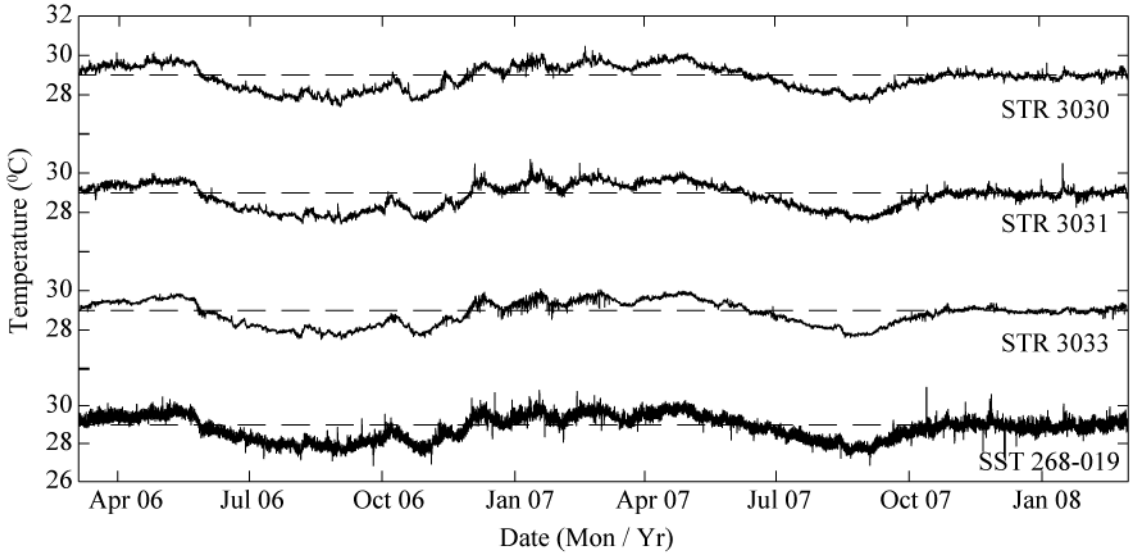

Figure D.1.2.--Temperature data obtained from 3 STR locations and 1 SST location around Ta`u.

Water Quality

At regular intervals, 38 shallow-water conductivity, temperature, and depth (CTD) casts were conducted along the 30-m isobath around the entire island. All conductivity-temperature-depth (CTD) casts were completed over 2 consecutive days (Fig. D.1.3).

Day 1: TAU01–TAU16
Day 2: TAU17–TAU38

At 4 CTD cast locations, duplicate CTD casts were conducted (TAU04–TAU35, TAU08–TAU36, TAU12–TAU37, and TAU16–TAU38) on the 2 consecutive sampling days to look at temporal variability (Fig. D.1.4). Clearly, there was some temporal variability, which was likely in large part a result of the heavy winds that occurred over this period that caused vertical mixing of the water column and yielded more homogeneous casts with depth on the second day of sampling (as seen in casts TAU35–TAU37, especially). However, the temperature variation was not especially large (~ 0.5 °C), and both the maximum and minimum values occurred in CTD cast TUT-12.

Discrete water samples from a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m were collected concurrently with shallow-water CTD casts at 4 of the CTD sites, yielding a total of 18 chlorophyll-*a* (Chl-*a*) and 18 nutrient samples.

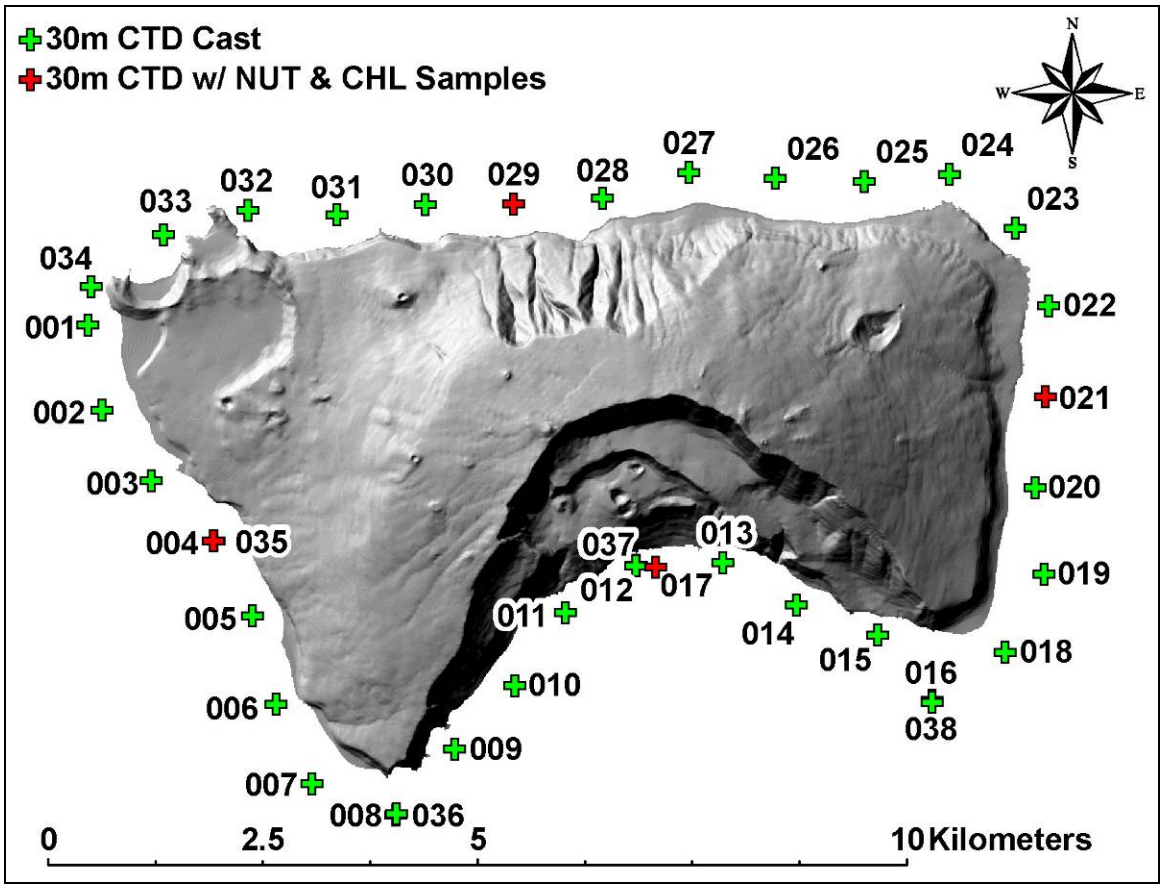

Figure D.1.3.--Shallow-water CTD casts and water sampling locations around Ta`u, labeled by cast number.

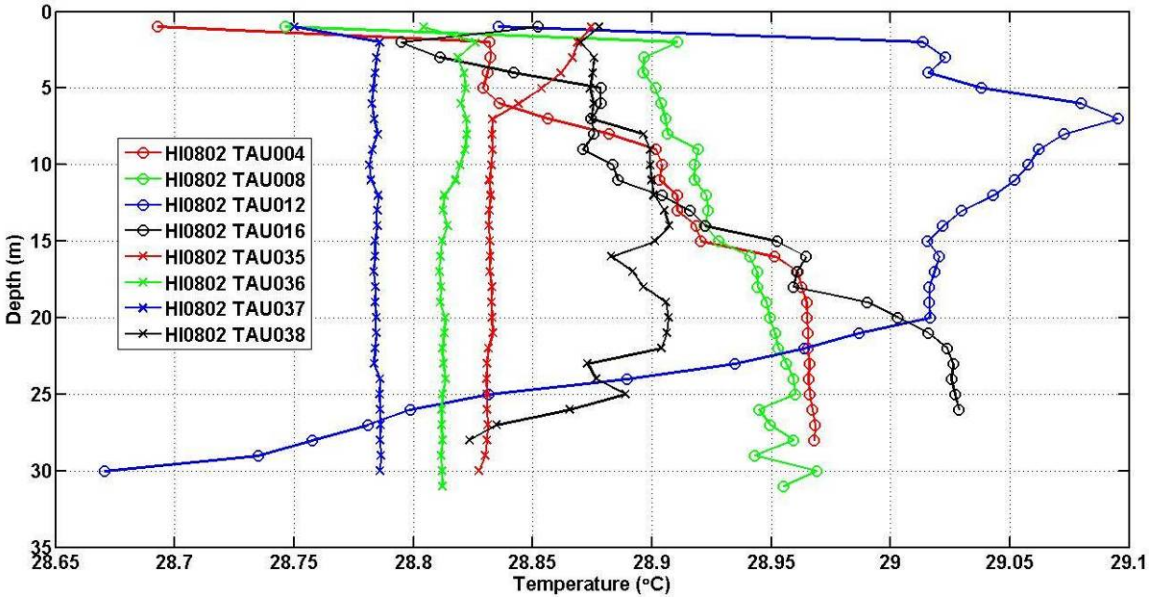

Figure D.1.4.--Duplicate shallow-water CTD casts around Ta`u (TAU004–TAU035, TAU008–TAU036, TAU012–TAU037, and TAU016–TAU038) revealed the temporal variability of temperature at the same sites on 2 consecutive days.

Around the Manua Group—Ofu, Olosega, and Ta`u—6 shipboard CTD casts were conducted (Fig. D.1.5). All casts were made to a depth of 500 m, and water samples were collected at 3 m, 80 m, 100 m, 125 m, and 150 m for nutrient and Chl-*a* analysis. Nutrient and Chl-*a* samples were processed and stored according to protocols provided by Pacific Marine Environmental Laboratory (PMEL) scientists. Samples were sent to PMEL and the University of Hawai`i when the cruise returned. CTD casts were conducted February 29–March 5, 2008, using the Coordinated Universal Time (UTC) standard, based on the schedule below.

Day 1: MAN15–MAN17
Day 2: MAN18
Day 6: MAN19–MAN20

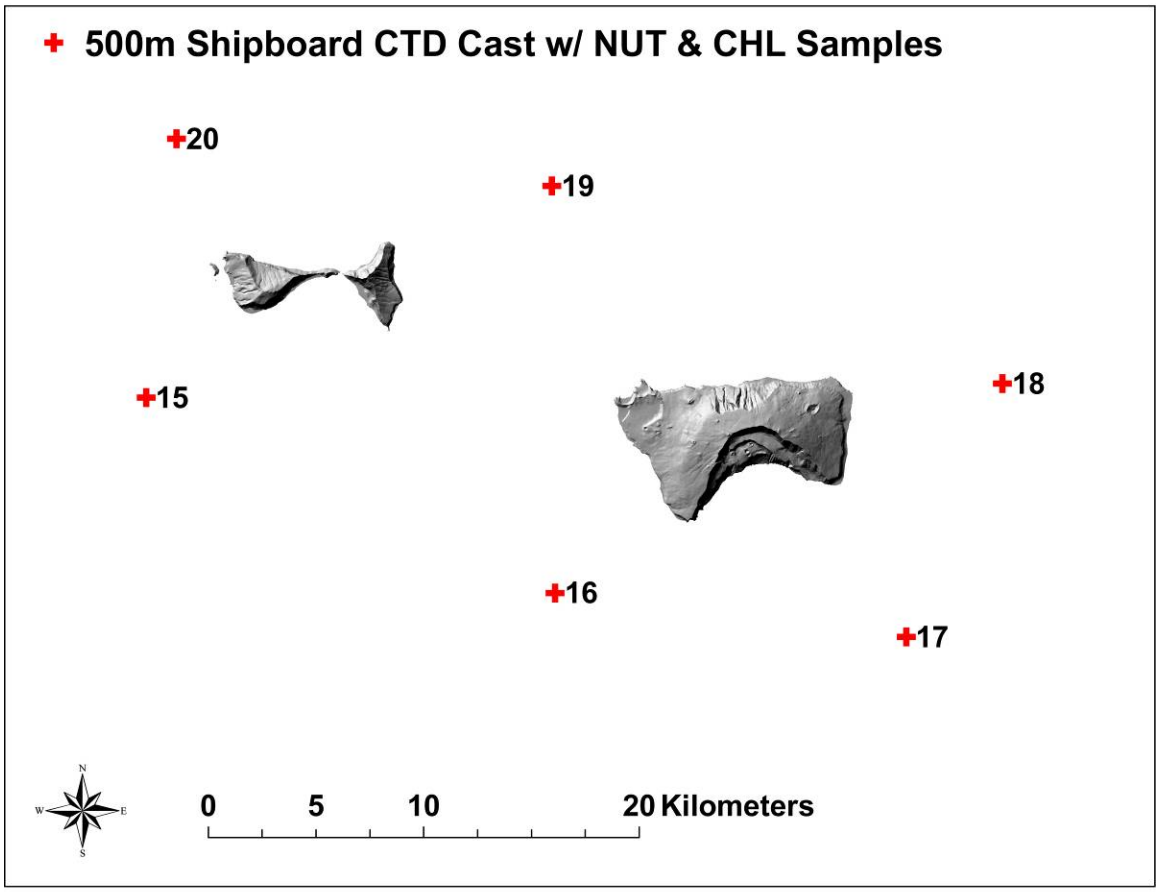

Figure D.1.5.--Shipboard CTD casts as well as nurtrient and Chl-*a* sites in the Manua Group—Ofu, Olosega, and Ta`u—during the HI-08-02 ASRAMP cruise, labeled by cast number.

Preliminary Water Quality Results

Temperature, salinity, density, and beam transmittance throughout the 30-m water column showed some variability vertically around Ta`u during this sampling period (Fig. D.1.6). In general, surface waters (< 10 m deep) were cooler (by ~ 0.5 °C), had less saline, and were less dense than deep waters. This difference is likely the result of the heavy rains experienced during the sampling period, which caused a surface lens of freshwater from both direct rainfall to the surface and terrestrial freshwater runoff. The north shore of the island experienced the largest freshwater influx to the surface waters, but additional data would be required to assess the longevity of such events (casts 31–34). The warmest waters with the highest salinity and density occurred in the deeper portions of the south bay region (casts 14–10, Fig. D.1.7). Strong winds caused an eddy effect and effectively trapped water in the bay. Additionally, eddies derived from wind may be causing downwelling of surface waters as water accumulates in the lee. This effect would also increase the residence time of the water in this area. This theory may be tested by looking at productivity within the bay: longer than average residence times could cause relatively low productivity in this region. The water column around the west side of Ta`u was relatively vertically homogeneous (casts 10–5).

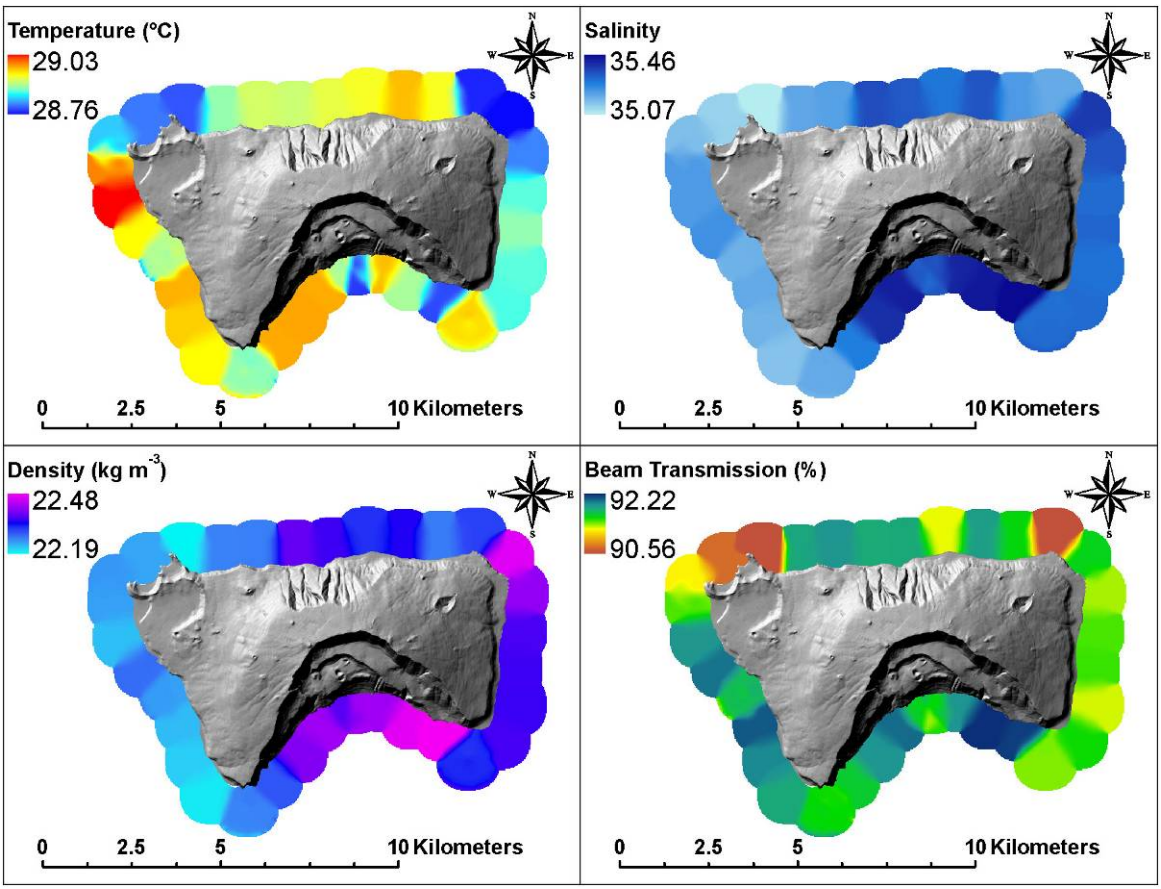

Figure D.1.6.--Interpolated shallow-water CTD cast data at a depth of 20 m around Ta`u during the HI-08-02 ASRAMP cruise: temperature (upper left), salinity (upper right), density (bottom left), and beam transmission (bottom right).

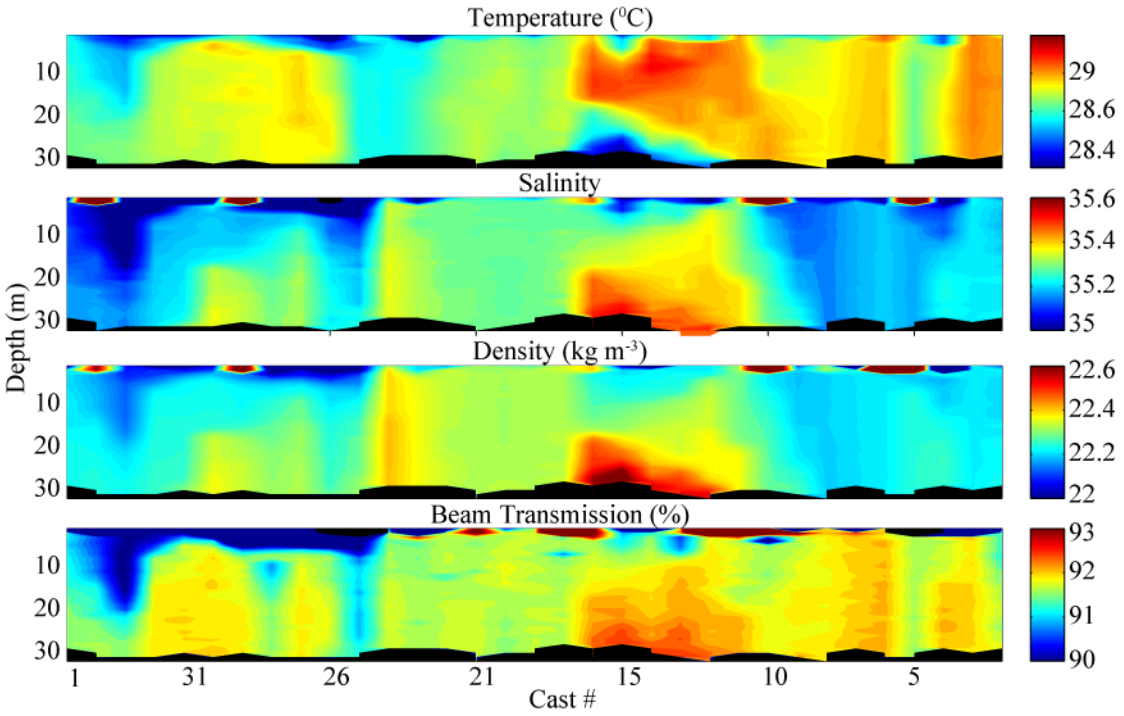

Figure D.1.7.--Cross-sectional plot of shallow-water CTD data (temperature, salinity, density, and beam transmission) collected around Ta`u during the HI-08-02 ASRAMP cruise. Refer to Figure D.1.3 for CTD cast locations.

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

Around Ta`u on March 1–5, 2008, 15 REA sites were visited by a team of up to 8 scientists. At 4 of those sites, only fish surveys were conducted over differing depth ranges. These site locations are shown in Figure D.2.1, and the survey dates and efforts are shown in Tables D.2.1 (benthic surveys) and D.2.2 (Fish surveys). Individual site descriptions are included for the following discipline communities: coral, coral and coralline disease, macroinvertebrates, algae, and fish.

Table D.2.1.--Ta`u 2008 benthic REA site survey dates, teams present, and additional comments. All dives were conducted in the forereef stratum.

Site ID	Date	Teams Present	Comments
TAU-01	3/2/2008	Coral, Algae, Invertebrates	No disease and health survey
TAU-02	3/2/2008	Coral, Algae, Invertebrates	No disease and health survey
TAU-04	3/5/2008	Coral, Algae, Invertebrates	*
TAU-05	3/5/2008	Coral, Algae, Invertebrates	*
TAU-07	3/2/2008	Coral, Algae, Invertebrates	No disease and health survey
TAU-08	3/1/2008	Coral, Algae, Invertebrates	No disease and health survey
TAU-09	3/1/2008	Coral, Algae, Invertebrates	No disease and health survey
TAU-11	3/5/2008	Coral, Algae, Invertebrates	*
TAU-12	3/1/2008	Coral, Disease, Algae, Invertebrates	

* Because the disease specialist was injured, a secondary scientist gathered health and disease data at these sites. This data will be processed after the cruise and entered into the database upon the discretion of Bernardo Vargas-Ángel.

Table D.2.2.--Ta`u 2008 fish REA survey sites. At each site, 2 belt-transect surveys (25 × 4 m) and a stationary-point count survey (circular plot with a 7.5-m radius) were performed unless otherwise noted. All dives were done in the forereef stratum.

Site ID	Date	Depth (m)	Comments
TAU-01	3/2/2008	11	**
TAU-02	3/2/2008	11	**
TAU-04	3/5/2008	13	**
TAU-07	3/2/2008	13	**
TAU-08	3/1/2008	11	**
TAU-09	3/1/2008	12	**
TAU-10	3/5/2008	14	**
TAU-11	3/5/2008	14	**
TAU-12	3/1/2008	11	**
TAU-50	3/1/2008	4	**
TAU-51	3/2/2008	23	1 BLT & 1 nSPC *
TAU-52	3/5/2008	21	**

** Since 1 fish team member was ill and unable to participate in dives, the protocol for fish surveys was modified slightly: the 3 remaining fish team members were deployed on a boat separate from the benthic REA team; during each dive, 2 team members conducted 2 belt-transect (BLT) surveys and 1 stationary-point count (nSPC) survey while the third member conducted 2 nSPC surveys in an area close to the original transect line.

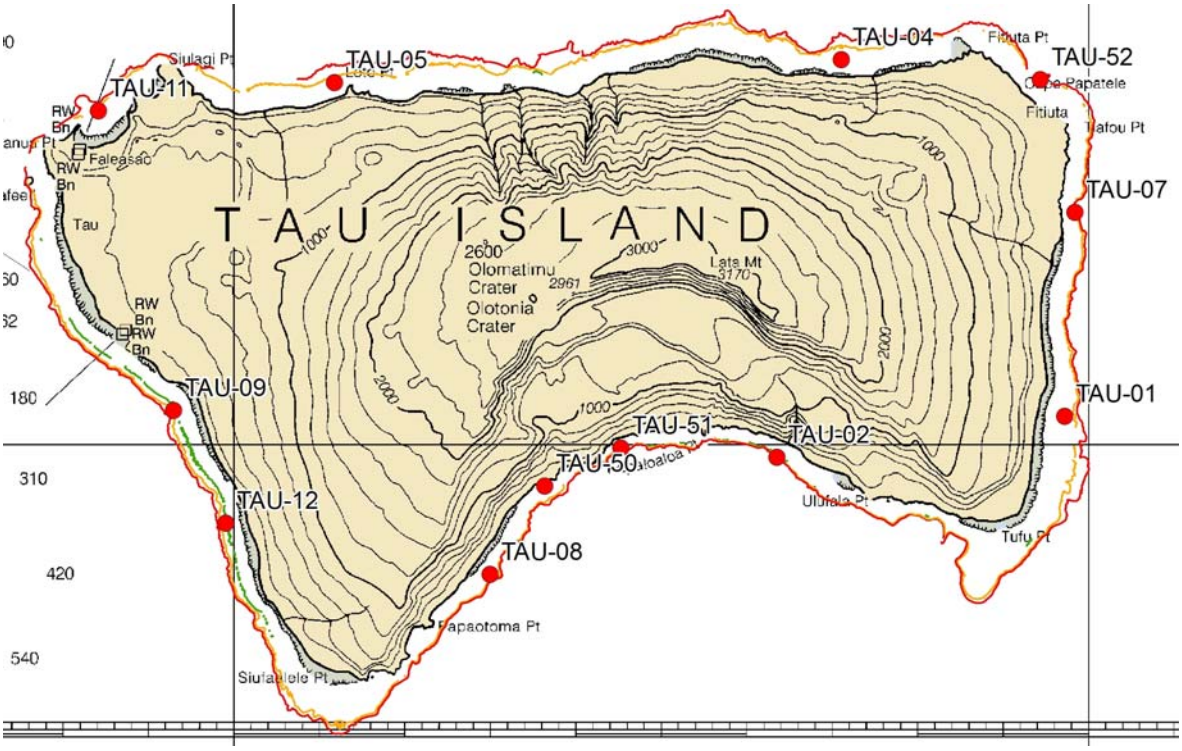

Figure D.2.1.--REA site locations around the Ta`u during the HI-08-02 ASRAMP 2008 cruise.

Site Descriptions

March 1, 2008

TAU-12
14°15.469′ S, 169°30.032′ W
Depth Range: 10.36–14.33 m
A total of 24 coral genera were recorded within this site's belt transects, and *Montipora*, *Goniastrea*, *Astreopora*, *Acropora, Favia, Leptastrea, and Porites* were the most abundant coral taxa found. Coral disease and health assessments revealed 2 cases of subacute tissue loss (*Montipora, Pavona varians*), 1 case of skeletal growth anomaly (Montipora), 2 cases of bleaching (*Pocillopora eydouxi*), and 2 cases of barnacle infestations (*Goniastrea*) in a survey area of 186 m^2. Line-point intercept analysis found 42.2% hard coral cover, 2 cases of subacute tissue loss (*Montipora, Pavona varians*), 1 case of skeletal growth anomaly (*Montipora*), 2 cases of bleaching (*Pocillopora eydouxi*), and 2 cases of barnacle infestations (*Goniastrea*) in a survey area of 186 m^2. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis*, followed by *Calcinus* hermit crabs. *Tridacna* and trapezid crabs were common. Macroalgae identified in this site's photoquadrats included cyanophytes, crustose coralline red algae, turf algae, *Halimeda*, *Jania*, and *Lobophora variegata*. *Tydemania expeditionis* and *Chlorodesmis fastigiata* were noted along the random swim survey. Small damselfishes were prevalent at this site, primarily *Chromis acares* and *Pomacentrus vaiuli.* Acanthurids were also abundant. Of note were high numbers of juvenile *Parupeneus multifasciatus*.

TAU-09
14°14.752′ S, 169°30.384′ W
Depth Range: 14.06–16.46 m
This site was located on the west side of Ta`u. This site was characterized by moderately high coral cover (40.1%) and turf algae (29.4%). A total of 22 coral genera were recorded within this site's belt transects, and *Montipora*, *Astreopora*, and *Porites* were the most abundant coral taxa found. No disease and health assessment survey was conducted. No coral and coralline algae health and disease assessment data was gathered. The dominant macroinvertebrates observed were Coralliophilidae snails, followed by *Calcinus* hermit crabs. *Tridacna* and trapezid crabs were common. Dominant macroalgae in this site's photoquadrats consisted of turf algae, crustose coralline red algae, *Halimeda*, *Lobophora variegate*, and *Peyssonnelia. Chlorodesmis fastigiata* was recorded on the random swim survey. Fish diversity at this site was relatively high with all size classes represented, from smaller damselfishes (*Chromis*, *Pomacentrus*) to large parrotfish (*Scarus*), grouper (*Cephalopholis*), snappers (*Lutjanus*, *Aphareus*), emperor (*Monotaxis*), soldierfish (*Sargocentron*), and triggerfish (*Balistoides*). Larger sizes of *Ctenochaetus striatus* were seen, as well as recruits and juveniles.

TAU-08
14°15.736′ S, 169°28.468′ W
Depth Range: 9.14–12.80 m
A total of 22 coral genera were recorded within this site's belt transects, and *Montipora*, Galaxea, *Astreopora*, and *Acropora* were the most abundant coral taxa. Coral disease and health assessments revealed 8 cases of barnacle infestation (*Goniastrea*), 1 case of discoloration (*Astreopora*), and 2 cases of tissue loss (*Porites, Montipora*) in a survey area of 150 m^2. No disease and health assessment survey was conducted. Line-point intercept analysis found 39.2% hard coral cover, 8 cases of barnacle infestations (*Goniastrea*), 1 case of discoloration (*Astreopora*), and 2 cases of tissue loss (*Porites, Montipora*) in a survey area of 150 m^2. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis*, followed by *Calcinus* hermit crabs. *Tridacna* and *Linckia multifora* were common. The observed *Tridacna* were ≤ 7 cm long. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes, and *Chlorodesmis fastigiata. Chlorodesmis fastigiata* and *Halimeda opuntia* were noted on the random swim survey. Large fish were virtually absent from this site with the exception of 1 large goatfish (*Parupeneus cyclostomus*). Small damselfishes again were dominant, including *Chromis acares*, *Chrysiptera brownriggii*, *Pomacentrus richardsoni*, *Stegastes fasciolatus*, and *Plectroglyphididon dickii*. Recruits and juvenile fish were common here, as triggerfish (*Balistapus undulatus*) and an unusually high number of filefishes (*Cantherhines pardalis*, *Sufflamen bursa*, *S. chrysopterus*, and the rarely seen *Pervagor alternans*) were observed.

TAU-50
14º15.237′ S, 169º28.174′ W
Depth Range: 2–4 m
This site is located on the south central section of Ta`u. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had zero coral cover with high complexity (large boulders) inshore, while, slightly offshore, there was

a flat expanse of low complexity pavement. The lack of coral structure is probably responsible for the absence of small fish (damselfish) in the vicinity of boulders. However, the shelter provided by the boulders is probably the reason why many large fish were observed here (surgeonfish, snapper, etc.). On the flat expanse, large numbers of damselfish (*Chrysiptera*) recruits were observed.

March 2, 2008

TAU-02
14°15.077′ S, 169°26.791′ W
Depth Range: 10.97–12.19 m
This site was located on the southeast forereef of Ta`u. This site was characterized by high coral cover (56.2%). A total of 21 coral genera were recorded within this site's belt transects, and *Montipora* was the most abundant coral taxon found within the survey area. No disease and health assessment survey was conducted. Noncryptic macroinvertebrates were observed in low abundance. *Tridacna* and *Calcinus* hermit crabs were common. *Linckia multifora* and *Echinostrephus aciculatis* were rare. An unidentified ruffled gray sponge was widespread throughout this site. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes, *Lobophora variegata*, *Halimeda*, and *Chlorodesmis fastigiata.* This site was dominated by juvenile fishes of many species. The overwhelming characteristic of this site was the absence of many fishes over 20 cm in total length. Small damselfishes were abundant, as were small individuals of *Parupeneus multifasciatus*. Off transect and in deeper waters, a single whitetip reef shark was observed.

TAU-07
14°16.630′ S, 169°25.100′ W
Depth Range: 38–45 m
This site was located on the east side of Ta`u. Coralline algae on pavement dominated the benthic substrate; coral cover was 18.6%. A total of 27 coral genera were recorded within this site's belt transects, and *Montipora* and *Goniastrea* were the most abundant coral taxa. No disease and health assessment survey was conducted. With the exceptions of *Calcinus* hermit crabs and one segment having an abundant number of *Echinostrephus* sp., the macroinvertebrates were observed in low abundance. *Tridacna* were common. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes, *Lobophora variegate*, and *Halimeda*. The random swim survey produced *Caulerpa sertularoides, Chlorodesmis fastigiata*, *Portieria hornemannii*, and a *Halymenia* sp. (possibly *H. maculate*). Again, the surgeonfish *Ctenochaetus striatus* was common, and the small damselfish *Chromis acares* was the most abundant fish observed. Large fishes were seen in smaller numbers—including the grouper *Cephalopholis argus*; the snappers *Aphareus furca*, *Lutjanus bohar*, L. *kasmira* and *Macolor niger*; and the parrotfish,*S. oviceps*. Off transect, the trevally *Caranx melampygus* was observed.

TAU-01
14°14.829′ S, 169°25.139′ W
Depth Range: 10.97–12.80 m
Coralline algae on pavement dominated the benthic substrate; coral cover was 34.3%. A total of 25 coral genera were recorded within this site's belt transects, and *Turbinaria*, *Porites, Galaxea*, and *Goniastrea* were the most abundant coral taxa. No disease and health assessment survey was conducted. Overall, noncryptic macroinvertebrates were observed in low abundance. Only *Calcinus* hermit crabs were common. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes, *Lobophora variegata*, *Halimeda*, *Jania, Chlorodesmis fastigiata*, and an unknown slippery red algae, possibly a *Gracilaria* sp. Algal genera found along the random swim survey included *Wrangelia* sp., *Martensia* sp., *Bryopsis pennata*, and *Dictyosphaeria versluysii.* The acanthurids *Ctenochaetus cyanocheilus* and *Ctenochaetus striatus* were very abundant here. Also of note were large numbers of the wrasse *Thalossoma quinquevittatum*.

TAU-51
14º15.015′ S, 169º27.731′ W
Depth Range: 20–24 m
This site is located on the south central section of Ta`u. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site is characterized by a vertical wall extending to about 37 m. The reef had medium complexity with medium coral cover. Many large fishes where observed, including both *Macolor niger* and *Macolor macularis*.

March 5, 2008

TAU-04
14°12.717′ S, 169°26.416′ W
Depth Range: 11.89–15.63 m
This site was located on the north forereef of Ta`u. Pavement covered with turf algae dominated the benthos with moderate high coral cover (26.5%). A total of 23 coral genera were recorded within this site's belt transects, and *Montipora*, *Astreopora*, and *Goniastrea* were the most abundant coral taxa. Corals measuring < 5 cm in diameter were most abundant. No disease and health assessment survey was conducted. With the exception of *Echinostrephus aciculatis,* noncryptic macroinvertebrates were observed in low abundance. *Tridacna* and *Calcinus* hermit crabs were rare. Dominant macroalgae in this site's photoquadrats consisted of turf algae, crustose coralline red algae, cyanophytes, *Lobophora variegata, Dictyosphaeria versluysii*, and *Peyssonnelia. Chlorodesmis fastigiata* and *Tydemania expeditionis* were recorded on the random swim survey. Large species of acanthurids were present at this site, including *Acanthurus maculiceps*, *A. olivaceous,* and *A. pyroferus.* These fishes hung around the periphery of the stationary-point count survey area in greater numbers than they did inside it. The small pomacentrids *Chromis margaritifer* and *Pomacentrus richardsoni* were also found in greater numbers at this site.

TAU-05
14°12.882′ S, 169°29.383′ W
Depth Range: 13.11–15.54 m
This site was located on the north forereef of Ta`u. Pavement covered with turf algae dominated the benthos with moderate high coral cover (31.4%). A total of 23 coral genera were recorded within this sites' belt transects, and *Astreopora*, *Montipora*, and *Favia* were the most abundant coral taxa. Corals measuring < 5 cm in diameter were most abundant. No disease and health assessment survey was conducted. The dominant macroinvertebrate observed was the echinoid *Echinostephus aciculatis. Tridacna,* zoanthids, and hermit crabs were common. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes, *Lobophora variegata, Dictyosphaeria versluysii*, and *Peyssonnelia.* Noted on the random swim survey were *Chlorodesmis fastigiata, Dictyosphaeria versluysii, Tydemania expeditionis, Haloplegma duperreyi, Galaxaura filamentosa, Halimeda, Neomeris, Gelidiopsis, Caulerpa taxifola*, and *Padina.* The murky, surgy, boulder-strewn areas where the fish transects were laid were characterized by very low numbers of fish; on one belt transect survey, only 4 individuals were recorded. Of the fishes present, *Ctenochaetus striatus* and *Chrystiptera taupou* were most abundant; still, the number of these fishes was relatively low in comparison to their abundance at other sites. A few large fishes wandered into or across this site's transects, including a variety of goatfishes, a small school of snapper, and a bluefin trevally.

TAU-11
14°13.021′ S, 169°30.744′ W
Depth Range: 11.89–15.82 m
This site was located on the north forereef of Ta`u. The benthos was dominated by encrusting montiporid corals with coral cover averaging 50.9%. A total of 19 coral genera were recorded within this site's belt transects, and *Montipora*, *Porites*, and *Astreopora* were the most abundant coral taxa. Corals measuring < 5 cm in diameter were most abundant. No disease and health assessment survey was conducted. On the first transect, the dominant macroinvertebrate observed was the echinoid E*chinostephus aciculatis*, and *Tridacna* were common. Noncryptic macroinvertebrates were observed in extremely low abundance on the second transect. Photoquadrat abundances of macroalgae consisted of crustose coralline red algae, turf algae, branched crustose coralline red algae, *Halimeda, Amphiroa, Dictyosphaeria versluysii, Gibsmithia*, and *Chlorodesmis fastigiata. Caulerpa sertularoides, Haloplegma duperreyi, Amansia, Gelidiopsis*, and *Peyssonnelia* were found during the random swim survey. Greater numbers of large, skittish species were recorded within this site's stationary-point count and belt-transect survey areas than at other survey sites, making this site relatively unusual. These species included *Lutjanus monostigma, Lutjanus fulvus, Plectorhynchus vittatu*s, and *Kyphosus cinerascens.* Large scarids were observed here as well, in addition to high numbers of small pomacentrids.

TAU-52
14º12.861′ S, 169º25.280′ W
Depth Range: 21–26 m
This site is located on the northeast corner of Ta`u. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site is a gently slopping

fringing reef ending over sand at about 37 m. This reef had low complexity and medium coral cover. Very few large fishes were observed here. This site was dominated by small damselfishes (*Chromis acares, Chromis iomelas*) and anthia (*Pseudoanthias bartlettorum*).

D.3. Benthic Environment

D.3.1. Algae

Quantitative algal surveys were conducted at 9 sites around Ta`u, American Samoa. A total of 9 species of macroalgae were recorded along survey transects: 3 species of green algae, 5 species of red algae, and 1 species of brown algae, as well as crustose coralline red algal, turf algal, and cyanophyte functional groups (Table D.3.1.1).

Table D.3.1.1.--Algal genera or functional groups recorded in photoquadrats around Ta`u. Numbers indicate the percentage of photoquadrats in which an alga occurred.

Division	Species/Name	TAU-01	TAU-02	TAU-04	TAU-05	TAU-07	TAU-08	TAU-09	TAU-11	TAU-12
	Cyanophyte	16.67	33.33	16.66	25	8.33	75			75
	turf algae	75	91.66	100	100	75	100	100	100	100
Chlorophyta	*Chlorodesmis fastigiata*	8.33	33.33				16.66		8.33	
Chlorophyta	*Dictyosphaeria versluysii*		66.67	33.33				16.67		
Chlorophyta	*Halimeda sp.*	16.67	66.66			16.66		25	8.33	66.67
Ochrophyta	*Lobophora variegata*	25								
Rhodophyta	*Amphiroa sp.*								25	
Rhodophyta	*crustose coralline red algae*	108.33	100	100	91.66	100	100	33.33	75	91.66
Rhodophyta	*Gelidiella sp.*									
Rhodophyta	*Gibsmithia sp.*								8.33	
Rhodophyta	*Jania sp.*	8.33								25

D.3.2. Corals

Coral REA surveys were conducted February 28–March 5, 2008 at 9 forereef sites around Ta`u (Fig. D.2.1). All sites surveyed in 2006 were resurveyed in 2008 with the addition of site TUT-03, which was last surveyed in 2004. Survey depths ranged between 11 and 16 m. Coral population surveys were conducted by Jason Helyer, Coral Reef Ecosystem Division (CRED), and coral disease and health assessments were conducted by Jean Kenyon, PhD. (CRED).

D.3.2.1 Percent Benthic Cover

The line-point intercept method accounted for a total of 969 points along 500 m of forereef coral communities. Patterns of intraisland variability in percent benthic cover, derived from the 9 independent REA surveys in 2008, are reflected in Fig. D.3.2.1.1. Scleractinian corals, turf algae, and coralline algae were again the primary benthic components with 37.7% (SE 3.9), 31.8% (SE 3.9), and 22.3% (SE 5.4) of total benthic element cover. TAU-02 to the south and TAU-11 to the northwest had the highest values of coral cover at 56.2% and 51.0%. The highest value of turf algal cover (53.9%) was found at TAU-05 on the north side; the highest value of coralline algal cover (54.9%) was found at TAU-01 on the southeast side.

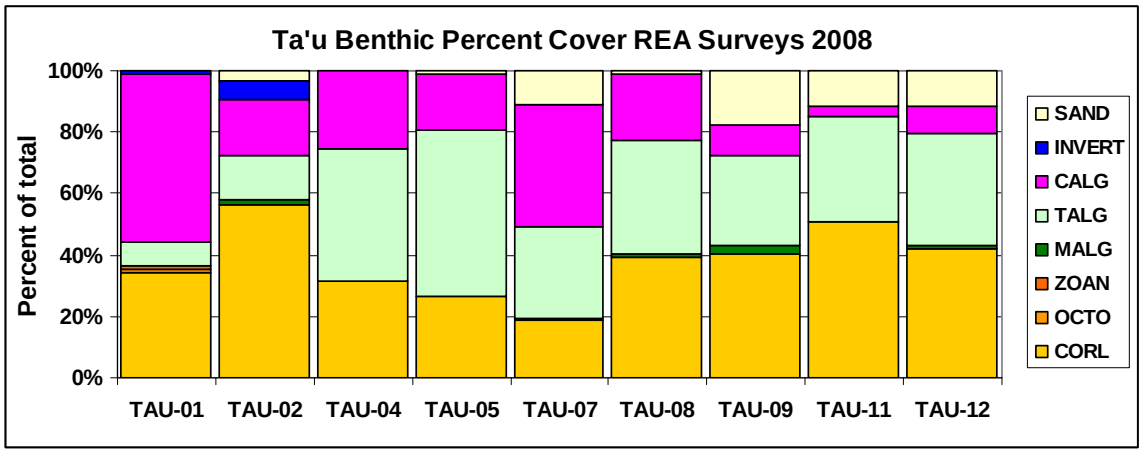

Figure D.3.2.1.1.--Mean percent cover of benthic elements derived from 9 sites around Ta`u Island during the HI-08-02 ASRAMP cruise, February 28–March 5, 2008. CORL: scleractinian and hydrozoan coral; OCTO: octocoral; ZOAN: zoanthids; MALG: macroalgae; TALG: turf algae (on pavement, rubble, and dead coral); CALG: crustose coralline algae (on pavement, rubble, and dead coral); INVT: nonanthozoan invertebrates; SAND: sand.

D.3.2.2. Coral Populations

A total of 4179 coral colonies belonging to at least 36 cnidarian taxa (30 scleractinian genera, 5 octocorals, and 1 hydrozoan) were enumerated within the 300 m^2 of reef surveyed around Ta`u (Table D.3.2.2.1). Members of the genera *Montipora* and *Astreopora* were the most abundant coral taxa in terms of number of colonies with each genus contributing 27.3% and 10.2%, respectively, of the total number of colonies recorded. Density values at individual

sites ranged from 6.1 colonies m^{-2} at TAU-02 to 26.1 colonies m^{-2} at TAU-08. Generic richness values ranged from 19 coral genera recorded at TAU-11 to 27 coral genera observed at TAU-07. Inspection of coral size histograms show an overwhelming majority (84%) of corals had maximum diameters < 20 cm. Less than 1% of all colonies measured had diameters > 40 cm. The distribution of coral sizes in 2008 appears similar to coral size distribution observed in 2006 (Fig. D.3.2.2.1).

Table D.3.2.2.1.--Number of corals, by genus, enumerated along belt transects in 2008 coral REA surveys. Genera contributing more than 10% of the total number of colonies are highlighted in bold.

Coral Taxon	# of Colonies	% of Total	Coral Taxon	# of Colonies	% of Total
Acanthastrea	23	0.6	Merulina	1	0.0
Acropora	168	4.0	Millepora	3	0.1
Astreopora	**425**	**10.2**	Montastrea	229	5.5
Cladiella	6	0.1	**Montipora**	**1142**	**27.3**
Coscinaraea	13	0.3	Palythoa.	37	0.9
Cyphastrea	25	0.6	Pavona	82	2.0
Echinophyllia	5	0.1	Platygyra	61	1.5
Echinopora	15	0.4	Pocillopora	166	4.0
Favia	368	8.8	Porites	332	7.9
Favites	98	2.3	Psammocora	59	1.4
Fungia	12	0.3	Sandalolitha	3	0.1
Galaxea	216	5.2	Sarcophyton	5	0.1
Goniastrea	266	6.4	Symphyllia	7	0.2
Goniopora	1	0.0	Turbinaria	84	2.0
Hydnophora	9	0.2	Zoanthus	17	0.4
Leptastrea	173	4.1	Unknown	3	0.1
Leptoria	104	2.5			
Lobophyllia	6	0.1			
Lobophytum	15	0.4	**Total**	**4179**	**100**

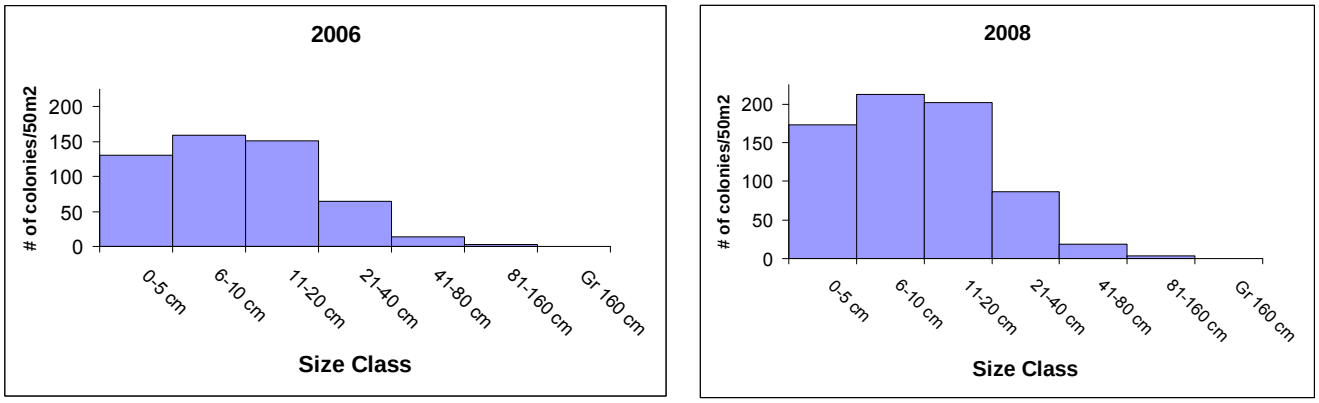

Figure D.3.2.2.1.--Coral size-class distributions for Tutuila in 2006 and 2008.

D.3.2.3 Coral Health and Disease

In 2008, a total area of 336 m^2 across 2 sites (TAU-08, TAU-12) was surveyed for coral and coralline algal disease during REA surveys around Ta`u. Overall, coral disease/anomaly occurrence and abundance were low; a total of 20 cases of 7 categorized anomalies (barnacle infestation, bleaching, other discolorations, predation, skeletal growth anomaly, subacute tissue loss, and acute tissue loss "white syndrome") were tallied around Ta`u. A summary of coral disease occurrence is presented in Figure D.3.2.3.1. The commensal relationship between barnacles and *Goniastrea* was the most frequently tallied condition and accounted for 60% of cases around Ta`u. Although it is arguable if this condition can be considered a disease, it was included in survey observations because it is noted on diagnostic cards produced by Thierry Work and Greta Aeby (Diseases of American Samoan Corals) and because a large proportion (≥ 50%) of corallites in affected colonies were frequently inhabited by barnacles. Other than barnacle infestation, the taxa most frequently affected by anomalies were *Montipora* and *Pocillopora*. No cases of coralline algal disease were observed at the 2 sites surveyed around Ta`u.

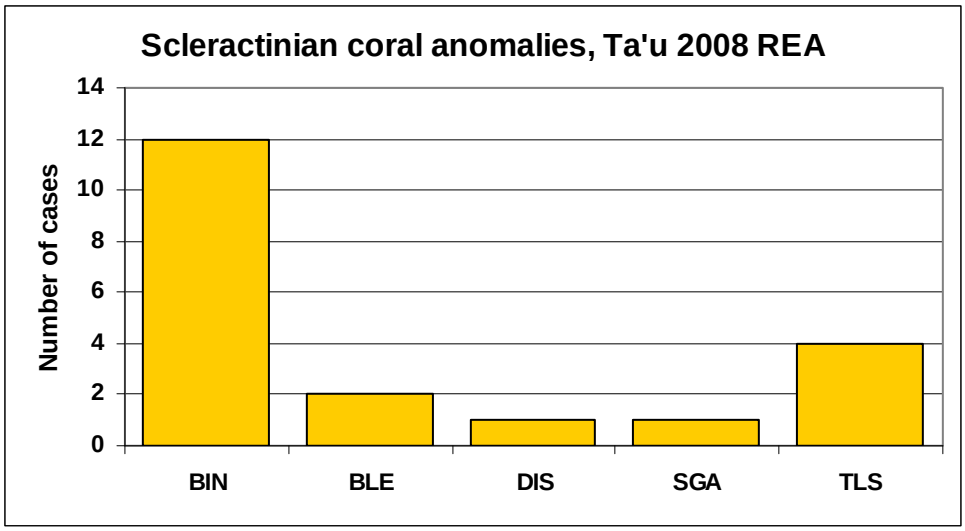

Figure D.3.2.3.1.--Number of cases of scleractinian disease enumerated during REA surveys, Ta`u, American Samoa, 2008. BIN: barnacle infestation; BLE: bleaching; DIS: other discolorations; PRE: predation; SGA: skeletal growth anomaly; TLS: subacute tissue loss; and WSY: acute tissue loss, "white syndrome".

D.3.3. Macroinvertebrates

Noncryptic invertebrates were observed in low abundance around Ta`u during ASRAMP 2008. *Calcinus* hermit crabs and the rock boring urchin (*Echinostrephus aciculatus*) were the most abundant macroinvertebrates. Hermit crab, predominantly *Calcinus minutus*, densities were greatest at sites TAU-01, TAU-09, and TAU-07 at 0.45, 0.33, and 0.32 m². *Echinostephus aciculatus* densities were greatest at TAU-04, TAU-05, and TAU-08 at 2.08, 1.69, and 1.45 m². Excluding *Echinostrephus aciculatus*, echinoderms were observed in relatively low abundance. No other echinoids were observed. Only one species of asteroid was observed: *Linckia multifora* at density of 0.11 m² at TAU-08. Two species of holothuroids were recorded: *Thelona ananas* and *Holothuria whitamaei. Tridacna* clams were rare except at TAU-11 and TAU-05 where these clams' densities were 0.11 and 0.09 m².

D.3.3.1. Urchin and Giant Clam Measurements

Figure D.3.3.1.1 on the next page reveals the average test diameter of the urchin, *Echinostrephus aciculatus,* encountered at each site. No other urchins were recorded. Only sites where ≥ 5 measurements were recorded are represented. Measurements were not recorded specifically along the survey transect but rather throughout the site.

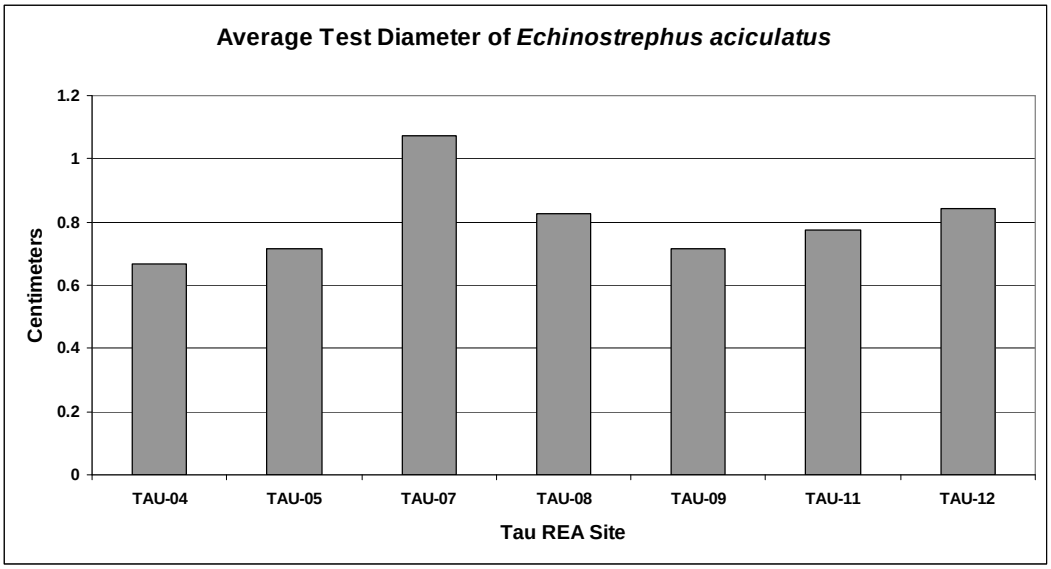

Figure D.3.3.1.1.--Average test diameter of *Echinostrephus aciculatus* at Ta`u REA sites.

Figure D.3.3.1.2 below reveals the average maximum shell length of giant clams observed at sites around Ta`u. Only sites where ≥ 5 measurements were recorded are represented. Measurements were not recorded specifically along the survey transect but rather throughout the site.

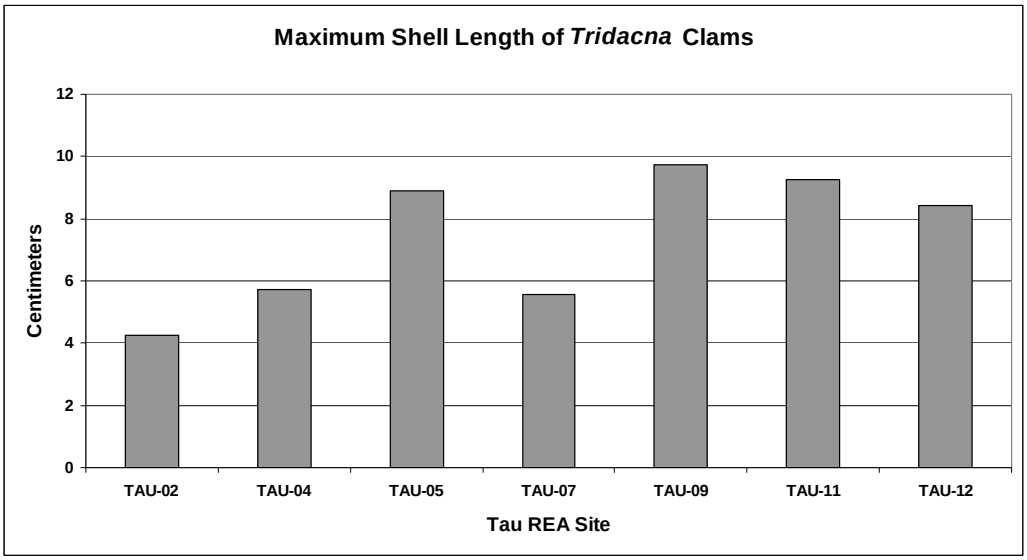

Figure D.3.3.1.2.--Average maximum shell length of *Tridacna* clams at Ta`u REA sites.

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

No ARMS were deployed around Ta`u.

D.3.3.3. Invertebrate Collections

Nondestructive tissue samples of the organisms listed in Table B.3.3.3.1 were collected for the Hawai`i Institute of Marine Biology, the University of Hawai`i at Mānoa, for the purpose of genetic analysis.

Table B.3.3.3.1.--Invertebrate tissue collection information for specimens from Kingman Reef.

Species	Number	REA site	Latitude	Longitude
Crinoid sp.	2	TAU-12	14°15.469′ S	169°30.032′ W
Crinoid sp.	3	TAU-11	14°13.021′ S	169°30.744′ W
Linckia multifora	15	TAU-08	14°15.736′ S	169°28.468′ W
Linckia multifora	2	TAU-02	14°15.077′ S	169°26.800′ W

D.3.4 Towed-diver Benthic Surveys

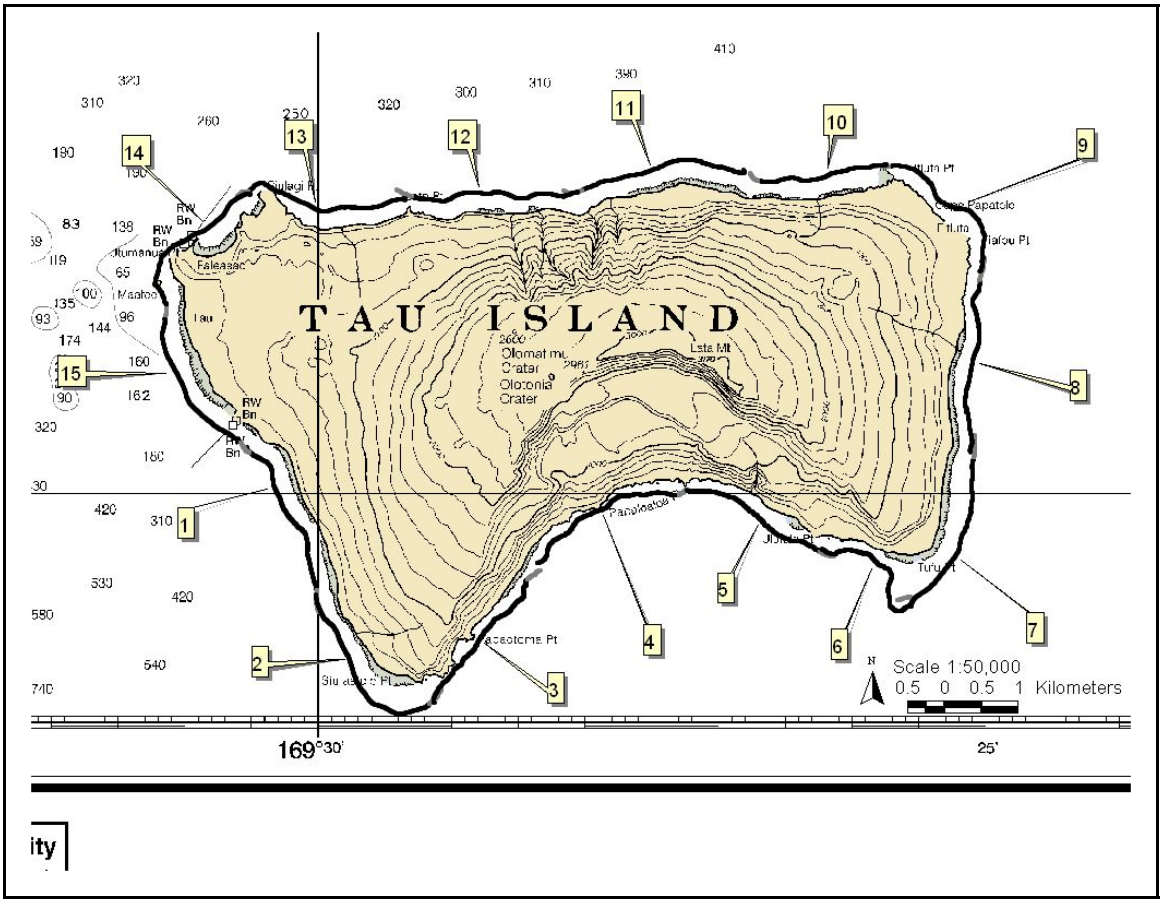

Figure D.3.4.1.--Towed-diver benthic surveys completed around Ta`u.

A total of 15 towed-diver benthic surveys covering 34.89 km of habitat were completed along the forereef of Ta`u. The average total hard coral cover was 18.5%, within a range of 0.1–75%. The highest average coral cover for a single survey was 42%, given a range of 5.1–75%, at survey site No. 5 along the south-southeastern reef of Ta`u. The habitat was made up

of mostly continuous reef of medium-high to high complexity, with a number of very steep drop-offs and walls. The most common corals observed along this transect included *Favites spp.*, *Millepora* sp., *Porites rus*, *Diploastrea* spp., and *Fungia* spp. Several large *Porites* colonies were observed during towed-diver surveys that are worth noting. Two large colonies were observed during survey No. 8 along the east side of the island at lat. 14°14.205′ S, long. 169°25.142′ W and lat. 14°13.277′ S, long. 169°25.001′ W, measuring 9.4 and 14 m across, respectively. A substantially larger colony was measured at lat. 14°15.561′ S, long. 169°30.041′ W to be 44 m wide along the southwest side of the island.

The average total hard coral stress was 1.5%, within a range of 0–20%, for all surveys. The highest coral stress was recorded at 3.5%, within a range of 0.1–10%, during a survey along the most southern reef near southwest Ta`u. No direct cause of the observed coral stress was recognized.

The average total soft coral cover was 1.1%, within a range of 0–10%, for all surveys. The highest soft coral cover was recorded along the south-central portion of continuous reef and boulders. Soft coral cover averaged 3.5%, given a range of 0–10%. The soft corals present included *Sarcophyton* and *Lobophyton* and were much more abundant in shallow waters.

The average pooled macroalgal cover was 6.4%, within a range of 0.1–50%, while the average pooled coralline algae cover was 28.9%, within a range of 0.1–75%. The highest average macroalgal cover was 16%, within a range of 1.1–40%, and occurred along the east continuous reef, where *Halimeda* was the dominant genus. The highest average coralline algae cover of 54%, within a range of 40.1–75%, occurred along Tu'u Point on the southeast side of Ta`u.

Macroinvertebrate populations around Ta`u varied greatly per species and habitat type. The boring sea urchin (*Echinostrephus aciculatus*) was the most abundant macroinvertebrate with an overall average of 400.5 urchins ha^{-1}. The highest density of urchins was found along the northwest pavement and rock habitat, where the average was 2339.5 individuals ha^{-1}. A total of 141 giant clams were recorded during the surveys of Ta`u (4 clams ha^{-1}). Giant clams were most abundant along the continuous reef of the north coastline, where in 4 surveys, 88 clams were recorded (8.9 clams ha^{-1}). Sea cucumbers were the next most abundant recorded macroinvertebrate and were recorded 26 times (0.75 sea cucumbers ha^{-1}). The surveys along both the northwest and northeast points counted 6 sea cucumbers each, both of which were primarily pavement habitats with some areas of rock boulders. No crown-of-thorns seastars (*Acanthaster planci*) were observed.

D.4 Fish

D.4.1 REA Fish Surveys

Stationary-Point Count Data (new methodology)

A total of 24 individual stationary-point count surveys were conducted at 12 sites around Ta`u (depths: 2 deep, 9 mid, 1 shallow). Surgeonfish (Acanthuridae) were the largest contributor to biomass with 1.1 kg 100 m^{-2}. Parrotfish (Scaridae) were the second most abundant family with a biomass of ~ 0.2 kg 100 m^{-2} (Fig. D.4.1.1 and Table D.4.1.2).

Belt-transect Data

During the survey period, 24 belt-transect surveys were conducted at 12 sites around Ta`u. Surgeonfish were the primary contributors to biomass with 1.4 kg 100 m^{-2}. (Table D.4.1.1). Snapper (Lutjanidae) and triggerfish (Balistidae) were also moderately abundant at 0.4 kg 100 m^{-2}.

Overall Observations

A total of 177 species were observed during the survey period by all divers. The average total fish biomass at the sites in Ta`u during the survey period was 0.37 t ha^{-1} for the stationary-point count surveys (Table D.4.1.2), and the average fish biomass was 0.25 t ha^{-1} for the belt-transect surveys (Table D.4.1.1).

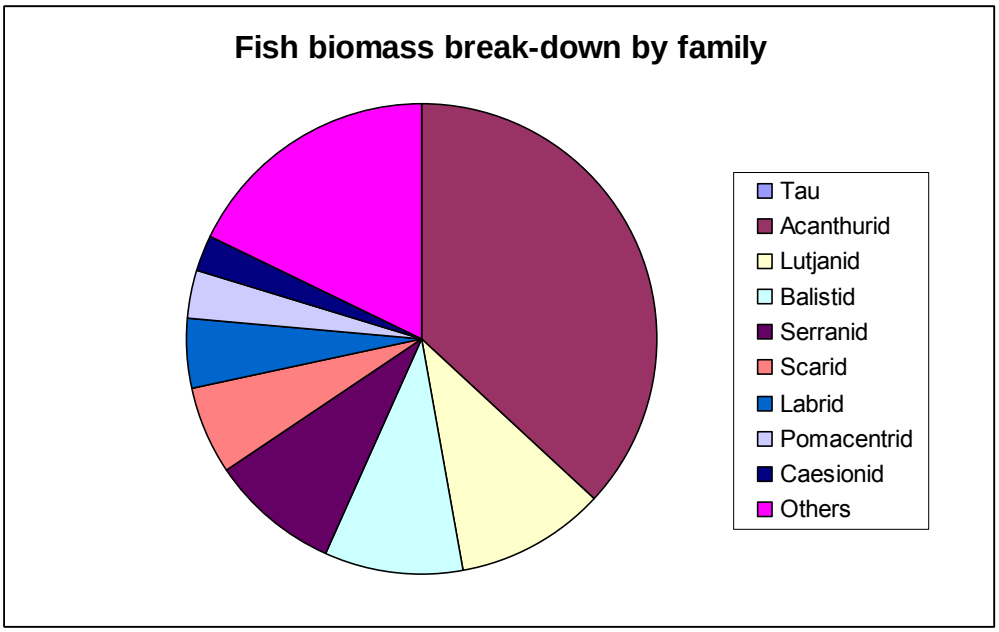

Figure D.4.1.1.--Total fish biomass composition by family, measured by the stationary-point count method.

Table D.4.1.1.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Ta`u as measured in the belt-transect surveys.

Stratum Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
Forereef—Deep	TAU-51	3.2	0.55	0.00	0.00	0.00	0.00	0.07	0.40	0.85	0.60	0.48	0.29
	TAU-52	2.5	1.41	0.00	0.00	0.15	0.00	0.29	0.27	0.10	0.07	0.08	0.17
Forereef—Mid	TAU-01	3.4	2.77	0.00	0.00	0.23	0.00	0.05	0.00	0.14	0.00	0.10	0.06
	TAU-02	1.3	0.41	0.00	0.00	0.21	0.00	0.11	0.13	0.22	0.00	0.05	0.17
	TAU-04	1.8	1.19	0.00	0.00	0.09	0.00	0.08	0.25	0.07	0.00	0.10	0.04
	TAU-07	1.9	1.12	0.00	0.00	0.00	0.00	0.05	0.17	0.05	0.04	0.21	0.28
	TAU-08	0.8	0.29	0.00	0.00	0.00	0.00	0.18	0.12	0.07	0.00	0.06	0.08
	TAU-09	2.0	0.24	0.00	0.00	0.61	0.00	0.14	0.02	0.59	0.18	0.12	0.08
	TAU-10	2.0	0.82	0.00	0.00	0.29	0.00	0.01	0.33	0.10	0.00	0.05	0.39
	TAU-11	6.1	1.48	0.00	0.00	0.59	0.00	0.16	0.46	0.37	0.48	0.08	2.46
	TAU-12	1.9	0.84	0.00	0.00	0.00	0.00	0.13	0.37	0.34	0.00	0.11	0.07
Forereef—Shallow	TAU-50	2.7	1.73	0.00	0.00	0.00	0.00	0.02	0.01	0.03	0.00	0.20	0.67
Grand average		**2.5**	**1.1**	**0.0**	**0.0**	**0.2**	**0.0**	**0.1**	**0.2**	**0.2**	**0.1**	**0.1**	**0.4**

Table D.4.1.2.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Ta`u as measured in the stationary-point count surveys.

Stratum Depth	Site	Total	Acanthurid	Sphyraenid	Caesionid	Scarid	Carcharhinid	Pomacentrid	Balistid	Serranid	Lutjanid	Labrid	Others
Forereef—Deep	TAU-51	4.4	0.34	0.00	0.00	0.00	0.00	0.16	0.39	0.67	2.40	0.10	0.36
	TAU-52	4.3	1.88	0.00	0.00	0.26	0.00	0.33	0.28	0.67	0.00	0.24	0.62
Forereef—Mid	TAU-01	3.1	1.82	0.00	0.00	0.08	0.00	0.04	0.18	0.46	0.12	0.23	0.13
	TAU-02	2.9	0.91	0.00	0.00	0.20	0.00	0.11	0.96	0.24	0.00	0.07	0.39
	TAU-04	2.1	1.08	0.00	0.00	0.12	0.00	0.06	0.15	0.14	0.14	0.18	0.27
	TAU-07	4.8	2.31	0.00	0.00	0.83	0.00	0.09	0.48	0.26	0.40	0.24	0.21
	TAU-08	1.1	0.18	0.00	0.00	0.00	0.00	0.13	0.32	0.07	0.00	0.09	0.31
	TAU-09	4.4	1.32	0.00	0.00	0.98	0.00	0.15	0.57	0.09	0.42	0.13	0.77
	TAU-10	4.1	1.27	0.00	0.00	0.14	0.00	0.02	0.51	0.47	0.59	0.14	0.91
	TAU-11	7.1	1.71	0.00	1.05	0.06	0.00	0.28	0.16	0.45	0.50	0.13	2.76
	TAU-12	2.2	0.94	0.00	0.00	0.16	0.00	0.19	0.14	0.25	0.06	0.18	0.32
Forereef—Shallow	TAU-50	4.1	2.69	0.00	0.00	0.00	0.00	0.01	0.03	0.16	0.00	0.29	0.89
Grand average		**3.7**	**1.4**	**0.0**	**0.1**	**0.2**	**0.0**	**0.1**	**0.3**	**0.3**	**0.4**	**0.2**	**0.7**

D.4.2 Towed-diver Fish Surveys

Table D.4.2.1.--HI-08-01 Towed-diver survey report for Ta`u.

			Survey Length (km)				Mean Depth
		N	Min	Max	Median	Sum	Average (m)
Tutuila Island	**03/01/08**	6	2.00	2.55	2.30	13.80	-15.58
	03/02/08	6	2.19	2.48	2.37	14.24	-15.82
	03/05/08	3	2.13	2.39	2.28	6.85	-15.56
	All	15	2.00	2.55	2.33	34.90	-15.83

N = number of surveys conducted.

Depth readings are taken at 5-s intervals during each 50-min survey and are reported as a mean depth per survey. Mean Depth Average is the median mean depth value for all surveys on a given day.

A total of 30 species of large fishes (> 50 cm in total length) representing 14 families were observed around Ta`u during the survey period (March 1–2, 2008, and March 5, 2008). The mean number of fishes (all species pooled) observed by divers was 11.37 fish ha^{-1}. The 7 most frequently recorded species are shown in Figure D.4.2.1. The bigeye jack (*Caranx sexfasciatus*) was the most abundant species observed during the quantitative surveys with a mean number of 2.69 fish ha^{-1} observed. The steephead parrotfish (*Chlorurus microhinus*) was the second most abundant fish species encountered during the survey with 1.70 fish ha^{-1} recorded. It should be noted that 2 large schools of bigeye jacks were encountered, a circumstance that accounts for their high density.

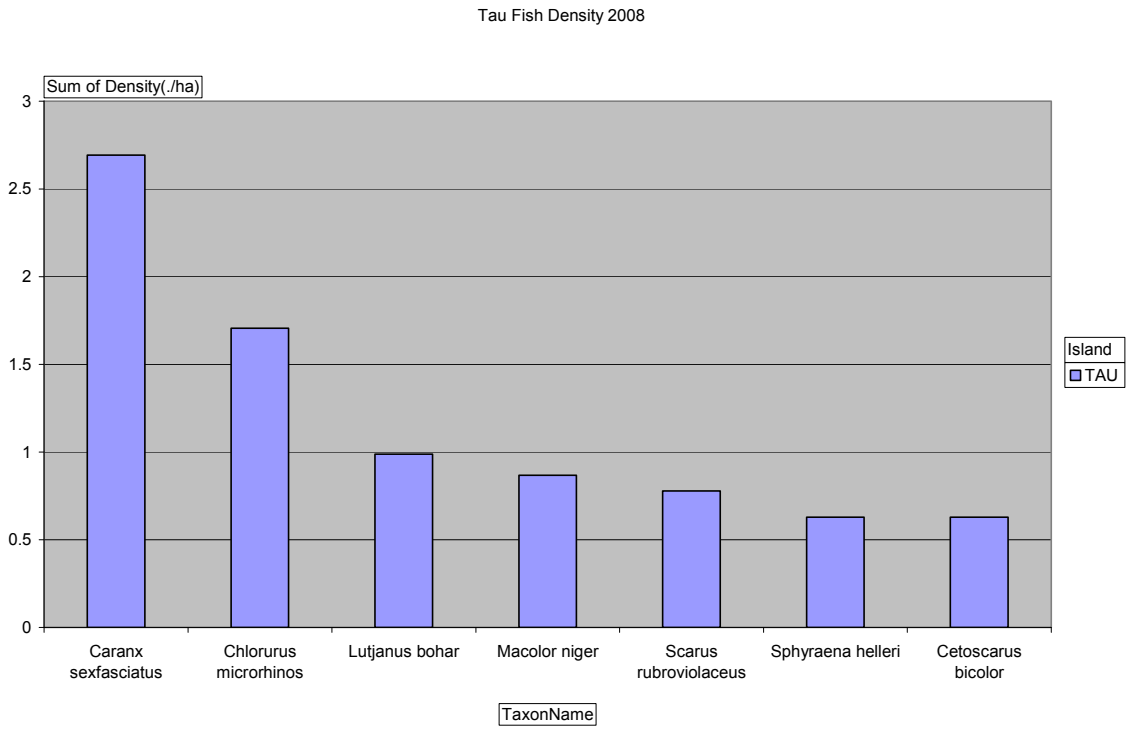

Figure D.4.2.1.--Density of the 7 species most frequently recorded around Ta`u.

The grand mean biomass density of fishes observed on the shallow reefs (< 30 m) around Ta`u during the survey period was 0.039 t ha^{-1}. The bigeye jack (*Caranx sexfasciatus*) and the steephead parrotfish (*Chlorurs microhinus*) accounted for 33% of that total mean biomass (Fig. D.4.2.2). The total biomass density for the Napolean wrasse (*Chellinus undulatus)* was 0.0029 t ha^{-1}, putting it fourth in terms of largest biomass at Ta`u. One large zebra shark (*Stegostoma fasciatum*) measuring 1.8 m long was seen, and its large size put that fish third in terms of large biomass observed around Ta`u.

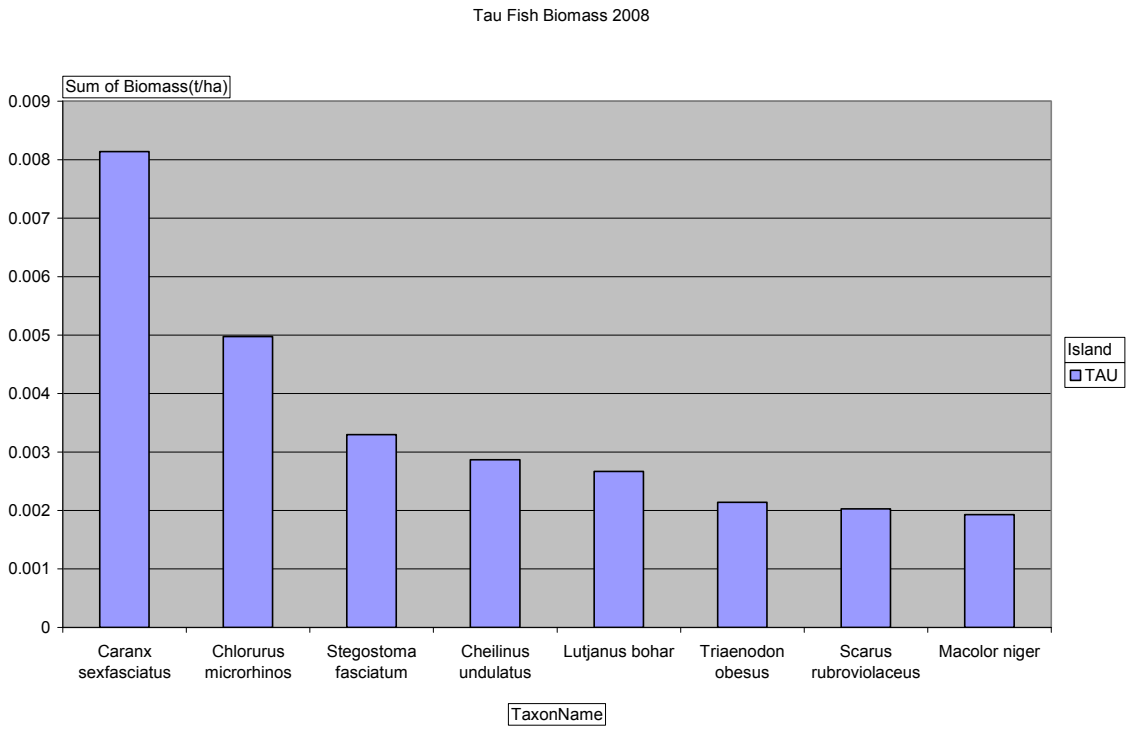

Figure D.4.2.2.--The 8 species with the highest biomass around Ta`u.

Appendix E: Rose Atoll

E.1. Oceanography and Water Quality

Moorings

A total of 6 subsurface temperature recorders (STRs) and 1 wave-and-tide recorder (WTR) were recovered and replaced at Rose Atoll during the HI-08-02 American Samoa Reef Assessment and Monitoring Program (ASRAMP) cruise (Fig. E.1.1, Table E.1.1). A standard Coral Reef Early Warning System (CREWS) buoy with an extra STR attached to the arm was recovered and replaced with a sea surface temperature (SST) buoy inside the lagoon on the southwest side of this atoll. A new ecological acoustic recorder (EAR) and STR were deployed together just outside the northwest channel leading into the lagoon of Rose Atoll. This EAR was deployed to monitor vessel traffic that's heard around this reserve or attempting to enter the lagoon and to enable biological passive acoustic monitoring of this area.

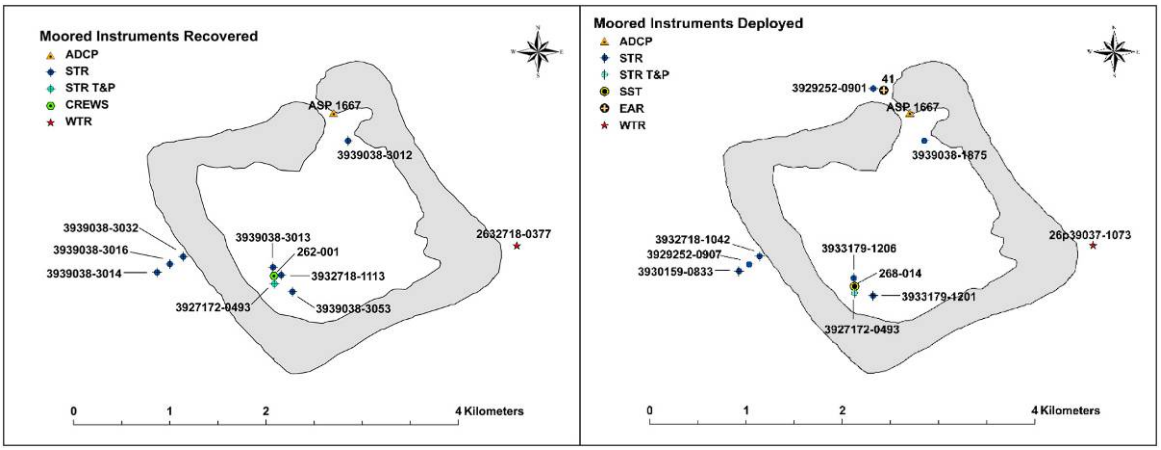

Figure E.1.1.--Moored oceanographic instrumentation map for Rose Atoll.

Table E.1.1.--Moored oceanographic instrumentation for Rose Atoll.

Instrument	Serial Number	Latitude	Longitude	Depth (m)	Data Start	Data End
CREWS	262-001	14 33.0806 S	168 9.615 W	1.00	3/7/2006 2:59	3/12/2008 0:59
STR	3932718-1113	14 33.0806 S	168 9.615 W	1.00	3/7/2006 0:30	9/2/2007 18:30
STR	3939038-3013	14 33.0806 S	168 9.615 W	8.53	3/8/2006 0:00	3/12/2008 3:30
STR	3939038-3012	14 32.2648 S	168 9.2054 W	2.44	3/7/2006 19:30	3/12/2008 3:30
STR	3939038-3053	14 33.0762 S	168 9.6093 W	3.35	3/8/2006 0:00	3/12/2008 4:00
STR	3939038-3014	14 32.9226 S	168 10.1298 W	31.39	3/8/2006 0:00	3/13/2008 3:00
STR	3939038-3016	14 32.9221 S	168 10.1227 W	16.46	INSTRUMENT FAILED	
STR	3939038-3032	14 32.9095 S	168 10.1191 W	7.92	3/7/2006 19:00	3/12/2008 2:00
WTR	2632718-0377	14 32.8596 S	168 8.2569 W	16.76	AWAITING DOWNLOAD	
STR T&P	3927172-0493	14 33.0933 S	168 9.5962 W	10.36	3/11/2008 23:33	3/14/2008 23:22
ADCP	ASP 1667	14 32.1062 S	168 9.2886 W	6.10	3/11/2008 20:00	3/14/2008 19:30
EAR	41	14 31.9764 S	168 9.432 W	14.94	LOGGING DATA	
SST	268-014	14 33.0933 S	168 9.5962 W	1.00	LOGGING DATA	
STR	3939038-1875	14 32.2648 S	168 9.2054 W	2.44	LOGGING DATA	
STR	3933179-1206	14 33.0933 S	168 9.5962 W	10.36	LOGGING DATA	
STR	3933179-1201	14 33.0762 S	168 9.6093 W	3.35	LOGGING DATA	
STR	3929252-0901	14 31.9764 S	168 9.432 W	14.94	LOGGING DATA	
STR	3930159-0833	14 32.9226 S	168 10.1298 W	31.39	LOGGING DATA	
STR	3929252-0907	14 32.9221 S	168 10.1227 W	16.46	LOGGING DATA	
STR	3932718-1042	14 32.9095 S	168 10.1191 W	7.92	LOGGING DATA	
WTR	26p39037-1073	14 32.8596 S	168 8.2569 W	16.76	LOGGING DATA	

In addition to long-term monitoring instrumentation, 2 instruments were deployed temporarily during the 4-day sampling period at Rose Atoll to help understand the flushing and residence times of water within the lagoon. For this temporary deployment, a Nortek Aquadopp 2-MHz acoustic Doppler current profiler was deployed in the channel on the north side of this atoll to measure flow through the channel, and an SBE 39 temperature and pressure recorder (Sea-Bird Electronics Inc.) was deployed on the new SST anchor to measure water level changes in the lagoon. These 2 data sets, combined with shipboard meteorological observations and NOAA Wavewatch III wave model data, will offer insights into the circulation of the lagoon waters at Rose Atoll.

Preliminary Mooring Results

Of the 7 STRs recovered from Rose Atoll, 6 yielded quality data sets (Fig. E.1.2); a crack in the housing of the seventh STR had caused that unit to flood. Between March 2006 and March 2008, subsurface water temperatures around this atoll and surface temperature on the west side of Rose Atoll fluctuated seasonally with lows (~ 27 °C) occurring July–October and highs (~ 30 °C) occurring January–April. Large diurnal fluctuations were observed inside the lagoon near the CREWS buoy site, suggesting daily heating and cooling with little mixing. STR No. 3012, located inside the lagoon but near the north channel, showed far less diurnal variability, suggesting water in this part of the lagoon is better mixed. Forereef locations have shown only seasonal variability. Although the CREWS buoy stopped transmitting data via the satellite uplink several months prior to the cruise, the SBE 37 MicroCAT conductivity and temperature recorder continued to record data (Fig. E.1.3). Salinity and temperature at the CREWS buoy site, as expected, tended to vary inversely. A number of freshwater salinity spikes appear to coincide with low temperature spikes, suggesting that they may be associated with passing storm events. A large freshwater salinity excursion around February 2007 may be a data error; however, it did occur concurrently with a large temperature spike and, thus, may be associated with an intense precipitation event.

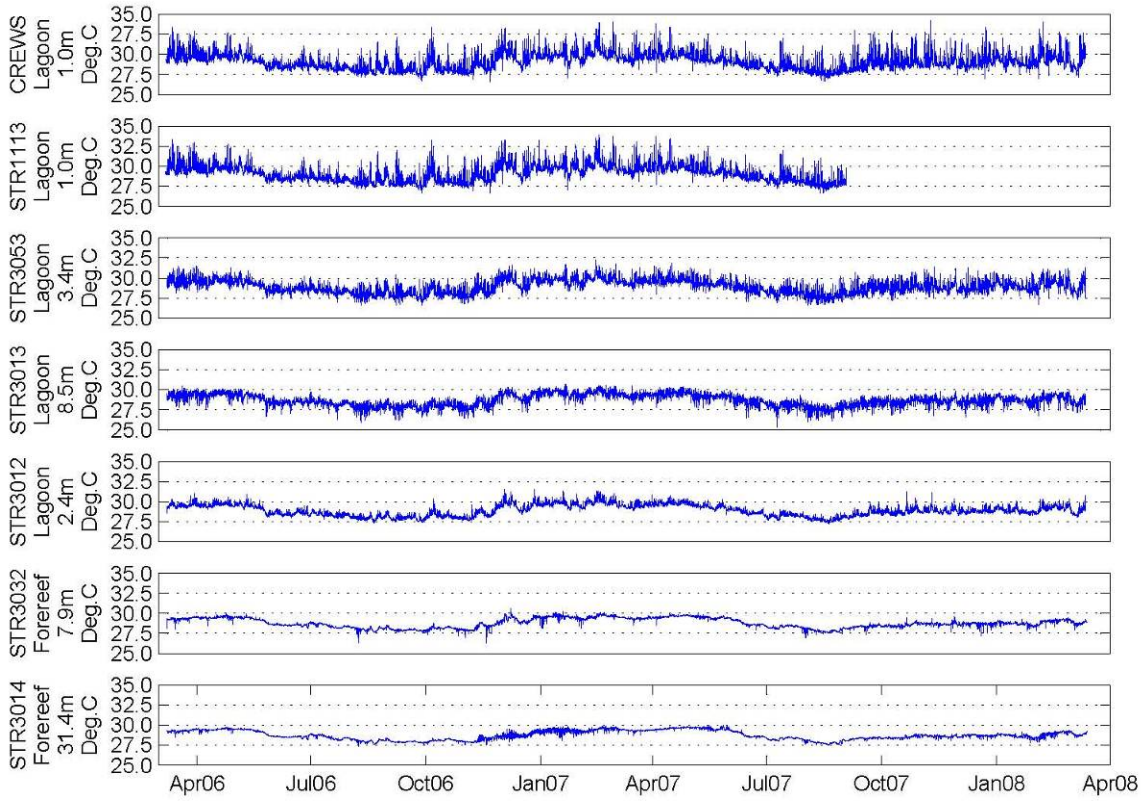

Figure E.1.2.--Temperature data obtained from 1 CREWS buoy and 6 STR locations around Rose Atoll.

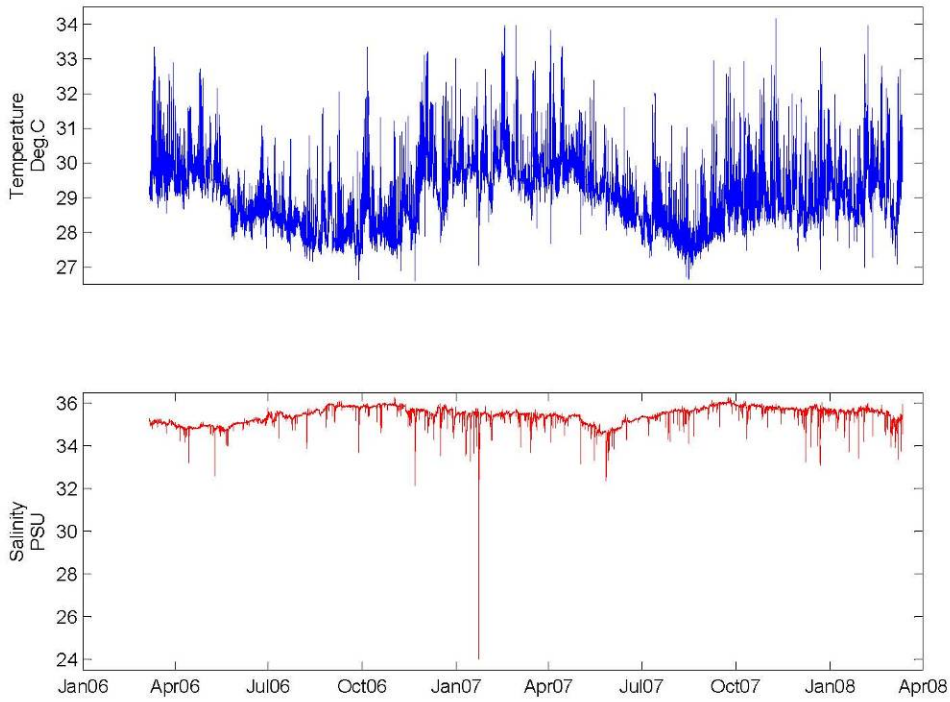

Figure E.1.3.--Temperature and salinity data from the SBE 37 MicroCAT deployed on the CREWS buoy in the lagoon of Rose Atoll.

Water Quality

Along the 30-m isobath around the Rose Atoll at 500-m intervals, 22 shallow-water conductivity, temperature, and depth (CTD) casts were conducted (Fig. E.1.4). In the lagoon and in and around the pass of this atoll, 10 shallow-water CTD casts were conducted.

Casts ROS01–ROS22 (500-m intervals at the 30-m isobath around this atoll)
Casts ROS23–ROS32 (locations in and around the pass and lagoon)

Discrete water samples from a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m were collected concurrently with shallow-water CTD casts at 4 of the shallow-water CTD sites, as well as at depths of 1 m, 10 m, and 20 m at 1 of the CTD sites. At a depth of 1 m from various locations within the lagoon, 4 additional nutrient and chlorophyll-*a* (Chl-*a*) samples were taken, yielding a total of 23 Chl-*a* and 23 nutrient samples. Nutrient and Chl-*a* samples were processed and stored according to protocols provided by Pacific Marine Environmental Laboratory (PMEL) scientists. Samples were sent to PMEL and the University of Hawai`i when the cruise returned.

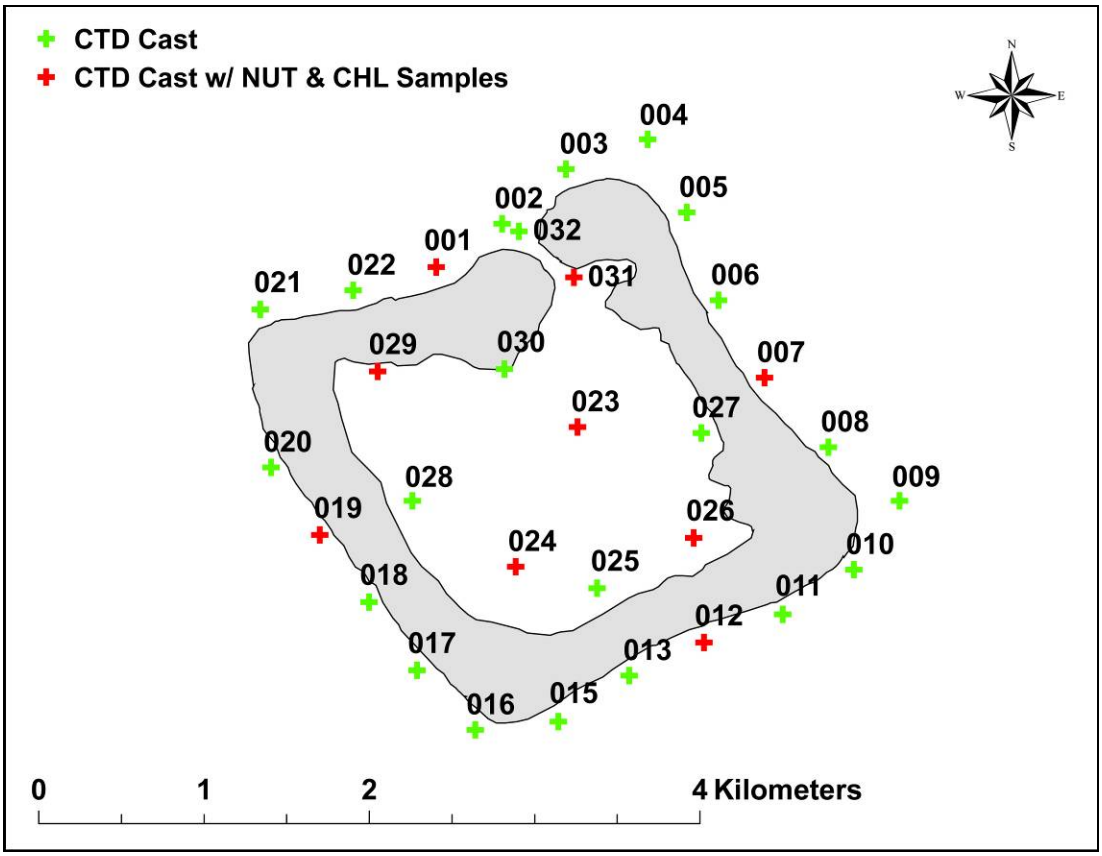

Figure E.1.4.--Shallow-water CTD and water sampling locations around Rose Atoll, labeled by cast number.

In addition to the standard set of shallow-water water quality sampling, a set of nearshore dissolved inorganic carbon (DIC) samples were collected at 4 areas around Rose Atoll. These samples were collected from various geomorphological reef zones and benthic habitat types around this atoll in order to determine the effects of the reef on the shallow-water carbonate chemistry (Fig. E.1.5). These 4 regions included a high coral cover forereef area, a low coral cover forereef area, a lagoon patch reef, and a pavement/rubble backreef area (Table E.1.2). Within each area, 3 distinct sites were identified and water samples were collected directly above the bottom and at a depth of 2 m below the surface. Deployed concurrently with the DIC water collections was an SBE 19*plus* Seacat Profiler, a conductivity, temperature, and depth recorder, with an SBE 43 dissolved oxygen sensor. Water samples were collected and stored according to protocols established by PMEL scientists. Chl-*a* and nutrient samples were collected concurrently at 1 site in each of the 4 areas, and salinity samples were taken with every third DIC water sample to aid in the calibration of the SBE 19*plus*. All samples were sent to PMEL and the University of Hawai`i when the cruise returned.

Table E.1.2.--Shallow-water carbonate chemistry sampling for Rose Atoll.

Area	Type	CTD Cast ID	Bottom Depth (m)	Bottom DIC Sample	2m DIC Sample	Replicate DIC	Chl-a	Nutrient	Salinity
1	Forereef, High Coral Cover	HI0802_ROS001_DIC	11.0	YES	YES	NO	YES	YES	NO
		HI0802_ROS002_DIC	10.4	YES	YES	NO	NO	NO	YES
		HI0802_ROS003_DIC	11.0	YES	YES	NO	NO	NO	YES
2	Backreef, Pavement/Rubble	HI0802_ROS004_DIC	2.1	YES	NO	NO	YES	YES	NO
		HI0802_ROS005_DIC	2.1	YES	NO	NO	NO	NO	YES
		HI0802_ROS006_DIC	2.1	YES	NO	NO	NO	NO	NO
3	Lagoon Patch Reef	HI0802_ROS007_DIC	12.2	YES	YES	NO	YES	YES	NO
		HI0802_ROS008_DIC	11.9	YES	YES	NO	NO	NO	YES
		HI0802_ROS009_DIC	12.8	YES	YES	NO	NO	NO	YES
4	Forereef, Low Coral Cover	HI0802_ROS010_DIC	7.9	YES	YES	YES	YES	YES	NO
		HI0802_ROS011_DIC	7.9	YES	YES	NO	NO	NO	YES
		HI0802_ROS012_DIC	9.4	YES	YES	NO	NO	NO	YES

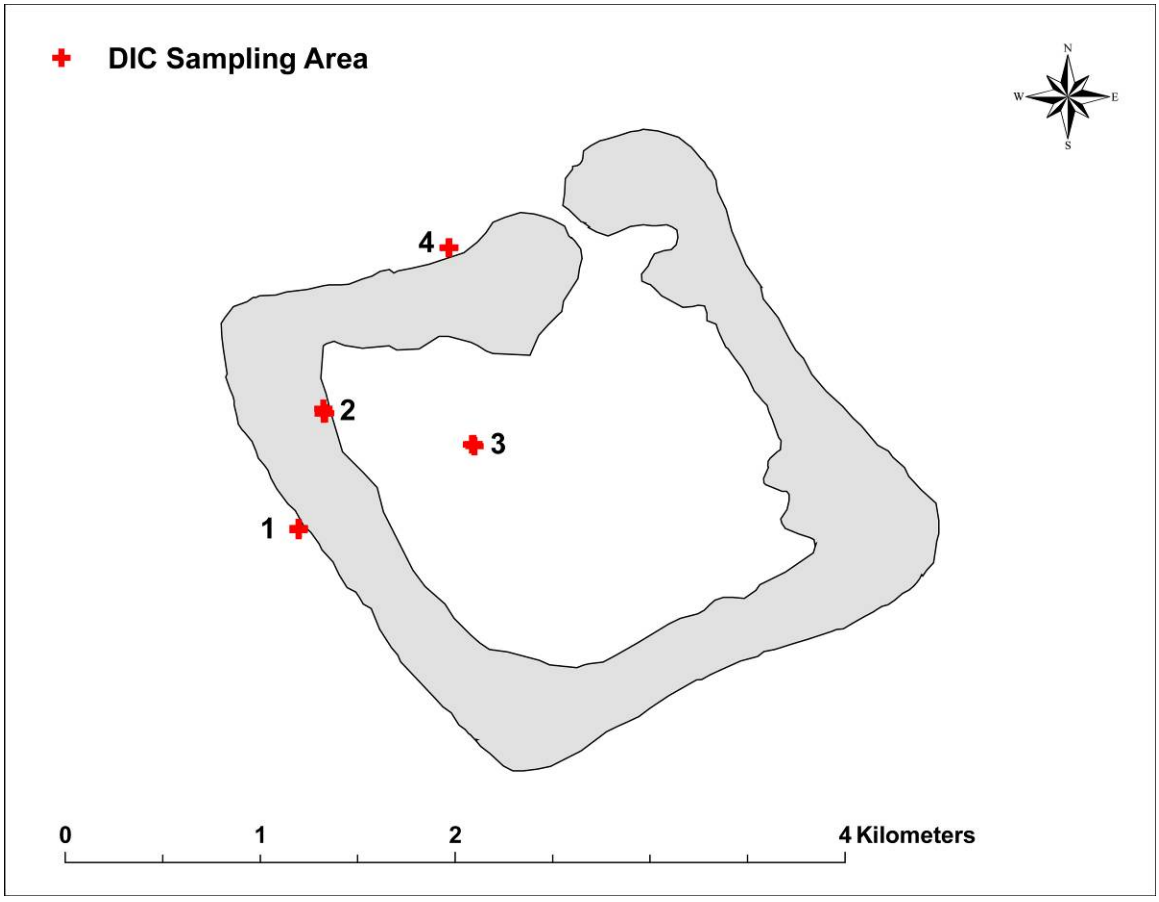

Figure E.1.5.--Shallow-water DIC sampling sites: Area 1: Forereef, high coral cover; Area 2: Backreef, pavement/rubble; Area 3: Lagoon patch reef; Area 4: Forereef, low coral cover.

Four standard shipboard CTD casts were conducted near Rose Atoll (Fig. E.1.6). Shipboard CTD casts Nos. 23–26 were conducted at cardinal points around this atoll on March 12, 2008, using the UTC standard, at a depth of 500 m, and water samples were collected at depths of 3 m, 80 m, 100 m, 125 m, and 150 m for nutrient and Chl-*a* analysis. Nutrient and Chl-*a* samples were processed and stored according to PMEL protocol and were sent to PMEL and the University of Hawaii for analysis when the cruise returned. Additionally, acoustic Doppler current profiler (ADCP) lines were run between the shipboard CTD casts.

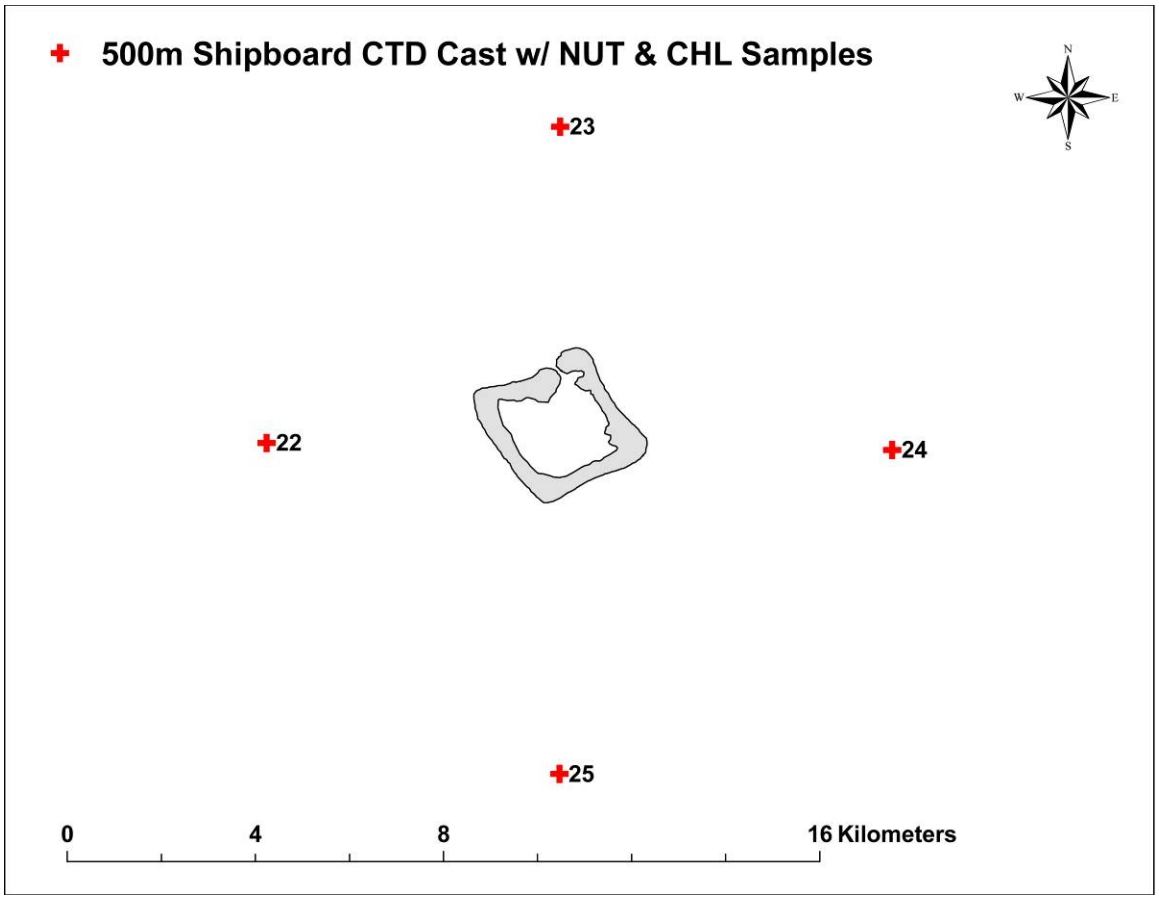

Figure E.1.6.--Shipboard CTD, nutrient, and Chl-*a* sites around Rose Atoll during the HI-08-02 ASRAMP cruise, labeled by cast number.

Besides the standard 500-m shipboard CTD casts, 4 shipboard casts were performed at a depth of 100 m for offshore carbonate chemistry analysis, and water samples were collected at depths of 2 m and 75 m. Shipboard DIC sites were determined based on the predominant north–south current observed from the shipboard ADCP during the 2 days prior to sampling. On the night of March 13, 2008, a 50-km belt-transect survey was performed upstream of the predominant current to the north of Rose Atoll with samples collected at 25 m and 50 km distal to this atoll. An analogous belt-transect survey was performed the evening of March 14, 2008, downstream of the predominant current to the south (Fig. E.1.7).

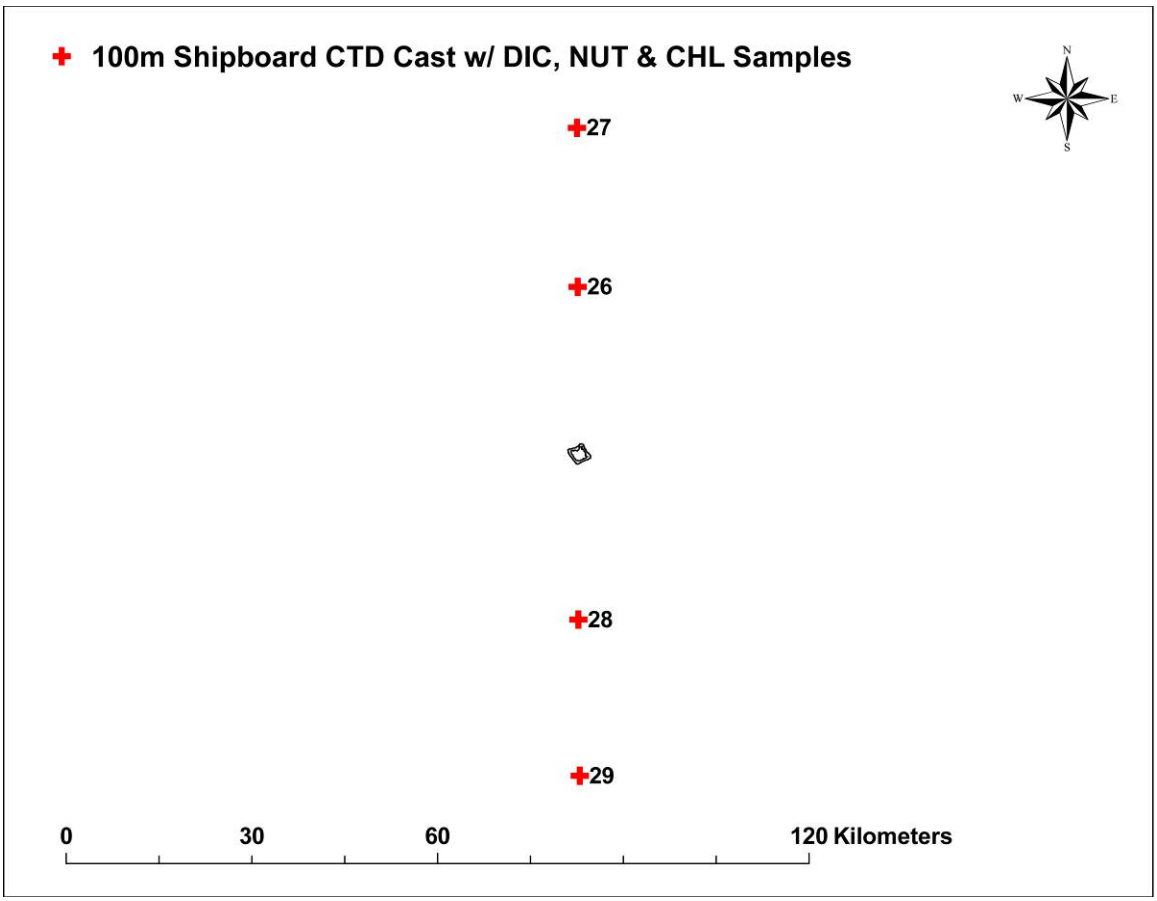

Figure E.1.7.--Shipboard DIC sampling sites at 25-km increments north and south of Rose Atoll, parallel to the direction of the predominant current as determined by the shipboard ADCP.

Preliminary Water Quality Results

The water column properties at Rose Atoll can be grouped into 2 basic but distinct regions that lie either inside or outside of the central lagoon—with one central pass acting as a transition zone that is tidally dependent (Fig. E.1.8). Waters inside of the lagoon at the 20-m depth bin were generally colder, more saline, and were more dense and more turbid than waters outside of the lagoon. The slightly warmer temperatures along the forereef on the southeast side of this atoll are indicative of less mixing and likely a result of this region being in the lee of the prevailing winds and swell during the sampling day. In all of the variables measured, the pass near the north point was clearly influenced by both the prevailing nearshore and lagoon water masses, as strong currents are often tidally driven. However, an exchange of surface waters between the nearshore waters and the lagoon occurs at almost every point around the lagoon from a well articulated spur-and-groove system in the forereef and a large reef flat leading to the backreef (Fig. E.1.9). This exchange, like the pass, is tidally dependent and can be seen in the greater variability in water quality properties of the surface waters (top 1–2 m) relative to the well-mixed deep waters.

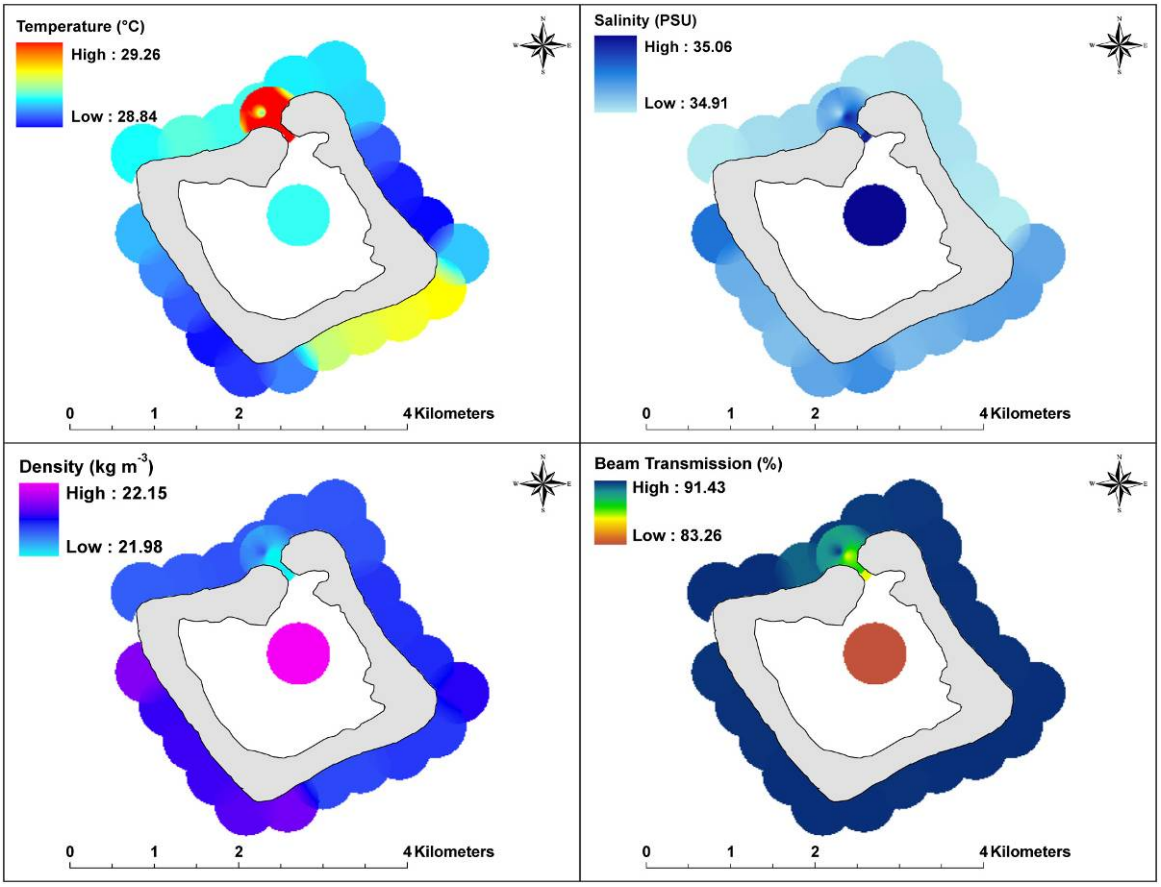

Figure E.1.8.--Interpolated shallow-water CTD cast data at the 20-m depth bin around Rose Atoll during the HI-08-02 ASRAMP cruise: temperature (upper left), salinity (upper right), density (bottom left), and beam transmission (bottom right).

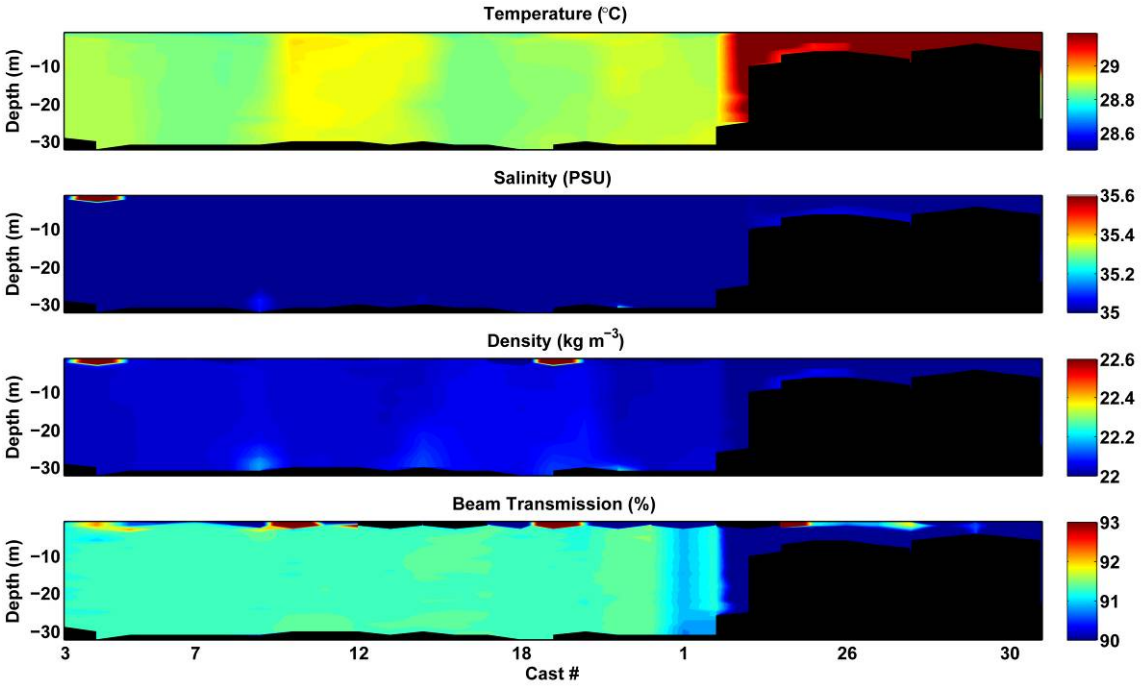

Figure E.1.9.--Cross-section plot of shallow-water CTD data (temperature, salinity, density, and beam transmission) collected around Rose Atoll during the HI-08-02 ASRAMP cruise. Refer to Figure E.1.4 for CTD cast locations.

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

Around Rose Atoll during the period of March 11–14, 2008, 27 Rapid Ecological Assessment (REA) sites were visited by a team of up to 8 scientists. At 14 of those sites, only fish surveys were conducted over differing depth ranges. These site locations are shown in Figure E.2.1, and the survey dates and efforts are shown in Tables E.2.1 (fish surveys) and E.2.2 (benthic surveys). Individual site descriptions are included for the following discipline communities: coral, coral and coralline disease, macroinvertebrates, algae, and fish.

Table E.2.1.--Rose Atoll fish REA survey sites during the HI-02-08 ASRAMP 2008 cruise. At each site, 2 belt-transect (25 × 4 m) surveys and a stationary-point count (over a circular plot with a 7.5-m radius) were performed unless otherwise noted.

Site	Date	Depth (m)	Strata
ROS-01	03/11/2008	11	Forereef
ROS-02	03/11/2008	12	Forereef
ROS-03	03/11/2008	12	Forereef
ROS-04	03/13/2008	11	Forereef
ROS-05	03/13/2008	13	Forereef
ROS-06	03/12/2008	12	Forereef
ROS-07	03/14/2008	11	Forereef
ROS-08	03/14/2008	12	Lagoon
ROS-09†	03/14/2008	6	Lagoon
ROS-21	03/13/2008	11	Forereef
ROS-23*	03/12/2008	13	Forereef
ROS-25	03/12/2008	10	Forereef

Site	Date	Depth (m)	Strata
ROS-50**	03/11/2008	22	Forereef
ROS-51	03/11/2008	4	Forereef
ROS-52	03/11/2008	5	Forereef
ROS-53*	03/11/2008	53	Forereef
ROS-54*	03/12/2008	22	Forereef
ROS-55	03/12/2008	4	Forereef
ROS-56	03/12/2008	4	Forereef
ROS-57*	03/13/2008	23	Forereef
ROS-58	03/13/2008	5	Forereef
ROS-59	03/13/2008	4	Forereef
ROS-60*	03/13/2008	23	Forereef
ROS-61*	03/14/2008	23	Forereef
ROS-62	03/14/2008	2	Backreef
ROS-63	03/14/2008	2	Backreef
ROS-64	03/14/2008	2	Backreef

*Only one stationary-point count survey done. **No belt-transect survey done. †Only one replicate done.

Table E.2-2.--Rose Atoll 2008 benthic REA site survey dates, teams present, and additional comments.

Site	Date	Teams Present	Comments
ROS-01	3/11/2008	Coral, Disease, Algae	
ROS-02	3/11/2008	Coral, Disease, Algae	
ROS-03	3/11/2008	Coral, Disease, Algae	
ROS-04	3/13/2008	Coral, Disease, Algae, Invertebrate	ARM deployment
ROS-05	3/13/2008	Coral, Disease, Algae, Invertebrate	
ROS-06	3/12/2008	Coral, Disease, Algae	
ROS-07	3/14/2008	Coral, Disease, Algae, Invertebrate	
ROS-08	3/14/2008	Coral, Disease, Algae, Invertebrate	
ROS-09	3/14/2008	Coral, Disease, Algae	ARM deployment
ROS-21	3/13/2008	Coral, Disease, Algae, Invertebrate	
ROS-23	3/12/2008	Coral, Disease, Algae	
ROS-25	3/11/2008	Coral, Disease, Algae	ARM deployment, new site location

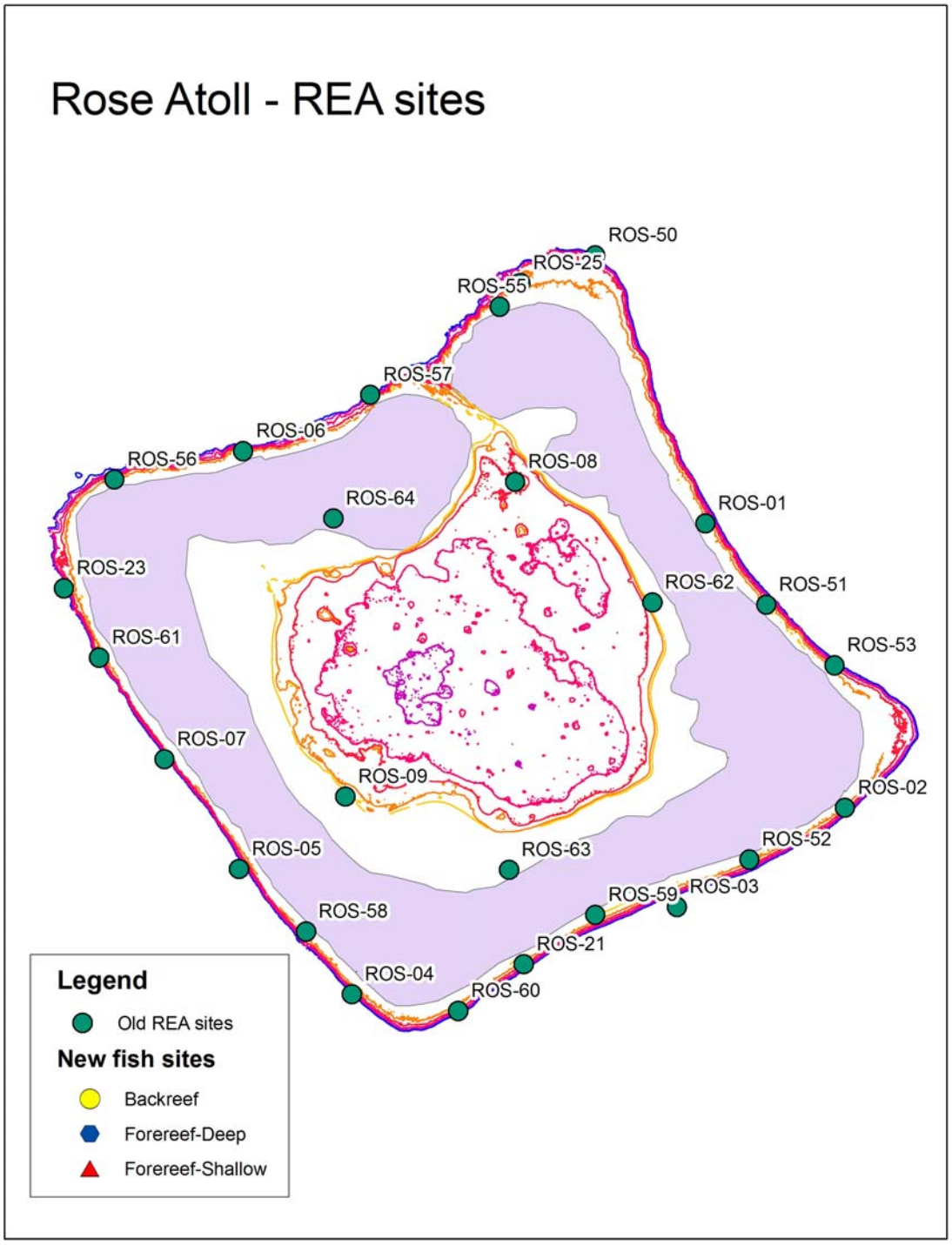

Figure E.2.1.--Rose Atoll REA site locations during the HI-02-08 ASRAMP 2008 cruise.

Site Descriptions

March 11, 2008

ROS-01
14º53.963′ S, 168º14.529′ W
Depth Range: 12.4–14.5 m
This site was located on the northeast arm of Rose Atoll. Coralline algae dominated the benthos (73.5%); coral cover was 13.7%. Sixteen coral genera were recorded within belt transects at this site, and *Pocillopora, Mantastrea,* and *Acropora* were the most abundant taxa. Coral disease and health assessments revealed 1 case of bleaching on *Turbinaria* and 9 cases of predation on *Pocillopora* sp. in a survey area of 300 m^2. *Microdictyon umbilicatum* and crustose coralline red algae dominated this survey area. Photoquadrat abundances of macroalgae consisted of turf algae, cyanophytes, *Dictyosphaeria versluysii, Lobophora variegate*, and *Valonia fastigiata. Caulerpa urvilleana* was found during the random swim survey. *Chromis acares* was recorded at this site in very large numbers and was by far the most numerous fish here. The groupers *Cephalophalis argus* and *Cephalophalis urodeta* were abundant, as were the acanthurids *Ctenochaetus cyanocheilus* and *Acanthurus thompsoni*.

ROS-02
14º55.171′ S, 168º13.988′ W
Depth Range: 10.3–12.5 m
This site was located on the east forereef of Rose. Coralline algae and macroalgae covered 32.9 and 33% of the benthos, respectively; coral cover was 12.7%. Sixteen coral genera were recorded within belt transects at this site, and *Pocillopora, Mantastrea,* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 6 cases of predation on *Pocillopora* spp., 10 cases on coralline fungal disease, and 1 case of coralline lethal disease in a survey area of 300 m^2. This site, an east shore forereef site at Rose Atoll, had a depth range between 11.3 and 13.4 m. As at ROS-01, *Microdictyon umbilicatum* and crustose coralline red algae dominated the photoquadrats along the transects at this site, although cyanophytes, *Caulerpa urvilleana*, *Dictyosphaeria versluysii*, turf algae, *Halimeda*, *Amphiroa*, and *Peyssonnelia* were noted. *Valonia fastigiata* was noted on the random swim survey. Large numbers of small *Acanthurus achilles* at this site seemed to indicate a recruitment event sometime in the recent past. *Chromis acares* was found here in large numbers, as were *Acanthurus thompsoni*. The latter hovered in large clouds in midwater. Noteworthy sightings were of 2 *Caranx ignobilis*, both 90 cm long and off-transect, and of a *Gymnosarda unicolor* on-transect.

ROS-03
14º55.551′ S, 168º14.839′ W
Depth Range: 11.2–13.3 m
This site was located on the southeast arm of Rose. Coralline algae dominated the benthos (50%); coral cover was 19.6%. Fourteen coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 1 case of bleaching on *Montipora*, 1 case of skeletal growth

anomaly on *Pocillopora eydouxi*, 7 cases of predation on *Pocillopora* spp., 1 case of coralline lethal disease, and 2 cases of coralline algal fungal disease in a survey area of 300 m^2. This southeast forereef site off Rose Atoll had survey depths ranging between 11.6 and 13.7 m. Photoquadrat abundances of macroalgae included crustose coralline red algae, *Microdictyon umbilicatum,* turf algae, cyanophytes, *Halimeda, Lobophora variegata*, *Dictyosphaeria versluysii*, and *Valonia fastigiata. Chromis acares* was the most numerous fish at this site. *Acanthurus thompsoni* also was seen in relatively large numbers hovering midwater. Two large *Lutjanus bohar* were included in one stationary-point count survey, as was one midsize *Caranx melampygus*. *Ctenochaetus cyanocheilus* was the most prominent acanthurid at this site.

ROS-50
14º31.692′ S, 168º09.020′ W
Depth Range: 20–23 m
This site is located at the very north tip of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef deep stratum. The site had medium coral cover with medium reef complexity. We encountered strong currents (~ 1 knot). We couldn't do the belt-transect surveys. Reef fish were mostly medium to large surgeonfish and parrotfish. Small fish diversity was surprisingly low (only *Chromis acares* and *Pseudoanthias bartlettorum*). A large dogtooth tuna was seen.

ROS-51
14º32.575′ S, 168º08.588′ W
Depth Range: 3–5 m
This site is located on the northeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with low reef complexity. Reef fishes consisted mostly of small damselfishes (*Stegastes*, *Pomacentrus*) with few large fishes (mostly scarids).

ROS-52
14º33.218′ S, 168º08.631′ W
Depth Range: 3–5 m
This site is located on the southeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with low reef complexity. Reef fishes consisted mostly of small damselfishes (*Stegastes*, *Pomacentrus*) with few large fishes (mostly scarids).

ROS-53
14º32.728′ S, 168º08.416′ W
Depth Range: 18–23 m
This site is located on the northeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef deep stratum. The site had high coral cover with medium reef complexity. Reef fish were mostly medium to large in size (parrotfish and surgeonfish). The diversity of small fishes was low (mostly *Chromis acares* and *Pseudoanthias bartlettorum*).

March 12, 2008

ROS-06
14º53.634′ S, 168º16.466′ W
Depth Range: 11.8–13.6 m
This site was located on the northern forereef of Rose. Crustose coralline algal cover represented 59% of the benthos, macroalgae cover was 18%, and coral cover was 12.7%. Twelve coral genera were recorded within this site's belt transects, and *Pocillopora, Montastrea,* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 9 cases of filamentous algal infections on *Montastrea curta* and *Montipora* sp., 3 cases of barnacle infestation on *Montipora* sp., and 6 cases of coralline algal lethal disease in a survey area of 300 m^2. This site was a forereef located on the southwest side of Rose Atoll. Depth of the survey ranged from 12.2 to 14.6 m. Crustose coralline red algae dominanted the belt transects at this site, but other macroalgae in the photoquadrats included *Halimeda,* turf algae, cyanophytes, *Peyssonnelia*, and *Lobophora variegata.* The random swim survey produced *Dictyosphaeria versluysii* and *Bryopsis pennata.* The small damselfish *Chromis acares* was most abundant at this site with the anthias *Pseudanthias pascalus* also recorded in large numbers. *Ctenochaetus cyanocheilus* and *C. striatus* represented the most abundant surgeonfishes present; surgeon larger than those species, such as *Acanthurus nigricans*, *A. lineatus*, *Naso literatus*, and *N.* vlamingii, were seen but in much fewer numbers.

ROS-25
14º52.938′ S, 168º15.348′ W
Depth Range: 12.2–13 m
This site was a new REA site near the channel entrance on the north side of Rose. Crustose coralline algal cover represented 59% of the benthos, macroalgae cover was 20%, and coral cover was 40%. Nineteen coral genera were recorded within belt transects at this site, and *Montipora, Montastrea, Porites*, *Favia*, *Leptastrea*, and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 15 cases of filamentous algal infections on *Montastrea curta*, *Favia stelligera*, *Porites* sp., and *Pocillopora meandrina*; 1 case on coralline algal lethal disease; and 1 case of tissue loss on *Montipora* sp. in a survey area of 300 m^2. This site was a forereef located on the most northern point of Rose Atoll with depths ranging from 10.1 to 13.4 m. Dominant macroalgae in this site's photoquadrats consisted of crustose coralline red algae, cyanophytes, turf algae, *Lobophora variegata, Halimeda*, *Dictyosphaeria versluysii, Caulerpa urvilleana*, and *Neomeris.* Again, the damselfish *Chromis acares* was the most abundant fish, and the surgeon *Ctenochaetus striatus* was counted as the most abundant moderate-sized fish. Fishes larger than the *C. Striatus* were not common, although a monstrous *Aprion virescens*, the green jobfish, was recorded on transect.

ROS-23
14º54.210′ S, 168º17.245′ W
Depth Range: 12.2–13 m
This site was located on the western side of Rose Atoll. Crustose coralline algal cover represented 45% of the benthos; coral cover was 16.6%. Sixteen coral genera were recorded within this site's belt transects, and *Montastrea, Montipora*, *and Pocillopora* were the most

abundant taxa. Coral disease and health assessments revealed 7 cases of filamentous algal infections on *Montastrea curta*, *Favia stelligera*, *Leptastrea* sp., and *Montipora* sp.; 7 cases of barnacle infestation on *Montipora* sp. and *Pavona varians*; and 3 cases of tissue loss on *Montipora* sp. in a survey area of 200 m^2. Photoquadrat abundances of macroalgae included crustose coralline red algae, turf algae, cyanophytes, *Halimeda, Dictyosphaeria versluysii*, and *Lobophora variegata.* On the random swim survey, *Caulerpa sertularioides* was recognized. As at previous sites, the most abundant fish was *Chromis acares.* Fishes larger than that small damselfish were commonly seen on transect here, including *Cephalopholus argus*, *Gracila albomarginata*, *Aphareus furca*, *Caranx melampygus, Chlorurus microrhinos*, and over a dozen *Elegatis bipinnulatus*. Off transect, the rare giant humphead wrasse (*Cheilinus undulates*) was observed.

ROS-54
14º32.728′ S, 168º08.416′ W
Depth Range: 20–26 m
This site is located on the northeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had low coral cover with medium reef complexity. This site is a large rubble zone in between what appears to be healthier reefs. Reef fishes were composed primarily of anthias (*Pseudanthias pascalus*) and small damselfish (*Chromis acares*). Additionally, there was a possible sighting of *Luzonichthys whitleyi* in which it was found schooling in with *P. pascalus*.

ROS-55
14º31.822′ S, 168º09.261′ W
Depth Range: 3–5 m
This site is located on the northwest fringing reef of Rose Atoll, just west of the channel. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with high reef complexity (surge channels). Reef fishes were observed in low abundance, especially in small sizes, with a relatively high amount of large fishes (mostly scarids).

ROS-56
14º32.259′ *S*, 168º10.234′ *W*
Depth Range: 3–5 m
This site is located on the northeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had low coral cover with low reef complexity. Reef fishes consisted mostly of scarids.

March 13, 2008

ROS-04
14º55.968′ S, 168º16.011′ W
Depth Range: 10.9–12.1 m
This site was located on the south side of Rose. Crustose coralline algal cover represented 52% of the benthos; coral cover was 31%. Twelve coral genera were recorded within this site's belt transects, and *Pocillopora* was the most abundant taxon. Coral disease and health

assessments revealed 9 cases of filamentous algal infections on *Montastrea curta*, *Favia stelligera*, and *Porites* sp.; 1 case of skeletal growth anomaly on *Montipora* sp.; 4 cases of multifocal discoloration on *Porites* sp.; and 7 cases of coralline algal lethal disease in a survey area of 270 m^2. This site, a south shore forereef located at Rose Atoll, had depths between 11.3 and 13.1 m. Macroalgae identified in the photoquadrats at this site included crustose coralline red algae, cyanophytes, turf algae, *Dictyosphaeria versluysii, Halimeda*, and *Peyssonnelia. Caulerpa urvilleana* was noted along the random swim survey. This site was characterized by large schools of *Chromis acares*, which was by far the most numerous fish. However, pomacentrid diversity was low. In the shallower waters, many *Scarus frontalis* were making their morning commute, and several were recorded within the belt-transect survey area. Also of note was 1 *Triaenodon obesus* recorded within the stationary-point count survey area.

ROS-21
14º0′ S, 168º0′ W
Depth Range: 11.8–14 meters
This site was located on the southeast arm of Rose Atoll. Crustose coralline algal cover represented 54% of the benthos; coral cover was 20.6%. Nineteen coral genera were recorded within this site's belt transects, and *Pocillopora, Montastrea,* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 1 case of white syndrome on *Montipora* sp. and 10 cases of coralline fungal disease in a survey area of 300 m^2. High cover of crustose coralline red algae and the macroalgae *Microdictyon umbilicatum* was observed. Others seen in the photoquadrats included turf algae, cyanophytes, *Dictyosphaeria versluysii, Bryopsis pennata, Valonia fastigiata, Halimeda*, and *Amphiroa*. Noted on the random swim survey was *Peyssonnelia.* Several scarid species were recorded at this site, including *Chlorurus sordidus, Scarus oviceps,* and *S. forsteni. Naso hexacanthus* rounded out the count of large fish. *Chromis acares* was found here in large numbers, as were *Acanthurus thompsoni* and *Ctenochaetus cyanocheilus*. Also of note was one off-transect sighting of *Triaenodon obesus*.

ROS-05
14º55.451′ S, 168º16.463′ W
Depth Range: 11.5–13.6 m
This site was located on the southwest arm of Rose Atoll. Crustose coralline algal cover represented 37% of the benthos, macroalgae cover was 40%, and coral cover was 15.5%. Nineteen coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montastrea* were the most abundant taxa. Coral disease and health assessments revealed 1 case of skeletal growth anomalies on *Pocillopora,* 1 case of white syndrome on *Montipora* sp., and 1 case of algal infection on *Porites* sp. in a survey area of 300 m^2. *Halimeda* and crustose coralline red algae dominated the photoquadrats at this site. Other macroalgae included turf algae, cyanophytes, *Peyssonnelia*, and *Lobophora variegata*. Several large (40–50 cm in length) fish were recorded within the survey area at this site. These large fishes included *Macolor niger*, *M. macularis*, and *Lutjanus bohar*. The amazing dwarf chromis *Chromis acares* was most abundant, followed by *Acanthurus thompsoni. Ctenochaetus cyanocheilus* was the most numerous acanthurid.

ROS-57
14º32.045′ S, 168º09.588′ W
Depth Range: 20–23 m
This site is located on the northwest fringing reef of Rose Atoll, just west of the channel. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had high coral cover with high reef complexity (and a small wall near the channel entrance with many *Macolors*). Large reef fishes were relatively abundant.

ROS-58
14º33.400′ S, 168º09.751′ W
Depth Range: 2–5 m
This site is located on the northeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had medium coral cover with medium reef complexity. Reef fishes were mostly in the medium–large size class with few damselfish.

ROS-59
14º33.359′ S, 168º09.020′ W
Depth Range: 2–5 m
This site is located on the northeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef shallow-depth stratum. This site had medium coral cover with low reef complexity. Reef fishes were relatively few.

ROS-60
14º33.601′ S, 168º09.366′ W
Depth Range: 3–5 m
This site is located on the northeast fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had high coral cover with medium reef complexity (high cover of complex crustose coralline algae). Reef fishes were moderately abundant.

March 14, 2008

ROS-07
14º45.950′ S, 168º16.808′ W
Depth Range: 11.2–14 m
This site was located on the western forereef of Rose. Crustose coralline algal cover represented 32% of the benthos; coral cover was 12.7%. Ten coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 1 case of bleaching on *Pavona maldivensis*, 1 case of algal infection on *Porites* sp., 1 case of skeletal growth anomalies on *Porites* sp., 1 case of discoloration on *Porites* sp., and 1 case of subacute tissue loss on *Montipora* sp. in a survey area of 300 m^2. Photoquadrat abundances of macroalgae included *Lobophora variegata*, cyanophytes, crustose coralline red algae, turf algae, *Jania, Bryopsis pennata, Halimeda*, *Dictyota*, and *Peyssonnelia*. In terms of fish, acanthurids dominated this site. *Naso vlamingii* and *N. literatus* were seen here in uncharacteristically high numbers. *Ctenochaetus*

striatus, *Acanthurus achilles*, and *A. nigrcans* were numerous as well. The ubiquitous *Chromis acares* was common too. Also of note were the large numbers of *Myripristis berndti* recorded at this site.

ROS-08
14º53.794′ S, 168º15.359′ W
Depth Range: 10–11.5 m
This site was located along the channel inside the lagoon at Rose Atoll. The benthos consisted primarily of sand and turf algae; coral cover was 15.6%. Twelve coral genera were recorded within this site's belt transects, and *Porites, Montipora,* and *Astreopora* were the most abundant taxa (most of the *Porites* colonies were less than 5 cm in diameter). Coral disease and health assessments revealed focal and mild bleaching on corals: 1 case on *Leptastrea* sp., 1 case on *Montipora* sp., 3 cases on *Astreopora* sp., and 1 case on *Porites* sp. This bleaching may be caused by the sedimentation regime present at this survey site. In addition, 8 cases of barnacle infestation on *Montipora* sp., 2 cases of discoloration on *Psammocora* sp., 1 case of discoloration on *Porites* sp., and 1 case of predation on *Acropora* sp. were observed in a survey area of 300 m^2. Macroalgae identified in the photoquadrats at this site included the mostly dominant turf algae, cyanophytes, *Lobophora variegata*, crustose coralline red algae, and *Peyssonnelia*. *Halimeda* was recorded on the random swim survey. This lagoon site had a very different assemblage of fish species than did the forereef sites surveyed for ASRAMP 2008. *Dascyllus aruanus* was prolific here, as was *Lutjanus kasmira*. *Cirrhilabrus temmenckii* and *Ostorhinchus leslie* were observed in large numbers as well. *Halichoeres trimaculatus* was another species present in significant amounts at this site that had not been regularly observed at the forereef sites.

ROS-09
14º55.115′ S, 168º16.027′ W
Depth Range: 6.1–7.6 m
This site was located within the lagoon at Rose. Coral cover was 40%. No crustose coralline or macroalgae were enumerated on the line-point intercept, but, instead, turf algae and sand represented 22.5% and 28% of the benthos. A total of 16 coral genera were recorded within this site's belt transects, and *Favia, Astreopora, Porites*, and *Montipora* were the most abundant taxa. Coral disease and health assessments detected 3 cases of subacute tissue loss on *Montipora* sp., *Porites* sp., and *Pavona varians* (1 case each); 1 case of discoloration on *Porites* sp.; 1 case of pink line/spot syndrome on *Porites* sp.; and 4 cases of cyanophyte infections on *Astreopora* sp. (3 cases) and *Montipora* sp. in a survey area of 300 m^2. Macroalgae included mostly turf algae and cyanophytes, although *Peyssonnelia* and *Lobophora variegata* were recorded. Noted on the random swim survey was only a very small amount of *Halimeda. Tridacna* clams were abundant along the 2 transects surrounding the pinnacle. As with the other lagoon site, the assemblage of fish species was very different from that of the forereef sites. This site was characterized by large schools of midsize to large fishes, including *Mulloidichthys vanicolensis*, *Gnathodentex aureolineatus*, *Lutjanus kasmira*, and *Monotaxis grandoculis*. Additionally, trains of *Scarus frontalis* were constantly passing through the survey area at this site. *Dascyllus aruanus, Chromis viridis*, and *Cirrhilabrus temmenckii* represented the majority of small fish biomass and were observed here in large numbers.

ROS-61
14º32.708′ S, 168º10.273′ W
Depth Range: 20–24 m
This site is located on the northwest fringing reef of Rose Atoll. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had high coral cover with medium reef complexity and high cover of complex crustose coralline algae. Reef fishes were moderately abundant.

ROS-62
14º32.569′ S, 168º08.876′ W
Depth Range: 1–2 m
This site is located on the northeast backreef of Rose Atoll. It was established by the REA fish team as a new sampling location in the backreef shallow-depth stratum. This site had low coral cover with low reef complexity. Reef fishes were relatively few but included mostly species not seen at the forereef sites: *Chromis viridis*, *Stegastes albifasciatus*, *Chrysiptera biocellata*, and *Halichoeres trimaculatus*.

ROS-63
14º33.245′ S, 168º09.238′ W
Depth Range: 1–2 m
This site is located on the northeast backreef of Rose Atoll. It was established by the REA fish team as a new sampling location in the backreef shallow-depth stratum. This site had low coral cover with low reef complexity. Reef fishes were relatively few but included mostly species not seen at the forereef sites: *Chromis viridis*, *Stegastes albifasciatus*, *Chrysiptera biocellata*, and *Halichoeres trimaculatus*.

ROS-64
14º32.357′ S, 168º09.682′ W
Depth Range: 1–2 m
This site is located on the northeast backreef of Rose Atoll. It was established by the REA fish team as a new sampling location in the backreef shallow-depth stratum. This site had low coral cover with low reef complexity. Reef fishes were relatively few but included mostly species not seen at the forereef sites: *Chromis viridis*, *Stegastes albifasciatus*, *Chrysiptera biocellata*, and *Halichoeres trimaculatus*.

E.3. Benthic Environment

E.3.1. Algae

Quantitative algal surveys were conducted at 12 sites around Rose Atoll, American Samoa. Fifteen species of macroalgae were recorded along survey transects: 9 species of green algae, 4 species of red algae, and 2 species of brown algae, as well as crustose coralline red algal, turf algal, and cyanophyte functional groups (Table E.3.1.1).

Table E.3.1.1.--Algal genera or functional groups recorded in photoquadrats around Rose Atoll. Numbers indicate the percentage of photoquadrats in which an alga occurred.

Division	Species/Name	ROS-01	ROS-02	ROS-03	ROS-04	ROS-05	ROS-06	ROS-07	ROS-08	ROS-09	ROS-21	ROS-23	ROS-25
	Cyanophyte	16.67	33.33	83.33	100	100	33.33	66.67	58.33	100	83.33	100	83.33
	turf algae	16.67	8.33	8.33	91.67	16.67	33.33	83.33	100	41.67	33.33	41.67	8.33
Chlorophyta	*Bryopsis pennata*							33.33			8.33		
Chlorophyta	*Caulerpa urvilleana*		33.33										16.67
Chlorophyta	*Dictyopsphaeria cavernosa*	58.33	75	33.33									
Chlorophyta	*Dictyosphaeria versluysii*				16.67						75	16.67	50
Chlorophyta	*Halimeda* sp.	8.33	16.67	41.67	75	100	100	16.67			41.67	91.67	83.33
Chlorophyta	*Microdictyon umbilicatum*	100	100	100							91.67		
Chlorophyta	*Neomeris* sp.												8.33
Chlorophyta	*Rhipilia orientalis*												
Chlorophyta	*Valonia fastigiata*	8.33		8.33							25		
Ochrophyta	*Dictyota sp.*							8.33					
Ochrophyta	*Lobophora variegate*	33.33		41.67		25	50	100	41.67	8.33		25	8.33
Rhodophyta	*Amphiroa* sp.		25								8.33		
Rhodophyta	*Crustose coralline red algae*	100	100	100	100	100	100	91.67	33.33		100	100	100
Rhodophyta	*Jania* sp.							16.67					
Rhodophyta	*Peyssonnelia* sp.		8.33		25	25	50	16.67	16.67	8.33			

E.3.2. Corals

Coral REA surveys were conducted March 11–14, 2008 at 10 forereef sites and 2 lagoon sites around Rose Atoll (Fig. E.2.1). All 11 sites surveyed in 2006 were resurveyed in 2008. One new site, ROS-25, was added east of the channel on the north forereef. Survey depths ranged between 6 and 15 m. Coral population surveys were conducted by Jason Helyer (CRED) and coral disease and health assessments were conducted by Bernardo Vargas-Ángel, PhD (CRED).

E.3.2.1. Percent Benthic Cover

Percent benthic cover surveys at Rose Atoll were conducted in concert with the fish, coral population, algae, and invertebrate REA surveys at 12 different sites established during prior CRED RAMP cruises in 2002 and 2004.The line-point intercept methodology was conducted along 2, end-to-end 25-m transects (51 points per transect) at each site, for a total of 918 points along 450 m of forereef and lagoonal coral communities (7 forereef and 2 lagoonal survey sites). A new REA site was established on the north sector of this atoll, ROS-25, co-located with an autonomous reef monitoring system (ARMS). The depths of survey transects ranged between 9 and 14 m for all locales visited. Patterns of intraisland variability in percent benthic cover, derived from the 12 independent REA surveys in 2008, are reflected in Figure E.3.2.1.1. Atollwide, coralline algae, scleractinian corals, macroalgae, and cyanophytes were the primary benthic components at 41.9% (SE 7.4), 21.0% (SE 3.4), 14.6% (SE 4.4), and 8.3% (SE 4.5) of total of benthic component cover. The greatest values for live coral cover were observed at ROS-25 (north arm) and ROS-09 (southwest inside lagoon). Highest values of coralline algal cover were found at ROS-01 (73.5%, east) and ROS-06 and ROS-23 (58.8%, north and west, respectively). Cyanophytes were still conspicuously abundant at the 1993 wreck site ROS-07 (51%, west). Of the 17 scleractinian genera enumerated along the 2 transects, 2 genera, *Pocillopora* and *Montipora*, contributed to 64% of the scleractinian coral cover with 36% and 28%, respectively. The other 15 genera collectively contributed 36 % of the scleractinian coral cover. Below, Table E.3.2.1.1 provides an itemized analysis of the relative contribution of the different scleractinian genera to the total percent live coral cover.

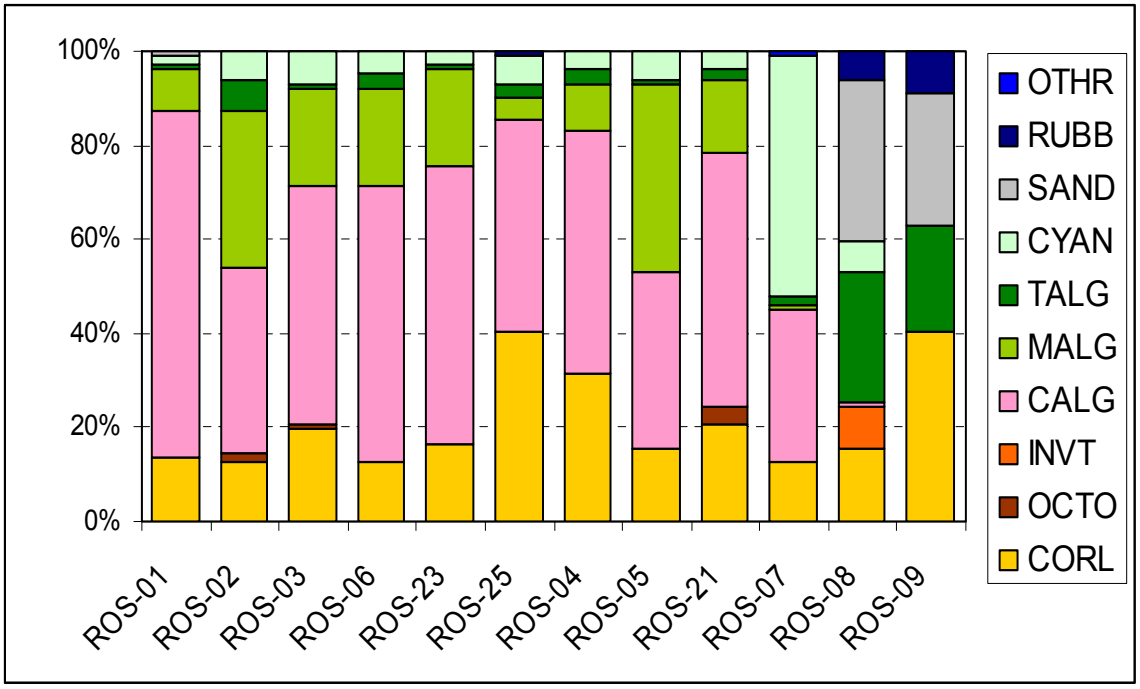

Figure E.3.2.1.1.--Mean percent cover of selected benthic elements derived from 9 independent REA surveys around Rose Atoll, during the HI-08-02 ASRAMP 2008 cruise, March 11–14, 2008. CORL: live scleractinian and hydrozoan stony corals; OCTO: octocorals; INVT: nonanthozoan invertebrate; CALG: coralline algae; MALG: macroalgae; TALG: turf algae (on pavement, rubble, and dead coral); CYAN: cyanophyte; SAND: sand; RUBB: coral rubble; and OTHR: other.

Table E.3.2.1.1. Relative contribution of the 30 scleractinian coral genera tallied in the line-intercept method for benthic cover.

Genus	Percent of Total
Montipora	28.3
Acropora	2.2
Astreopora	2.7
Pocillopora	36.3
Psammocora	1.1
Coscinaraea	0.3
Pavona	2.7
Leptoseris	0.3
Fungia	0.5
Hydnophora	0.8
Lobophyllia	0.3
Favia	7.7
Montastrea	3.8
Cyphastrea	1.4
Leptastrea	8.2
Echinopora	0.3
Porites	3.0

The previous quantitative data documents important characteristics of the coral reef benthic assemblages, providing an opportunity to monitor for change in response to alterations in the reef environment. An abridged comparison of percent live coral cover based on surveys conducted in 2006 and 2008 is illustrated in Figure E.3.2.1.2. Because of the lack of permanent stations at most of the sites surveyed, a rigorous statistical comparison of results is precluded. All sites, except for ROS-04, exhibited relatively minor changes in percent live coral cover (< 5%). At ROS-04 differences between the 2006 and 2008 surveys amounted to nearly 50%.

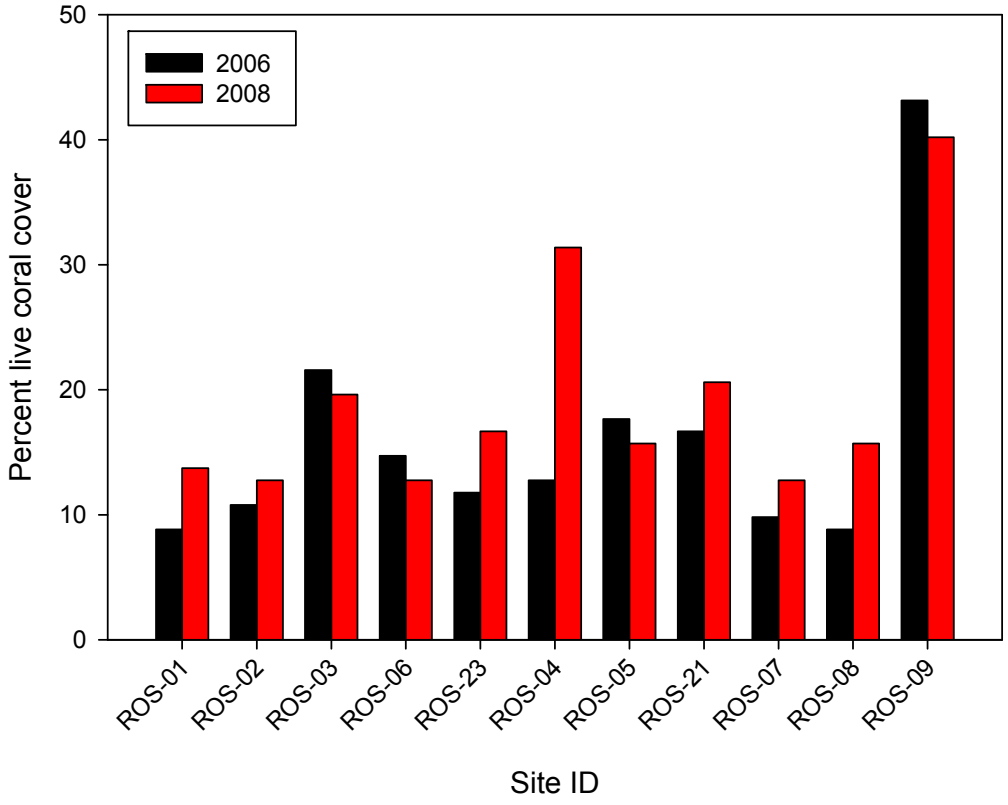

Figure E.3.2.1.2.--Percent live coral cover for 12 REA sites around Rose Atoll, comparing results for ASRAMP 2006 and ASRAMP 2008.

E.3.2.2. Coral Populations

A total of 3766 coral colonies belonging to at least 26 cnidarian taxa (21 scleractinian genera and 5 octocorals) were enumerated within 500 m^2 of reef surveyed on the forereef around Rose Atoll (Table E.3.2.2.1). Members of the genera *Pocillopora*, *Montipora*, and *Montastrea* were the most abundant coral taxa in terms of number of colonies with each genus contributing 34.8%, 14.7%, and 15.7%, respectively, of the total number of colonies recorded on the forereef at Rose. Density values at individual sites ranged from 3.7 colonies m^{-2} at ROS-06 to 10.3 colonies m^{-2} at ROS-21. Generic richness values ranged from 10 coral genera recorded at ROS-07 to 19 coral genera each observed at ROS-21 and ROS-25.

A total of 1049 coral colonies belonging to at least 17 cnidarian taxa (16 scleractinian genera and 1 octocoral) were enumerated within 100 m^2 of reef surveyed inside the lagoon at Rose Atoll (Table E.3.2.2.1). Members of the genera *Porites*, *Astreopora*, *Favia*, and *Montipora* were the most abundant coral taxa in terms of number of colonies with each genus contributing 31.6%, 22.4%, 19.8%, and 12.3%, respectively, of the total number of colonies recorded inside the lagoon at Rose. Density and generic richness were highest as ROS-09 at 13.26 colonies m^{-2} and 16 coral genera observed.

Table E.3.2.2.1.--Number of corals, by genus, enumerated along belt transects in 2008 coral REA surveys. Left table represents forereef sites; right table represents lagoon sites. Genera contributing more than 10% of the total number of colonies are highlighted in bold.

Coral Taxon	# of Colonies	% of Total
Acanthastrea	1	0.0
Acropora	151	4.0
Astreopora	1	0.0
Coscinaraea	13	0.3
Cyphastrea	67	1.8
Echinophyllia	2	0.1
Echinopora	5	0.1
Favia	144	3.8
Fungia	44	1.2
Goniopora	20	0.5
Hydnophora	8	0.2
Leptastrea	44	1.2
Leptoseris	72	1.9
Lobophyllia	2	0.1
Lobophytum	111	2.9
Montastrea	**590**	**15.7**
Montipora	**553**	**14.7**
Palythoa	16	0.4
Pavona	116	3.1
Platygyra	1	0.0
Pocillopora	**1312**	**34.8**
Porites	199	5.3
Psammocora	131	3.5
Sarcophyton	29	0.8
Soft Coral	132	3.5
Zoanthus	2	0.1
Total	**3766**	**100**

Coral Taxon	# of Colonies	% of Total
Acropora	39	3.7
Astreopora	**235**	**22.4**
Cyphastrea	7	0.7
Favia	**208**	**19.8**
Favites	1	0.1
Goniastrea	1	0.1
Leptastrea	28	2.7
Leptoseris	9	0.9
Montastrea	18	1.7
Montipora	**129**	**12.3**
Pavona	5	0.5
Platygyra	8	0.8
Porites	**332**	**31.6**
Psammocora	17	1.6
Sarcophyton	3	0.3
Scapophyllia	3	0.3
Stylocoeniella	6	0.6
Total	**1049**	**100**

E.3.2.3. Coral Health and Disease

In 2008, a total area of ~ 3600 m^2 across 12 sites was surveyed for coral and coralline algae disease during the REA surveys. Coral disease occurrence and abundance were low; a total of 139 cases of 12 categorized diseases and afflictions were enumerated. A summary of disease occurrence, relative abundance, and affected taxa are presented in Tables E.3.2.3.1 and E.3.2.3.2. Algal infections were the most abundant anomaly (28% of cases) and affected corals in the genus *Favia, Montastrea, Porites, Pocillopora*, and *Montipora*. Additionally, crustose coralline algae was the group most commonly affected by disease.

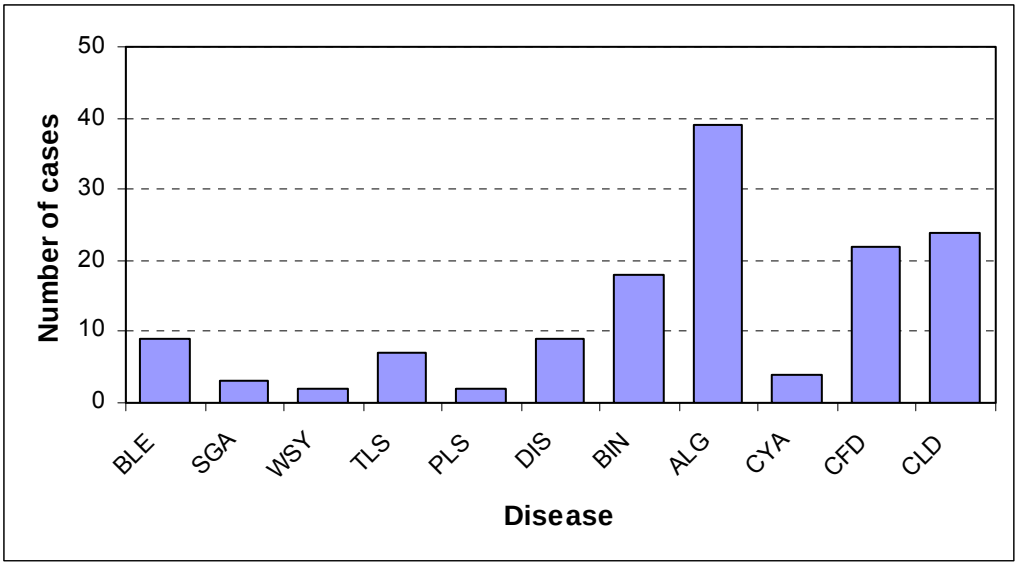

Figure E.3.2.3.1.--Number of cases of coral and coralline algal disease enumerated during REA surveys, Rose Atoll, during ASRAMP 2008. BLE: bleaching; SGA: skeletal growth anomalies; WSY: white syndrome; TLS: tissue loss; PLS: pink line/spot syndrome; DIS: other discolorations; BIN; barnacle infestation; ALG: algal infections; CYA: cyanophyte infections; CFD: coralline fungal disease; and CLD; coralline lethal disease.

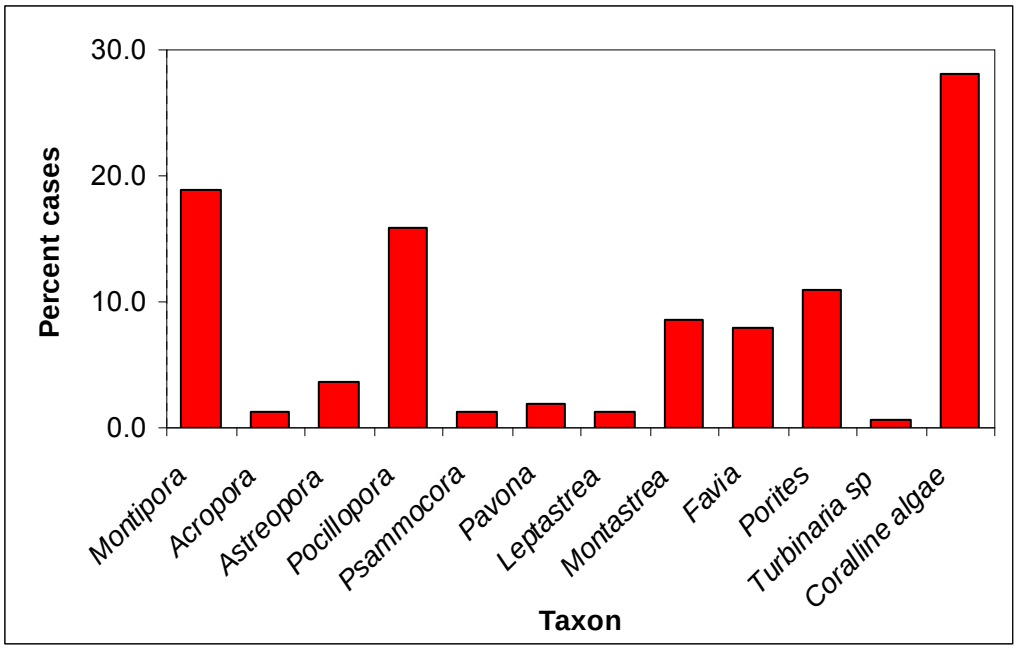

Figure E.3.2.3.2.--Percent occurrence of disease affecting coral and coralline algal taxa.

E.3.3. Macroinvertebrates

Macroinvertebrate surveys were conducted at only 4 REA sites (ROS-05, ROS-07, ROS-08, and ROS-21). Particularly on the forereef sites, very few noncryptic macroinvertebrates were observed along REA transects and during other dives. No echinoderms, except for a single ophiuroid and 1 crinoid, were recorded on transects at ROS-05. At forereef sites, small hermit crabs, mostly of the genus *Calcinus*, were common along with trapezid crabs. *Phyllidiela pustulosa* nudibranchs, *Saron* shrimp, and *Trochus* and *Turbo* snails were also encountered at most forereef sites. *Tridacna* clams were encountered within the lagoon, and other large bivalves, such as oysters were highly abundant around the lagoon patch reef site (ROS-08) near the channel (1.7 m^{-2}). The water at ROS-08 was highly turbid with organic material, and the surfaces of the pinnacle were blanketed in soft worm tubes.

E.3.3.1. Urchin and Giant Clam Measurements

No urchins were encountered during invertebrate REA surveys. This lack of sightings came about largely because invertebrate surveys were conducted at relatively few sites. *Tridacna* clams were measured at one lagoonal site (ROS-09) in appreciable numbers. Figure D.3.3.1.1 reveals the size distribution histogram of maximum shell size of *Tridacna* clams at that site.

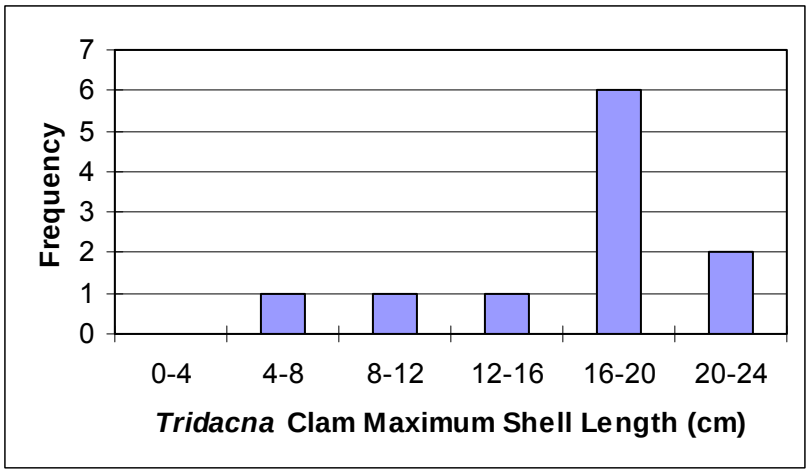

Figure D.3.3.1.1.--Maximum shell length distribution of *Tridacna* clams at REA site ROS-09.

E.3.3.2. ARMS Deployment

ARMS were deployed at the following REA survey sites around Rose Atoll. Each site contains 3 ARMS.

Table D.3.3.2.1.--ARMS deployment locations around Rose Atoll.

Site	Latitude	Longitude
ROS-25	14º31.763′ N	168º9.209′ W
ROS-19	14º32.937′ N	168º8.275′ W
ROS-04	14º33.579′ N	168º9.607′ W
ROS-09	14º33.096′ N	168º9.617′ W

E.3.4 Towed-diver Benthic Surveys

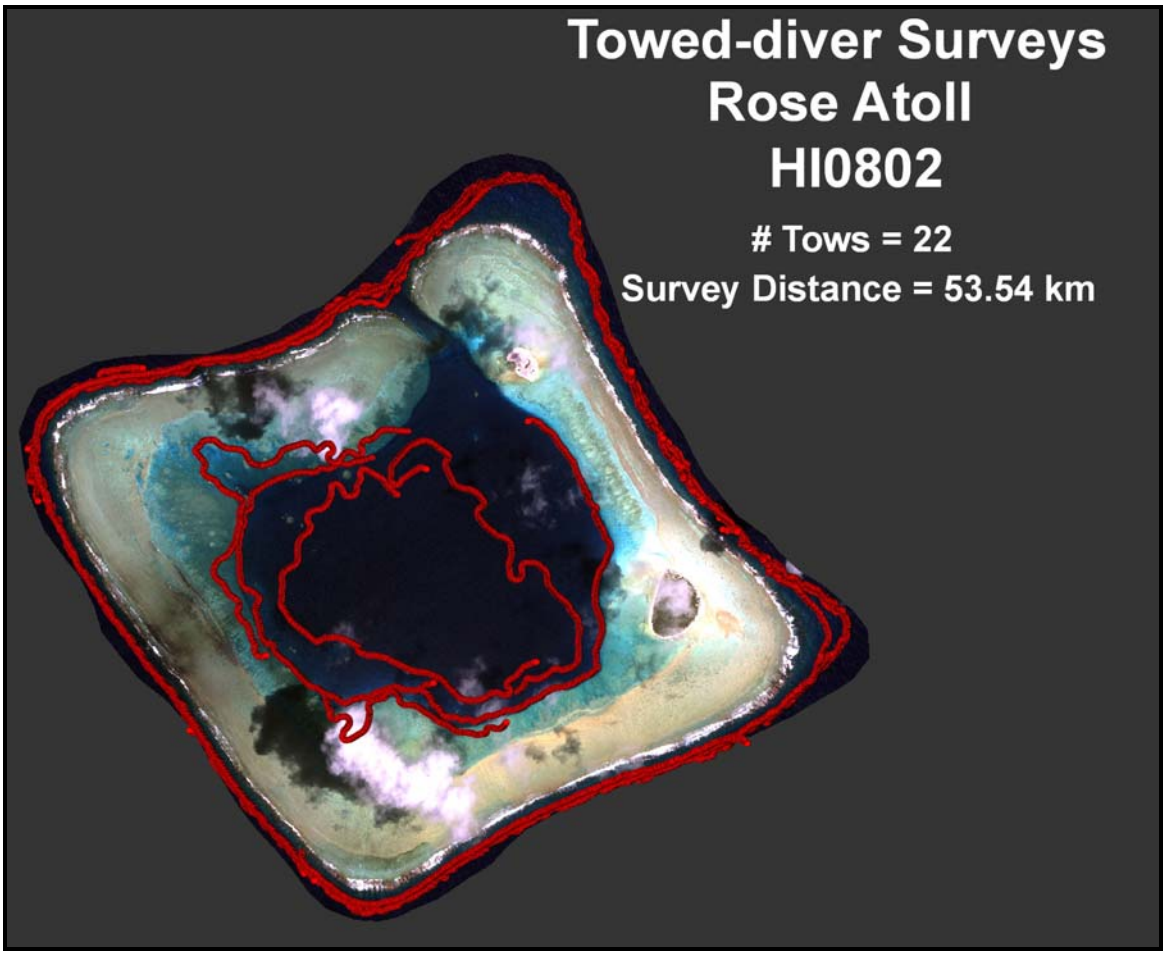

Figure E.3.4.1.--Towed-diver benthic surveys conducted around Rose Atoll during the HI-08-02 ASRAMP 2008 cruise.

A total of 22 towed-diver benthic surveys covering 53.54 km of habitat were completed along the forereef, backreef, and lagoon areas of Rose Atoll. The overall substrate averages for all pooled surveys are as follows: hard coral cover averaged 12.2% (range: 0%–75%), hard coral stress averaged 1.3% (range: 0%–20%), soft coral averaged 1.6% (range: 0%–30%), macroalgae averaged 11.9% (range: 0%–50%), and coralline algae averaged 27.9% (range: 0%–75%). Macroinvertebrate were observed in relatively low abundance throughout most surveys. Giant clams were the most abundant invertebrate recorded at 568 individuals in all surveys or 233.4 individuals ha^{-1}. Boring sea urchins totaled 239 individuals or 98.2 urchins ha^{-1}, an amount recorded over just 2 surveys along the shallow forereef. Sea cucumbers totaled 25 individuals in all surveys or 10.3 sea cucumbers ha^{-1}, and only 1 free-living sea urchin was recorded. No crown-of-thorns seastars (*Acanthaster planci*) were recorded.

Of the 22 surveys around Rose Atoll, 16 were conducted along the continuous forereef habitat, 5 surveys along the 10-m isobath, and 11 surveys along the 20-m isobath. Hard coral cover on the forereef averaged 19% with slightly higher values (range: 1.1%–75%) in

shallower waters. The highest coral cover occurred on the east forereef along a shallow shelf, where the hard coral cover average for the single survey was 34% (range: 20.1%–75%). The dominant corals present were *Pocillopora*, digitated acroporiids, *Porites*, *Montipora*, faviids, and *Lobophyllia*. Stressed coral present on the forereef averaged a total of 2.1%. The greatest amount of stress was recorded along the southeast forereef at 2.7%.

The forereef averages for macroalgae and coralline algae along the 10-m isobath were 17.8% and 46.5%, respectively. Elevated levels were recorded along the 20-m isobath (18.6% and 49.1%, respectively), an increase that can be attributed to the higher coral cover observed in shallower water. The greatest mean cover of macroalgae on the 20-m isobath was recorded along the east side of this atoll at 29% (individual segment range: 10.1–50%). *Halimeda* was the dominant algae at this site and present in several of the other surveys at Rose. An interesting relationship between *Halimeda* and the presence of *Microdictyon* was noted during forereef surveys where only one species of algae was present in any one area. A very distinct rise and fall of *Halimeda* was inversely correlated with the fall and rise of *Microdictyon* throughout all surveys. The highest mean coralline algae presence was recorded along the 20-m isobath along the west side of this atoll at approximately 57% (individual segment range: 40.1–75%).

The forereef macroinvertebrate counts were relatively low throughout all surveys. The forereef did host the greatest number of boring urchins for the entire atoll. The majority of boring urchins occurred in the shallow waters of the west side, where 202 individuals (79.5 urchins ha^{-1}) were recorded in one survey. A total of 20 sea cucumbers were recorded on the forereef, 18 of which were recorded in shallower water. The highest numbers of sea cucumbers were observed along the northeast side of the island, where 9 individuals (3.5 sea cucumbers ha^{-1}) were recorded in a single survey. Additionally, 8 giant clams (3.1 clams ha^{-1}) and 1 free-living sea urchin were recorded.

The remaining 6 surveys were conducted along the backreef (2) and within the lagoon (2 at 10 m, plus 2 at 20 m) of Rose Atoll. The habitats of each stratum were predominantly sand or rubble with a small patch reef that was dominated by branching acroporiids, *Hydnophora*, and giant clams. The hard coral cover average for all 6 surveys was 2.2% (range: 0%–20%) with stress levels below 1%. The greatest amount of hard corals was observed during the southwest lagoon survey along the 10-m isobath. Several large patch reefs were present in sections of this survey that were significantly larger and more frequent than other patch reef encountered throughout the lagoon waters. Macroalgae and coralline algae cover averaged 3.6% and < 1%, respectively. Additionally, large areas of cyanobacteria were observed in the sand and along the patch reef observed during the lagoon surveys.

Macroinvertebrate counts were limited to giant clams and a few sea cucumbers during the inside surveys. A total of 487 giant clams (229.4 clams ha^{-1}) were observed during the 4 lagoon towed-diver surveys, 474 (223.3 clams ha^{-1}) of which were counted along the 10-m isobath. An additional 73 giant clams (34.4 clams ha^{-1}) were recorded along the shallow backreefs. Giant clam densities exceeded 10 individuals per patch reef at times and were found on nearly every patch reef surveyed in shallow waters. A total of 5 sea cucumbers were recorded for an average of 2.3 individuals ha^{-1}.

E.4. Fish

E.4.1. REA Fish Surveys

Stationary-Point Count Data (new methodology)

A total of about 54 individual stationary-point count surveys were conducted at 27 sites around Rose Atoll (3 shallow backreef, 10 mid-depth forereef, 6 deep forereef, 6 shallow forereef, and 2 mid-depth lagoon). Surgeonfish (Acanthuridae) were the largest contributor to total biomass with 1.31 kg 100 m^{-2}. Snapper (Lutjanidae) and parrotfish (Scaridae) were also relatively abundant with a biomass of ~1.0 kg 100m^{-2} (Table E.4.1.2, Fig. E.4.1.1).

Belt-transect Data

During the survey period, 52 belt-transect surveys were conducted at 26 sites around Rose Atoll. Surgeonfish (Acanthuridae) were the largest contributor to total biomass with 1.44 kg 100 m^{-2}. Snapper (Lutjanidae) and parrotfish (Scaridae) were also relatively abundant with biomass values of ~0.60 kg 100m^{-2} (Table E.4.1.1).

Overall Observations

A total of 232 species were observed by all divers during the survey period. The average total fish biomass at the sites around Rose during the survey period was 0.64 t ha^{-1} for the stationary-point count surveys (Table E.4.1.2), and the average fish biomass was 0.48 t ha^{-1} for the belt-transect surveys (Table E.4.1.1).

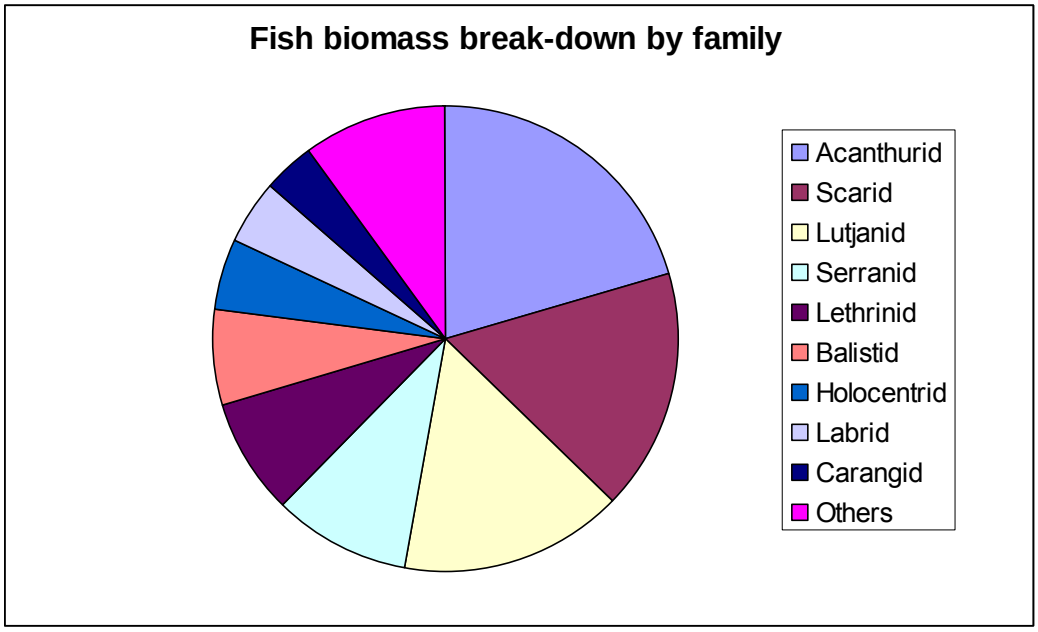

Figure E.4.1.1.--Total fish biomass composition by family, measured by the stationary-point count survey method

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Table E.4.1.1.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Rose Atoll as measured by belt-transect surveys.

Stratum Depth	Site	Total	Acanthurid	Lutjanid	Scarid	Chanid	Balistid	Serranid	Carangid	Holocentrid	Lethrinid	Labrid	Others
Backreef—Shallow	ROS-62	0.47	0.11	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.10
	ROS-63	1.09	0.31	0.32	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.13	0.18
	ROS-64	1.78	0.58	0.00	0.16	0.00	0.08	0.22	0.00	0.07	0.00	0.17	0.50
Forereef—Deep	ROS-53	3.19	0.66	0.47	0.15	0.00	0.06	0.72	0.00	0.30	0.10	0.10	0.65
	ROS-54	3.00	0.51	0.36	0.00	0.00	0.19	0.42	0.55	0.30	0.00	0.27	0.41
	ROS-57	7.19	1.47	1.47	1.21	0.00	0.19	1.25	0.00	0.55	0.00	0.15	0.90
	ROS-60	1.90	0.86	0.19	0.06	0.00	0.09	0.07	0.00	0.00	0.00	0.16	0.46
	ROS-61	5.11	2.30	0.31	0.92	0.00	0.18	0.41	0.21	0.38	0.07	0.05	0.27
Forereef—Mid	ROS-01	3.98	1.07	0.35	0.05	0.00	0.06	0.29	0.00	0.00	0.00	0.07	2.09
	ROS-02	2.71	1.21	0.09	0.32	0.00	0.00	0.44	0.00	0.00	0.00	0.18	0.47
	ROS-03	2.81	1.09	0.00	0.12	0.00	0.11	0.99	0.00	0.00	0.00	0.13	0.36
	ROS-04	11.03	1.62	0.00	0.04	0.00	0.14	0.28	0.00	0.00	0.00	0.11	8.84
	ROS-05	3.30	1.40	0.31	0.70	0.00	0.00	0.33	0.00	0.06	0.14	0.07	0.30
	ROS-06	12.13	4.89	2.87	0.49	0.00	0.09	1.83	0.00	1.21	0.00	0.17	0.58
	ROS-07	5.50	3.13	0.07	0.20	0.00	0.10	0.90	0.00	0.53	0.05	0.12	0.40
	ROS-21	2.46	0.71	0.00	0.13	0.00	0.03	1.17	0.00	0.00	0.00	0.16	0.26
	ROS-23	3.40	2.03	0.07	0.22	0.00	0.11	0.17	0.00	0.00	0.12	0.22	0.46
	ROS-25	5.75	2.41	1.81	0.62	0.00	0.25	0.25	0.00	0.00	0.00	0.16	0.24
Forereef—Shallow	ROS-51	2.89	1.60	0.00	0.10	0.00	0.56	0.23	0.00	0.00	0.00	0.31	0.09
	ROS-52	4.70	0.82	0.61	0.68	0.00	2.06	0.32	0.00	0.00	0.00	0.17	0.03
	ROS-55	4.64	2.60	0.00	0.43	0.00	0.32	0.71	0.00	0.16	0.00	0.20	0.22
	ROS-56	3.62	1.48	0.00	0.60	0.00	0.56	0.34	0.00	0.00	0.00	0.25	0.39
	ROS-58	6.46	1.96	0.78	0.67	0.00	1.42	0.72	0.00	0.16	0.00	0.43	0.32
	ROS-59	3.44	0.76	0.00	0.04	0.00	1.23	0.57	0.00	0.00	0.00	0.59	0.25
Lagoon—Mid	ROS-08	7.26	1.52	3.05	1.09	0.00	0.16	0.29	0.00	0.07	0.37	0.29	0.42
	ROS-09	15.66	0.29	3.23	7.76	0.00	0.00	0.00	0.00	0.00	2.25	1.35	0.79
Average		**4.83**	**1.44**	**0.63**	**0.65**	**0.00**	**0.31**	**0.50**	**0.03**	**0.15**	**0.12**	**0.24**	**0.77**

Table E.4.1.2.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Rose Atoll as measured by stationary-point count survey.

StratumDepth	Site	Total	Acanthurid	Lutjanid	Scarid	Chanid	Balistid	Serranid	Carangid	Holocentrid	Lethrinid	Labrid	Others
Backreef—Shallow	ROS-62	0.61	0.21	0.00	0.03	0.00	0.01	0.03	0.00	0.00	0.07	0.12	0.14
	ROS-63	1.57	0.25	0.25	0.00	0.00	0.00	0.22	0.16	0.22	0.00	0.32	0.15
	ROS-64	1.94	0.27	0.00	0.40	0.00	0.12	0.41	0.12	0.06	0.00	0.27	0.28
Forereef—Deep	ROS-50	7.83	0.64	1.88	2.07	0.00	0.45	0.81	0.00	1.14	0.23	0.16	0.44
	ROS-53	2.90	1.09	0.29	0.46	0.00	0.23	0.34	0.00	0.05	0.00	0.04	0.40
	ROS-54	3.45	0.78	0.29	0.04	0.00	0.30	0.36	0.00	0.00	0.19	0.41	1.10
	ROS-57	8.03	1.12	0.58	0.95	0.00	0.29	2.57	0.51	0.49	0.00	0.04	1.48
	ROS-60	8.28	1.61	3.61	0.00	0.00	0.37	0.67	0.00	0.76	0.30	0.11	0.87
	ROS-61	7.93	1.81	0.08	0.91	0.00	0.38	1.38	1.69	0.45	0.00	0.11	1.10
Forereef—Mid	ROS-01	2.37	0.71	0.18	0.03	0.00	0.14	0.86	0.00	0.01	0.00	0.14	0.31
	ROS-02	3.39	0.84	0.29	0.26	0.00	0.21	0.48	0.07	0.00	0.01	0.16	1.08
	ROS-03	2.63	0.82	0.37	0.04	0.00	0.32	0.60	0.13	0.00	0.00	0.07	0.27
	ROS-04	3.63	1.59	0.06	0.92	0.00	0.42	0.25	0.00	0.01	0.00	0.11	0.29
	ROS-05	6.02	2.01	2.20	0.27	0.00	0.17	0.49	0.00	0.39	0.04	0.07	0.38
	ROS-06	7.22	1.69	1.16	0.24	0.00	0.31	1.12	0.00	0.97	0.07	0.26	1.39
	ROS-07	8.12	3.74	1.04	0.70	0.00	0.26	0.46	0.00	1.42	0.01	0.06	0.43
	ROS-21	2.60	0.81	0.06	0.47	0.00	0.56	0.40	0.00	0.01	0.01	0.06	0.21
	ROS-23	5.91	1.85	0.43	1.70	0.00	0.03	0.77	0.70	0.00	0.00	0.11	0.32
	ROS-25	3.36	1.50	0.08	0.39	0.00	0.24	0.36	0.00	0.34	0.00	0.14	0.32
Forereef—Shallow	ROS-51	2.65	1.15	0.20	0.10	0.00	0.50	0.20	0.00	0.10	0.00	0.26	0.14
	ROS-52	5.11	1.21	0.75	0.14	0.00	1.54	0.71	0.16	0.00	0.05	0.29	0.27
	ROS-55	10.40	3.13	0.27	2.84	0.00	0.90	0.33	2.32	0.26	0.00	0.13	0.22
	ROS-56	6.55	2.43	0.12	1.19	0.00	0.99	0.79	0.16	0.11	0.00	0.45	0.32
	ROS-58	6.77	1.72	0.37	2.10	0.00	1.34	0.57	0.00	0.16	0.00	0.27	0.24
	ROS-59	6.58	0.99	2.58	0.12	0.00	1.16	0.84	0.00	0.00	0.00	0.48	0.41
Lagoon—Mid	ROS-08	3.66	0.78	1.20	0.25	0.00	0.08	0.16	0.21	0.16	0.22	0.25	0.35
	ROS-09	43.11	0.53	8.42	12.39	0.00	0.03	0.00	0.00	1.35	13.09	2.97	4.33
Average		**6.39**	**1.31**	**0.99**	**1.07**	**0.00**	**0.42**	**0.60**	**0.23**	**0.31**	**0.53**	**0.29**	**0.64**

E.4.2. Towed-diver Fish Surveys

A total of 23 species of large fishes (> 50 cm in total length) representing 13 families were observed around Rose Atoll during the March 11–14, 2008 survey period. Surveys were conducted along the forereef and backreef, as well as within the lagoon. The mean number of fishes (all species pooled) observed by divers on the forereef was 26.3 fish ha^{-1} (on the backreef was .45 fish ha^{-1} and within the lagoon was .56 fish ha^{-1}). The 6 most frequently recorded species found along the forereef are shown in Figure E.4.2.1, and all species observed on the backreef and within the lagoon are shown in Figure E.4.2.2. Along the forereef, fish of the Sphyraenidae family made up the greatest density of large fish observed with 2 of those species observed in large schools. The blackfin barracuda (*Sphyraena qenie*) was the most abundant species observed during the quantitative surveys with a mean number of 12.4 fish ha-1 observed. The brass-striped barracuda (*Sphyraena helleri*) was the second most abundant fish species encountered during the survey with 7.05 fish ha^{-1} recorded. The red snapper (*Lutjanus bohar*) was the third most abundant fish species encountered during the survey with 1.99 fish ha^{-1} recorded.

A total of 7 fishes of 5 species were observed in the lagoon and backreef around Rose Atoll. Two fishes, the red snapper (*Lutjanus bohar*) and the bluefin trevally (*Caranx melampygus*), were observed twice.

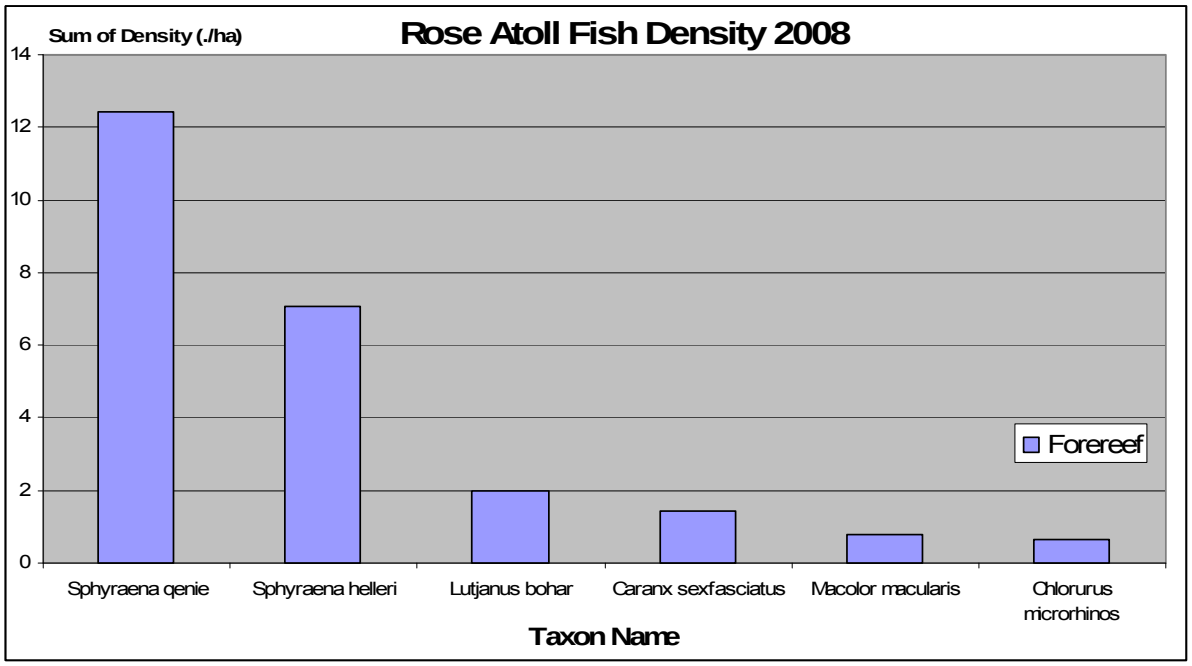

Figure E.4.2.1.--Density of the 6 species most frequently recorded on the forereef around Rose Atoll.

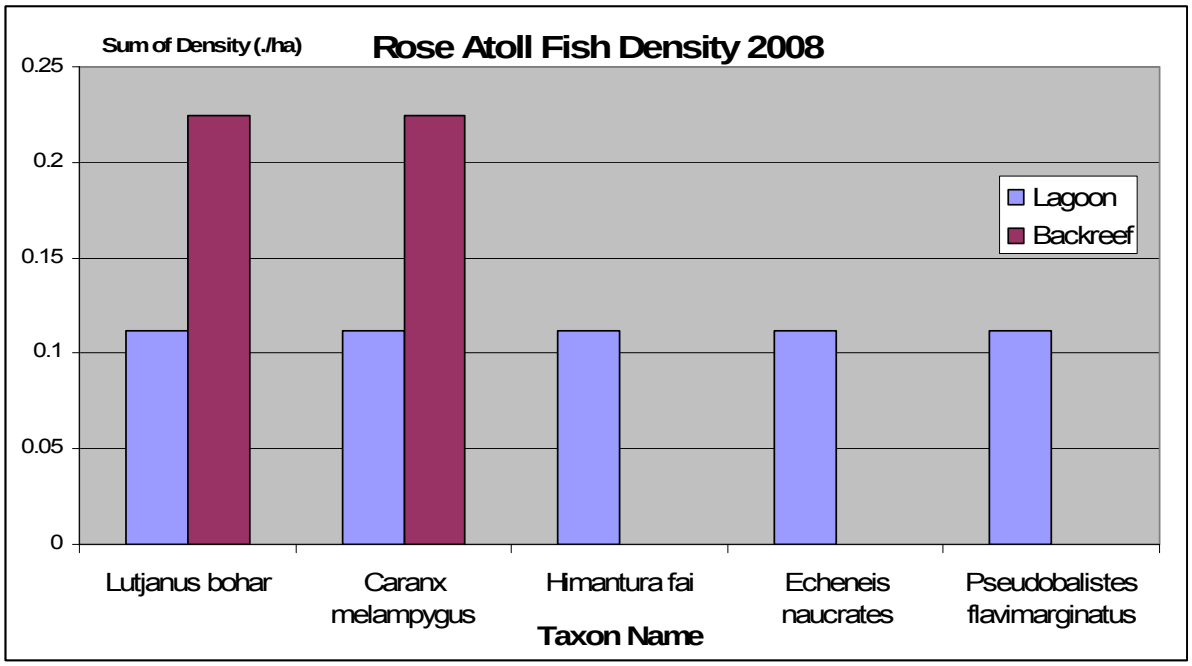

Figure E.4.2.2.-- Density of species observed around Rose Atoll along the backreef and lagoon.

The grand mean biomass of large fishes (> 50 cm in total length) observed on the forereef (< 30 m) around Rose Atoll during the March 11–14, 2008 survey period was 0.028 t ha^{-1}. The lagoon and backreef mean biomasses of large fishes were just 0.005 t ha^{-1} and 0.001 t ha^{-1}. The 6 encountered species with the greatest biomass are shown in Figure E.4.2.3. The blackfin barracuda (*Sphyraena qenie*) accounted for 48% (0.026 t ha^{-1}) of the total mean biomass. The brass-striped barracuda (*Sphyraena helleri*) accounted for 11% (0.006 t ha^{-1}), and the red snapper (*Lutjanus bohar*) accounted for 9% (0.005 t ha^{-1}). With a total biomass density of 0.003 t ha^{-1}, the rare Napoleon wrasse (*Chellinus undulatus*), which is red listed by the International Union for Conservation of Nature and Natural Resources (ICUN), is fifth in terms of largest biomass around Rose Atoll.

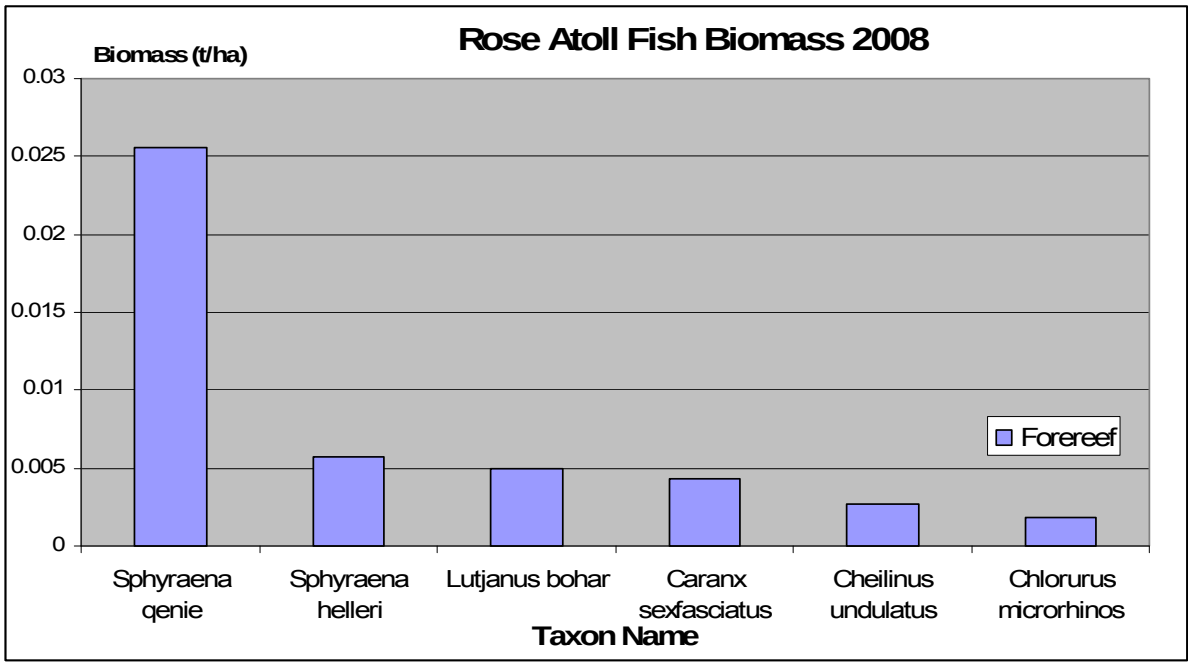

Figure E.4.2.3.--The 6 species with the highest biomass around Rose Atoll.

E.5. Terrestrial Team

Restablishing U.S. Navy Survey Monument on Rose Island

On March 11, Governor Togiola Tulafono, Lelei Peau (Deputy Director of the American Samoa Department of Commerce), and Don Palawski (Refuge Manager, U.S. Fish and Wildlife Service) landed on Rose Island by small boat launched from the NOAA Ship *Hi'ialakai*. Shortly after arriving, as the governor was walking along the shoreline, he discovered a concrete pedestal that had fallen over and had been almost completely buried by shifting sand. Based on anecdotal information, it is believed that this survey monument had been placed on Rose Island many years ago. The governor suggested that we should work to uncover this monument and reposition it so that it would stand upright. On March 12, the governor, Peau, and Palawski dug out the sand covering the monument on 3 sides. Then, with the assistance of NOAA scientists, the 3-ft concrete monument was raised to an upright position. Upon unearthing the monument, a circular brass plate was discovered on top of the monument. This plate was was inscribed with "USN Survey." The current position of this monument is on the west side of the island about 15 m from the high-tide line. The waypoint for the monument is lat. 14°32.783′ S; long. 168°08.708′ W.

Biological Survey Results

Weather—while on-island, the weather was sunny and hot with light winds. The maximum temperature was 29.9 °C and the minimum temperature was 28.5 °C. Winds ranged from 8 to 11 kn from the east.

Topography—The west side of the island appears to have experienced substantial erosion. Based on the Rose Island sampling grid, as much as 30 m of land has eroded from the midpoint of the western shoreline. Soil appears to have been deposited toward the north end of the west side of the island. During low tide, a sandbar ~ 90 × 60 m was visibly protruding out into the lagoon.

Sampling Grid—PVC pipe markers were missing from the northern half of the island. In addition, the erosion along the west side of Rose Island reduced its grid. The first pole found was No. 23. Because of the high density of nesting birds on the east side of the island, verification of the presence of grid markers in that area was not feasible. Also, there was not sufficient time to do a thorough search for all markers.

Vegetation—The lush vegetation on Rose was dominated by a thick stand of *Tournefortia argenta* that covers the majority of the island. Two dense groves of mature coconut trees (*Cocos nucifera*) are located between grid marker Nos. 74 and 84 and Nos. 63 and 73. Several hours were spent pulling young coconut seedlings by hand. Regeneration of *Pisonia grandis* was observed in the vicinity of the few mature trees found in the southeast corner of the Island. Some of these new trees are just reaching the height of the *Tournefortia argenta* canopy. No scale insects were observed on either the young or mature *Pisonia* trees.

Terrestrial Invertebrates—Small red ants were observed at the interface of the coral rubble and vegetation. Numerous orb-weaving spiders were encountered while walking between *Tournefortia* trees. Several different sizes of hermit crabs (*Coenobita* spp.) were observed in the coral rubble areas around the perimeter of the island.

Nearshore Fish—Small schools of bluefin trevally (C*aranx melampygus*) were observed swimming and feeding near shore. When these trevally fed on a school of small fish, brown noddies (*Anous stolidus*) would swoop down to feed on the small fishes not consumed by the trevallys. Blacktip reef sharks (*Carcharhinus melanopterus*) were seen daily patrolling the shoreline.

Reptiles—Signs of sea turtles coming ashore the previous evening were detected on 2 mornings. On March 12, Governor Tulafono followed 3 different tracks on the west side of the island that led to turtle pits. On March 14, 2 sets of tracks where turtles had hauled out the previous evening on the south shore were found. NOAA towboard divers observed 1 green turtle in the lagoon and saw 8 green and 2 hawksbill turtles during the their towed-diver surveys around the outer forereef of this atoll.

Birds—Due to time constraints, birds were surveyed on only select parts of the island. Many more birds were nesting in areas of the island that were not surveyed, so these observations are qualitative. Nesting birds were concentrated on the north coral rubble area, along the eastern third of the island and the south end of the island. Very few nesting or roosting birds were seen on the west side of the island. Still, 9 seabird species, 3 species of shorebirds, and 1 long-legged wading bird species were observed.

White-tailed Tropicbird (*Phaethon lepturus*)—None of this bird was observed during our stay.

Red-tailed Tropicbird (*Phaethon rubricauda*)—On the south end of the island, 9 nests were discovered during inspection of coconut groves. In some cases, nests were located on opposite sides of the same coconut tree. Six nests contained eggs, and 3 nests contained chicks.

Masked Booby (*Sula dactylatra*) —Three adults were observed on the east side of the island. No nests were found.

Brown Booby (*Sula leucogaster*)—No nests were detected, but observations were limited to viewing the vegetation next to the coral rubble on the east side of the island. Numerous adults were observed flying and roosting on *Tournefortia* and rocks in the water near the shoreline.

Red-footed Booby (*Sula sula*)—These birds were observed nesting on the east and south areas of the island. Nests with eggs were present in most of the *Tournefortia* shrubs on the eastern edge of the island.

Great Frigatebird (*Fregata minor*)—A relatively small number of adults were observed flying above the island, and only 2 nests were detected. Due to the height of the nest locations, it was not possible to observe whether eggs or chicks were present.

Lesser Frigatebird (*Fregata ariel*)—Fewer adults were seen compared to the Great frigatebirds, and no nests were detected.

Wandering Tattler (*Heteroscelus incanus*)—Two adults were observed on the south shore of Rose Island.

Ruddy Turnstone (*Arenaria interpres*)—A total of 23 of this bird was counted during a shore walk around the island.

Sooty Tern (*Sterna fuscata*)—A large colony of this bird occupied nests with eggs on the east side of the island. This colony encompassed an area approximately 45 m wide and 180 m long. Birds were literally nesting side by side over this entire area. In addition, 6 juvenile sooty terns were observed on the north end of the island. This area had a large number of old, rotten unhatched eggs from a previous nesting attempt. This area of the island appeared to experience a major overwash event with uprooted *Tournefortia* bushes and signs of erosion.

White Tern (*Gygis alba*)—This bird was also observed only on the east and southeast parts of the island. No eggs were detected, and only one late-stage chick was observed.

Brown Noddy (*Anous stolidus*)—Numerous nests were present in *Tournefortia* trees along the east and south sides of the island. Most trees had multiple nests containing eggs.

Black Noddy (*Anous minutus*)—This bird was observed nesting on the coral rubble at the north and northeast ends of the island. Eggs were present in all of the 46 nests observed in this area.

Pacific Reef-Heron (*Egretta sacra*)—On the southeast side of the island, 12 adults were observed flying from the shoreline to rocks on the reef flat and wading in the reef flat at low tide. Both dark morph and white morph individuals were present.

Biological Conclusions

Rose Island is supporting the largest seabird populations in American Samoa and provides an oasis of high-quality seabird nesting habitat in this area of the Pacific. While the *Tournefortia* trees provide substantial seabird nesting habitat, recovery of the *Pisonia* forest will take many years. Action is needed to remove coconut trees, which are proliferating on the south end of the island.

Trespass and Marine Debris

No signs of trespass on Rose Island or Rose Atoll were observed. Miscellaneous small amounts of marine debris in the form of fishing buoys, rope, plastic bottles, and aerosol cans were found on the island.

Management Recommendations

1. Enter into a new Memorandum of Understanding (MOU) between the U.S. Fish and Wildlife Service and the American Samoa Department of Marine and Wildlife Resources to replace the MOU that expired on December 31, 1999. This MOU should facilitate special, mutually beneficial projects identified by the U.S. Fish and Wildlife Service or the American Samoa Government that will enhance the management of natural resources at Rose Atoll National Wildlife Refuge.
2. Assess the significance of old monuments at Rose Atoll and determine whether they qualify for listing as historic landmarks.
3. Repair the sampling grid on Rose Island.
4. Conduct thorough seabird inventory and monitoring at Rose Island every year.
5. Cut down invasive coconut trees on the island.
6. Monitor the topography and perimeter of Rose Island to document changes and erosion of its shoreline.
7. Install a new refuge sign.

Appendix F: Swains Island

F.1. Oceanography and Water Quality

Moorings

A total of 3 subsurface temperature recorders (STRs) were recovered and replaced at Swains Island during the HI-08-02 American Samoa Reef Assessment and Monitoring Program (ASRAMP) cruise, and 2 new STRs were deployed, 1 off the north shore near Rapid Ecological Assessment (REA) site SWA-08 and 1 off the east shore near REA site SWA-07 (Fig. F.1.1 and Table F.1.1).

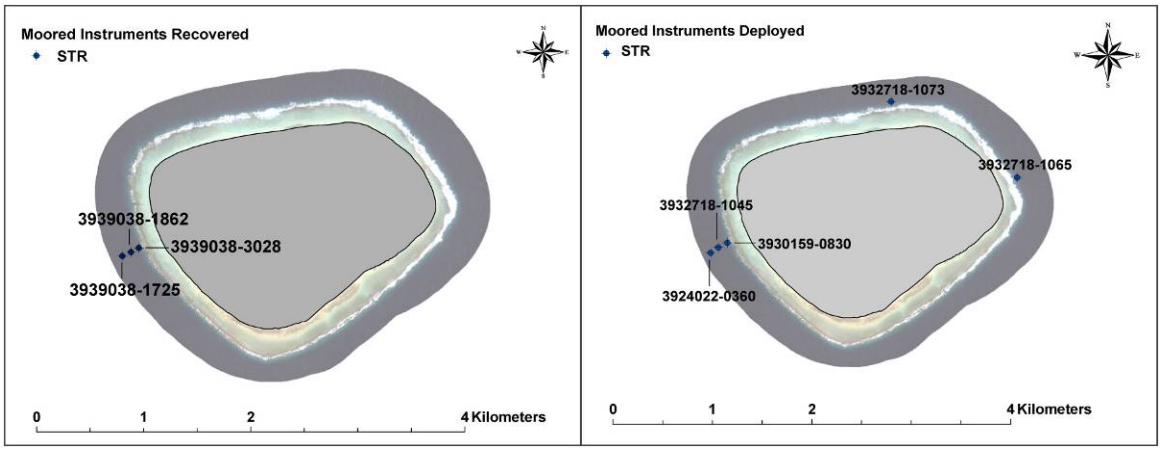

Figure F.1.1.--Moored oceanographic instrumentation map for Swains Island.

Table F.1.1.--Moored oceanographic instrumentation table for Swains Island.

Instrument	Serial Number	Latitude	Longitude	Depth (m)	Data Start	Data End
STR	3939038-1725	11 3.5168 S	171 5.4727 W	28.96	2/11/2006 22:00	6/30/2008 11:30
STR	3939038-1862	11 3.5119 S	171 5.456 W	15.24	2/11/2006 22:00	1/16/2008 3:00
STR	3939038-3028	11 3.5136 S	171 5.451 W	6.71	PROBLEM WITH DOWNLOAD	
STR	3924022-0360	11 3.5168 S	171 5.4727 W	28.96	LOGGING DATA	
STR	3932718-1045	11 3.5119 S	171 5.456 W	15.24	LOGGING DATA	
STR	3930159-0830	11 3.5136 S	171 5.451 W	6.71	LOGGING DATA	
STR	3932718-1065	11 3.1524 S	171 3.8838 W	15.24	LOGGING DATA	
STR	3932718-1073	11 2.7358 S	171 4.5675 W	14.63	LOGGING DATA	

Preliminary Moorings Results

Two of the 3 STRs recovered from Swains yielded good data (Fig. F.1.2), and the third will need to be evaluated by the manufacturer. Between March 2006 and March 2008, subsurface water temperatures around Swains fluctuated seasonally with lows (~ 29 $^{\circ}$C) occurring July–October and highs (30.5 °C) occurring January–April. Both sensors showed similar overall temperature trends; however, STR No. 1862 shows more diurnal variation because it was deployed at a depth that was shallower than the deployment depth of STR No. 1725.

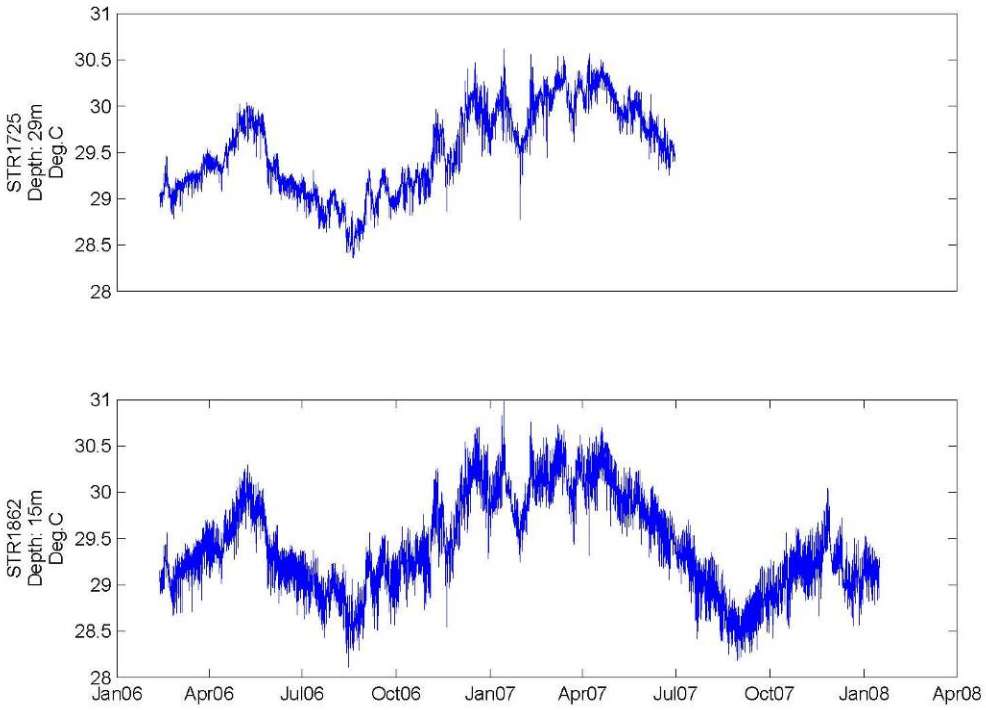

Figure F.1.2.--Temperature data obtained from 2 STR locations around Swains.

Water Quality

Along the 30-m isobath around Swains, 18 shallow-water conductivity, temperature, and depth (CTD) casts were conducted (Fig. F.1.3). Discrete water samples from a daisy chain of Niskin bottles at depths of 1 m, 10 m, 20 m, and 30 m were collected concurrently with shallow-water CTD casts at 4 of the CTD sites around Swains, including duplicate chlorophyll-*a* (Chl-*a*) and nutrient samples at 1 m and 30 m on cast SWA-01 of the HI-08-02 ASRAMP cruise. Additionally, 6 shallow-water CTD casts were conducted in the brackish water lake at Swains. Nutrient and Chl-*a* samples at 1 m were collected by hand concurrently with CTD casts in the lake. To investigate the shallow (< 1 m) waters of Swains' backreef zone, temperature data was collected with a handheld SBE 39 temperature and pressure recorder at 3 sites along the backreef with nutrient and Chl-*a* samples collected at 2 of those sites (Fig. F.4). Temperatures in the backreef were consistently at ~ 30 °C at all 3 sites. Shallow-water sampling at Swains yielded a total of 27 Chl-*a* and 28 nutrient samples. Nutrient and Chl-*a* samples were processed and stored according to protocols provided by Pacific Marine Environmental Laboratory (PMEL) scientists. Samples were sent to PMEL and the University of Hawai`i when the cruise returned. CTD casts, as follows, were conducted between March 17 and March 18, 2008:

Day 1: SWA-01–SWA-18
Day 2: SWA-19–SWA-24

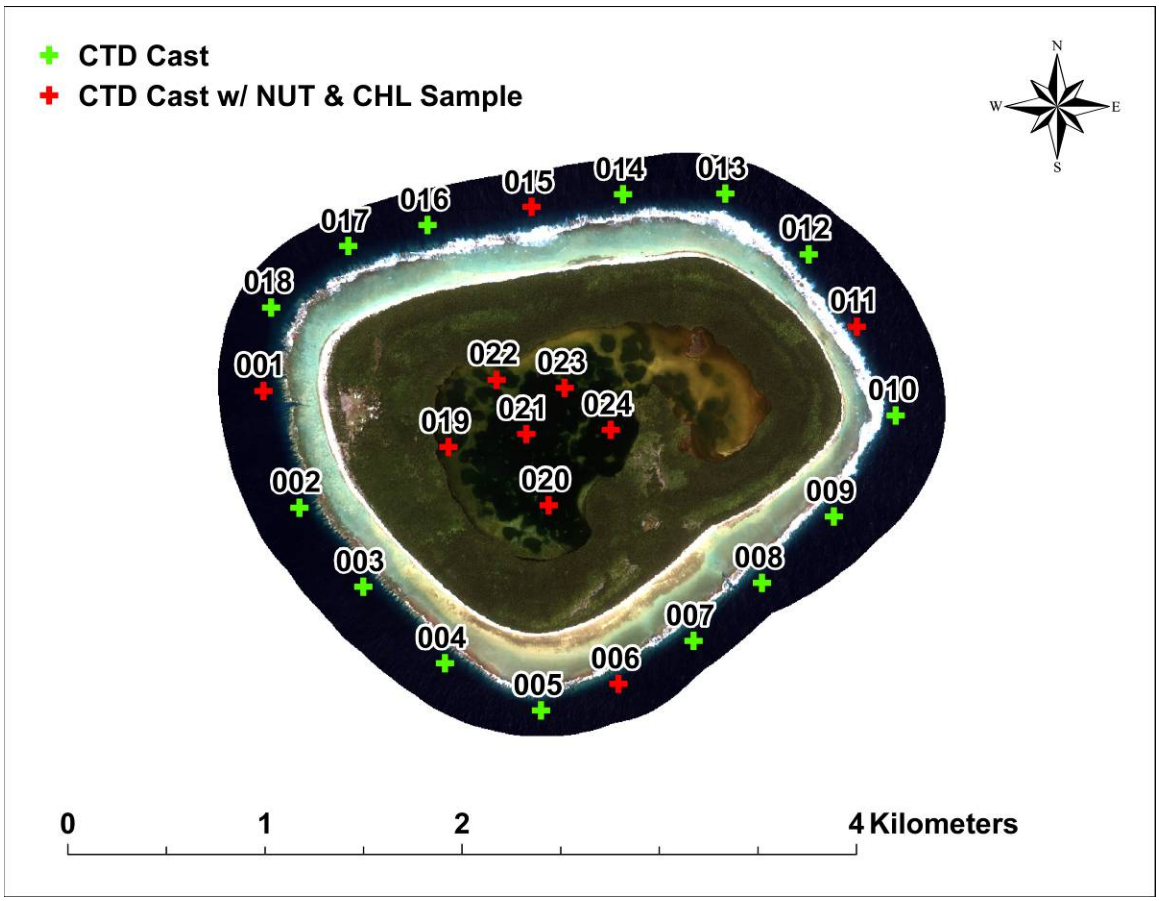

Figure F.1.3.--Shallow-water CTD cast and water sampling locations around Swains, labeled by cast number.

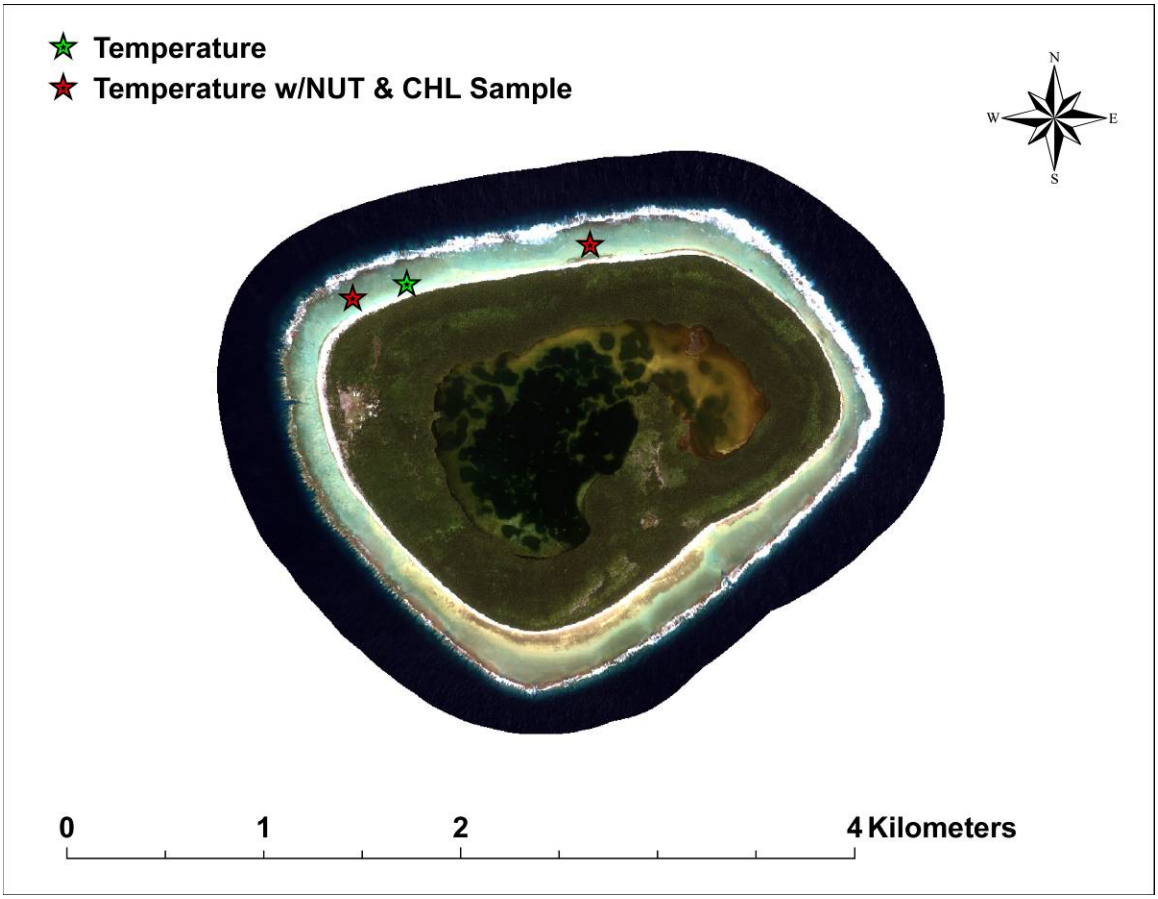

Figure F.1.4.--Shallow-water temperature and water sampling locations in the backreef zone around Swains.

At cardinal points around Swains, 4 shipboard CTD casts were conducted (Fig. F.1.5). All casts were made to a depth of 500 m and water samples were collected at 3 m, 80 m, 100 m, 125 m, and 150 m for nutrient and Chl-*a* analysis. Nutrient and Chl-*a* samples were processed and stored according to protocol and were sent out for analysis when the cruise returned. CTD casts were conducted March 18, 2008 and recorded using the Coordinated Universal Time (UTC) standard.

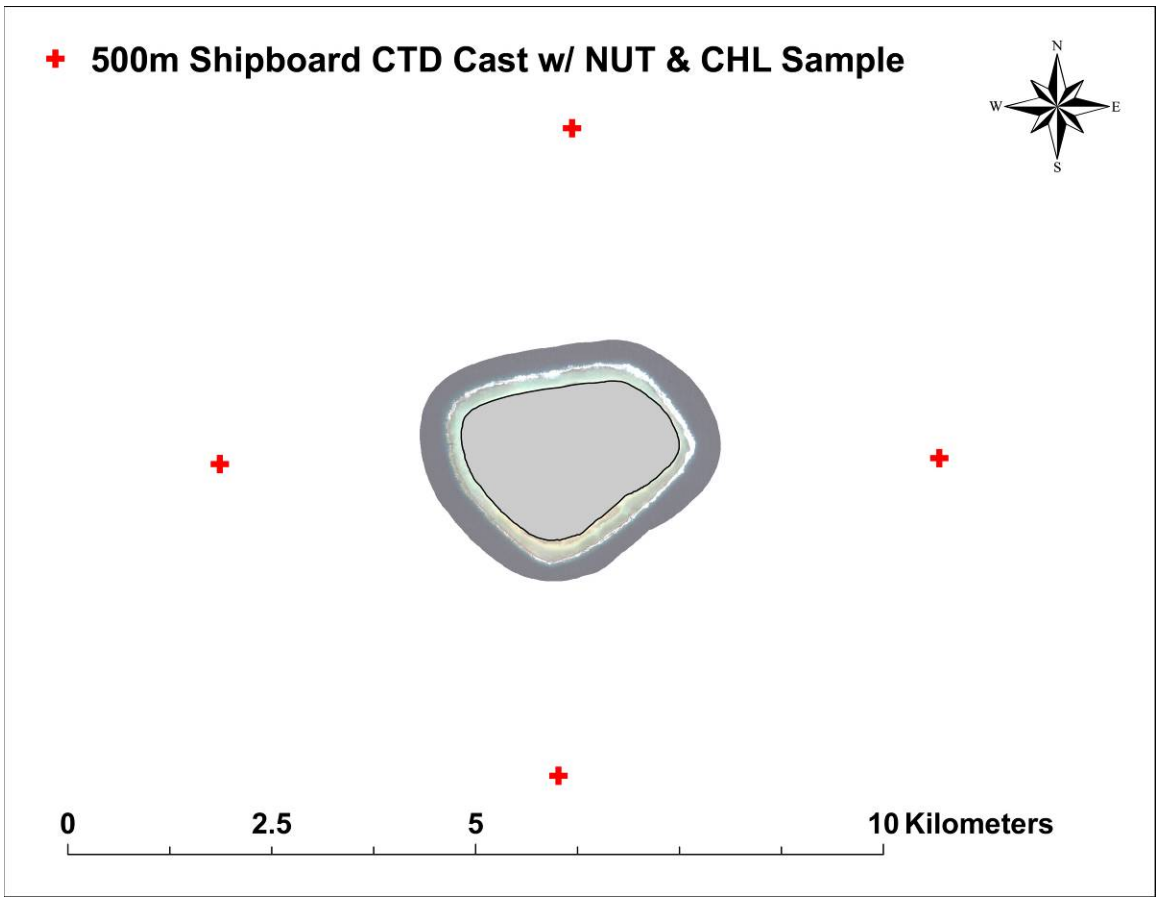

Figure F.1.5.--Sites for shipboard CTD casts, along with nutrient and Chl-*a* sampling, around Swains during the HI-08-02 ASRAMP cruise, labeled by cast number.

Preliminary Water Quality Results

Temperature, salinity, density, and beam transmittance throughout the 30-m water column around Swains showed very little overall variability (Figs. F.1.6 and F.1.7). For example, at the depth of 20 m, temperature varied by 0.04 °C, salinity varied by 0.3 practical salinity units, density varied by 0.2 kg m^{-3}, and beam transmittance percentage varied by 0.21%; all of these variables show almost negligible differences. These results illustrate the spatial homogeneity of the water surrounding Swains during the sampling period both horizontally and vertically within the water column.

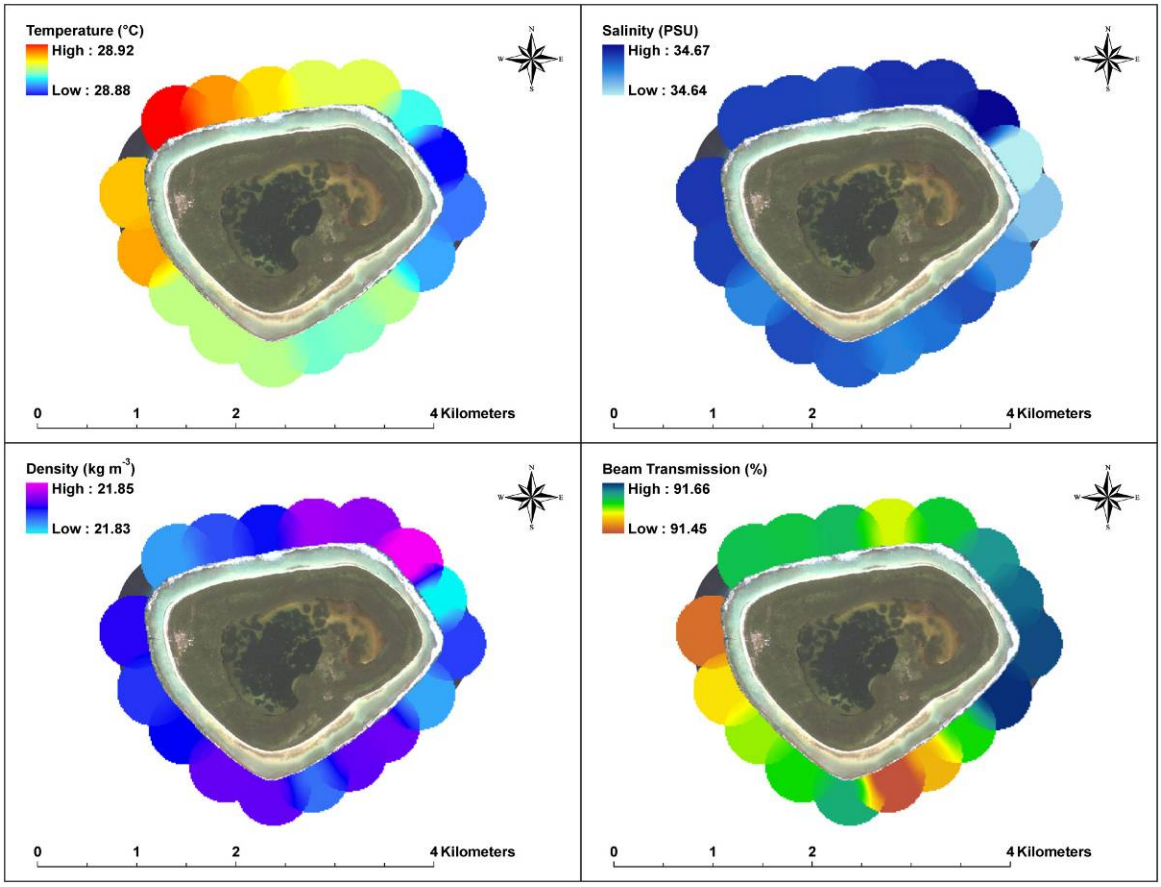

Figure F.1.6.--Interpolated shallow-water CTD cast data at the depth of 20 m around Swains during the HI-08-02 cruise: temperature (upper left), salinity (upper right), density (bottom left), and beam transmission (bottom right).

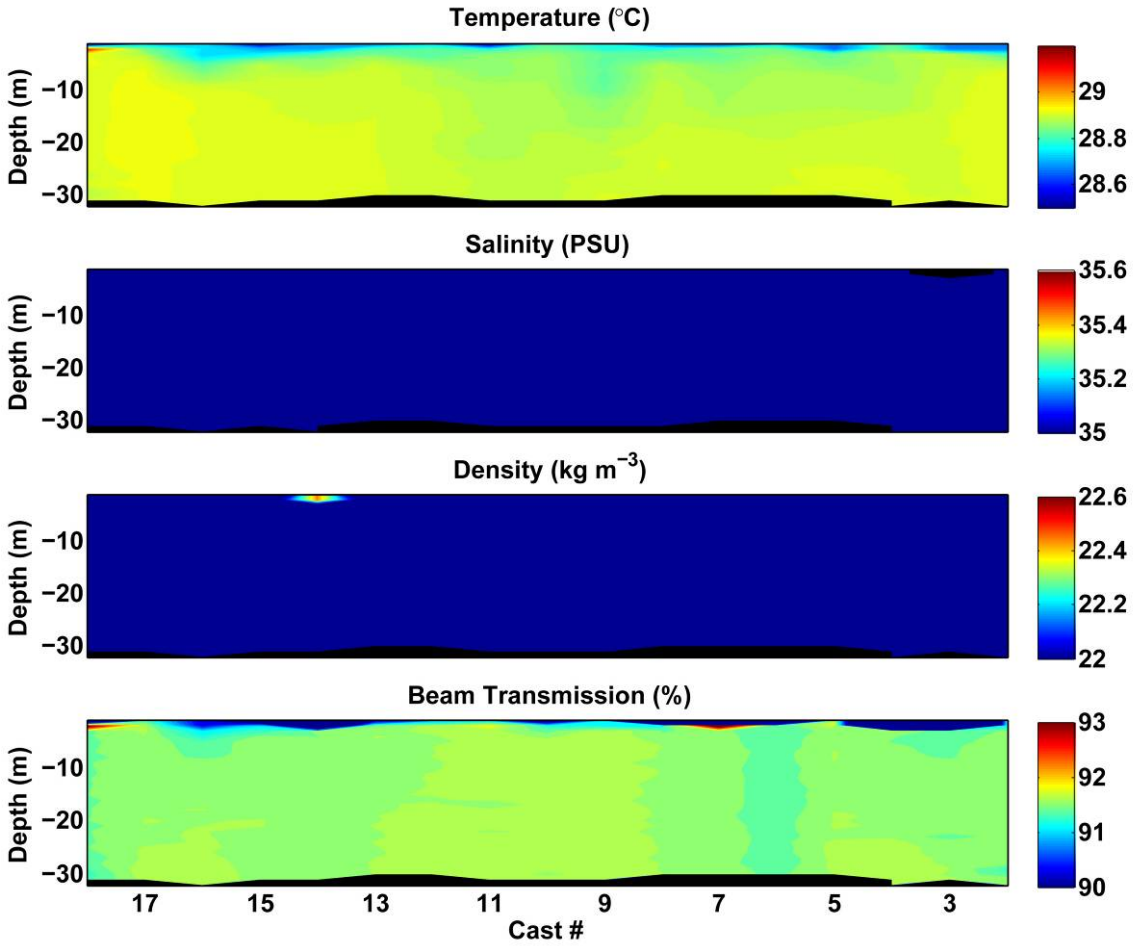

Figure F.1.7.--Cross-section plot of shallow-water CTD data (temperature, salinity, density, and beam transmission) collected at Swains during the HI-08-02 ASRAMP cruise. Refer to Figures F.1.4 and F.1.5 for CTD cast locations.

North Shore Backreef Investigation

In addition to collecting data on backreef water temperature, chlorophyll-*a*, and nutrient levels along the north shore of Swains, the oceanography team did visual surveys of the general benthic habitat. Very little variability in habitat type was seen, and the water depth was consistent all the way out to the forereef. There were small patches of macroalgae and a few patches of encrusting *Porites* coral colonies. Few fishes were observed in the backreef during the low tide observation period.

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

Around Swains between March 16 and 18, 2008, 17 REA sites were visited by a team of up to 8 scientists. At 9 of those sites, only fish surveys were conducted over differing depth ranges. The site locations are shown in Figure F.2.1, and the survey dates and efforts are shown in Tables F.2.1 (fish surveys) and F.2.2 (benthic surveys). Individual site descriptions are included for the following discipline communities: coral, coral and coralline disease, macroinvertebrates, algae, and fish.

Table F.2.1.--Swains 2008 benthic fish survey sites. At each site, 2 belt-transect surveys (25 × 4 m) and a stationary-point count survey (7.5-m radius plot) were performed unless otherwise noted.

Site	Date	Depth (m)	Strata
SWA-03	03/18/2008	11	Forereef
SWA-04	03/18/2008	11	Forereef
SWA-05	03/18/2008	11	Forereef
SWA-06	03/16/2008	12	Forereef
SWA-07***	03/16/2008	11	Forereef
SWA-08	03/16/2008	13	Forereef
SWA-10	03/17/2008	12	Forereef
SWA-16†	03/18/2008	12	Forereef
SWA-50*	03/16/2008	23	Forereef
SWA-51	03/16/2008	5	Forereef
SWA-52*	03/16/2008	5	Forereef
SWA-53*	03/16/2008	20	Forereef
SWA-54	03/17/2008	21	Forereef
SWA-55	03/18/2008	21	Forereef
SWA-56*	03/18/2008	3	Forereef
SWA-57	03/18/2008	4	Forereef
SWA-58*	03/18/2008	20	Forereef

*Only one stationary-point count survey done. **No belt-transect survey done. ***Only one belt-transect survey done. †Only one replicate done.

Table F.2.2.--Swains Atoll 2008 benthic REA site survey dates, teams present and additional comments.

Site	Date	Teams Present	Comments
SWA-03	3/18/2008	Coral, Disease, Algae, Invertebrate	
SWA-04	3/18/2008	Coral, Disease, Algae, Invertebrate	
SWA-05	3/18/2008	Coral, Disease, Algae, Invertebrate	
SWA-06	3/16/2008	Coral, Disease, Algae, Invertebrate	
SWA-07*	3/16/2008	Coral, Disease, Algae, Invertebrate	COTS invertebrate survey only*
SWA-08	3/16/2008	Coral, Disease, Algae, Invertebrate	
SWA-10	3/17/2008	Coral, Disease, Algae, Invertebrate	
SWA-16	3/18/2008	Coral, Disease, Algae, Invertebrate	New site locaiton

*Only a crown-of-thorns seastar (COTS) survey was done for invertebrates at this site.

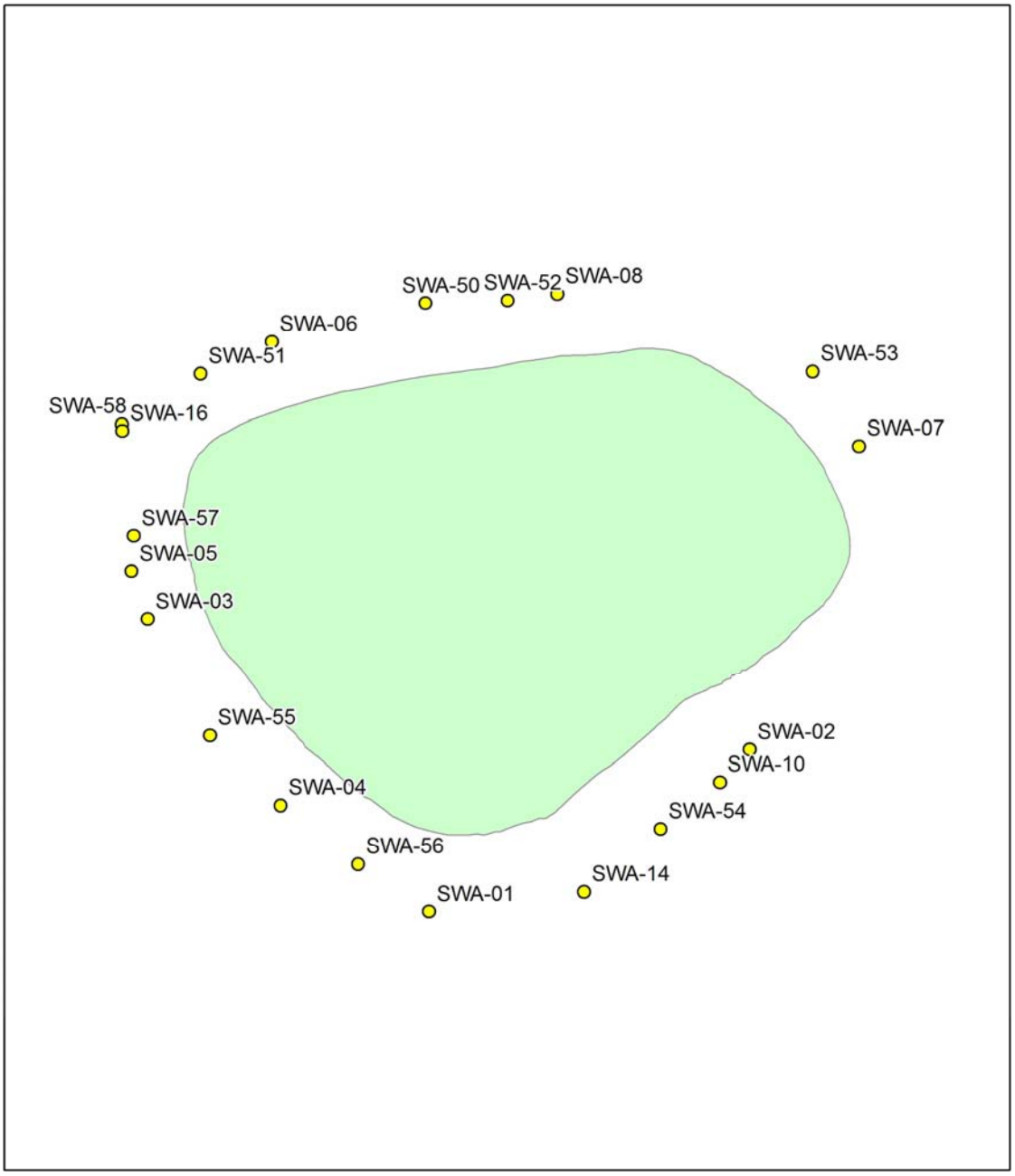

Figure F.2.1.--REA site locations around Swains during the HI-08-02 ASRAMP cruise.

Site Descriptions

March 16, 2008

SWA-07
11º05.116′ S, 171º06.574′ W
Depth Range: 11.8–12.4 m
This site was located on the northeast forereef of Swains. Live coral cover was 43%, made up mainly of platy *Montipora* and branching *Pocillopora*. Coralline algal cover represented 22.5% and macroalgae 6.8% of the benthos. A total of 8 coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 14 cases of coralline fungal disease and 1 case of hyperpigmented irritation on *Favia stelligera* in a survey area of 300 m^2. Also observed were numerous predation scars possibly attributable to *Drupella*. Photoquadrat abundances of macroalgae included crustose coralline red algae (CCA), *Microdictyon umbilicatum,* turf algae, cyanophytes, *Dictyosphaeria versluysii, Rhipilia orientalis*, and *Lobophora variegata. Peyssonnelia* was recorded on the random swim survey. The ubiquitous *Chromis acares* were joined by lower numbers of *Pseudanthias pascalus* and *C. agilis* at this site. Few large fishes were recorded, except for single sightings of *Lutjanus bohar*, *Cephalus argus*, and *Scarus forsteni*. Off transect, the whitetip reef shark *Triaenodon obesus* was seen.

SWA-08
11º04.574′ S, 171º07.686′ W
Depth Range: 11.5–12.4 m
This site was located on the north forereef of Swains. Live coral cover was 67%, made up mainly of platy *Montipora* and branching *Pocillopora*. Coralline algal cover represented 4% and macroalgae 4.8% of the benthos. Twelve coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 5 cases of coralline fungal disease in a survey area of 300 m^2. Also observed were numerous predation scars possibly attributable to *Drupella*. Macroalgae found inside the photoquadrats included turf algae, *Lobophora variegata*, crustose coralline red algae, cyanophytes, *Microdictyon umbilicatum, Dictyosphaeria versluysii, Rhipilia orientalis, Peyssonnelia*, and *Caulerpa sertularioides. Chromis acares* and *Pseudanthias pascalus* were counted ad nauseam. Large numbers of *Elegatis bipinnulatis* schooled off transect with about 12 of these fish venturing into the stationary-point count survey area to be recorded. Also of note off transect were large *Naso hexacanthus* and a large dogtooth *Gymnosarda unicolor*.

SWA-06
11º04.744′ S, 171º08.702′ W
Depth Range: 10.9–12.7 m
This site was located on the the north-northwest forereef of Swains. Live coral cover was 60%, mainly made up of platy *Montipora* and branching *Pocillopora*. Coralline algal cover represented 6.8% of the benthos. Eleven coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 2 cases of coralline fungal disease in a survey area of 300 m^2. Also observed were numerous predation scars possibly attributable to *Drupella*. Live coral dominated this site along with a possibly invasive green tunicate. Macroalgae identified in the

photoquadrats included cyanophytes, *Lobophora variegata*, crustose coralline red algae, *Caulerpa sertularioides*, *Microdictyon umbilicatum, Rhipilia orientalis*, and *Dictyosphaeria versluysii.* Noted on the random swim survey were *Dictyosphaeria cavernosa*. *Calcinus* hermit crabs and corallivorous *Drupella* snails were abundant at this site. As at previous Rose sites, *Chromis acares* and *Pseudanthias pascalus* were observed in large numbers. A few larger fish, such as *Acanthurus blochii*, *Elegatis bipinnulatus*, *Cephalopholis argus*, and *Aphareus furca* were seen singly or in groups of 2 or 3, and larger schools of curious *Naso hexacanthus* and *Caranx sexfasciatus* crowded into the transect areas.

SWA-50
11º02.773′ S, 171º04.878′ W
Depth Range: 20–26 m
This site is located on the north side of Swains. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had high coral cover with high reef complexity. Many large fishes were observed here: *Scarus xanthopleura*, *Naso hexacanthus, N. caesius*, and *N. vlamingii*.

SWA-51
11º02.773′ S, 171º04.878′ W
Depth Range: 4–6 m
This site is located on the north side of Swains. It was established by the REA fish team as a new sampling location in the forereef shallow stratum. This site had medium coral cover with medium reef complexity, as well as medium spur-and-groove formation. Many large fishes were observed. Large milkfish were observed.

SWA-52
11º02.767′ S, 171º04.701′ W
Depth Range: 3–5 m
This site is located at the north side of Swains. It was established by the REA fish team as a new sampling location in the forereef shallow stratum. This site had medium coral cover with medium reef complexity. Large *Scarus xanthopleura* were observed.

SWA-53
11º02.921′ S, 171º04.041′ W
Depth Range: 18–21 m
This site is located at the northeast side of Swains. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had medium coral cover with medium reef complexity. Many large *Naso* sp. were seen here.

March 17, 2008

SWA-10
11º06.320′ S, 171º07.051′ W
Depth Range: 10.9–13.6 m
This site was located on the east side of the forereef at Swains. Live coral cover was 28%, mainly made up of platy *Montipora*. Coralline algal cover represented 33% and macroalgae

(mainly *Microdictyon*) covered 32% of the benthos. A total of 7 coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 16 cases of coralline fungal disease in a survey area of 200 m^2. Macroalgae identified in the photoquadrats included crustose coralline red algae, *Microdictyon umbilicatum,* cyanophytes, *Lobophora variegata*, turf algae, *Rhipilia orientalis*, and *Peyssonnelia.* Algal species found along the random swim survey included *Caulerpa sertularioides.* Trapezid crabs and *Drupella* snails were abundant here, and *Saron* shrimp were highly abundant. This site was characterized by huge amounts of small pomacentrids. *Chromis acares* and *C. agilis* were found in very high numbers. A school of *Elagatis bipinnulata* was included in the belt-transect survey, and an off-transect sighting of *Triaenodon obesus* was recorded.

SWA-54
11º03.911′ S, 171º04.370′ W
Depth Range: 21–26 m
This site is located on the south fringing reef of Swains. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had medium coral cover with medium reef complexity. Few large fishes were observed here (some Macolor snappers).

March 18, 2008

SWA-05
11º05.589′ S, 171º09.199′ W
Depth Range: 11.2–13 m
This site was located on the west side of the forereef at Swains. Live coral cover was 26.5%, mainly made up of *Porites rus*. Coralline algal cover represented 26% and cyanophytes 44% of the benthos. Ten coral genera were recorded within the belt transects at this site, and *Pocillopora*, *Montipora,* and *Porites* were the most abundant taxa. Coral disease and health assessments revealed 1 case of bleaching, 2 cases of coralline fungal disease, and 19 cases of predation (*Drupella* and *Acanthaster*) in a survey area of 300 m^2. Photoquadrat abundances of macroalgae included cyanophytes, crustose coralline red algae, turf algae, *Lobophora variegata, Caulerpa serrulata, Galaxaura filamentosa*, and *Rhipilia orientalis.* The random swim survey produced *Dictyota. Saron* shrimp and vermetids were abundant at this site. Large schools of *Elagatis bipinulatus* dominated this site, both inside and outside the transect survey area, and undoubtedly accounted for much of the biomass here. Three large (~ 1 m long) *Chanos chanos* were also observed within the survey area at this site. A large individual *Platax orbicularis* was a rare on-transect sighting. The ubiquitous *Chromis acares* was present in the usual large numbers, and *Ctenochaetus cyanocheilus* remained the dominant acanthurid.

SWA-04
11º06.420′ S, 171º08.669′ W
Depth Range: 11.2–14 m
This site was located on the west-southwest side of the forereef at Swains. Live coral cover was 12%, mainly comprised of *Montipora* sp. Coralline algal cover represented 64% and cyanophytes 12% of the benthos.Eleven coral genera were recorded within the belt transects at this site, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health

assessments revealed only 3 cases of cyanophyte infections detected in a survey area of 300 m^2. High cover of crustose crustose coralline red algae and cyanophytes dominate the survey area. Other macroalgae found in the photoquadrats included *Microdictyon umbilicatum*, *Rhipilia orientalis*, *Caulerpa serrulata*, *Peyssonnelia*, *Dictyosphaeria versluysii*, *Lobophora variegate*, and *Bryopsis pennata.* Noted on the random swim survey was *Halimeda.* A shipwreck remnant of a large anchor chain was identified 2.5 m off the transect quadrant 1C2 and 2D1. Of note was *Bryopsis pennata* growing on top of these chain links. *Calcinus* hermit crabs and *Drupella* snails were conspicuous at this site. *Chromis acares* were the most numerous fish at this site, found in large clouds just above the reef. Occasionally *C. agilis* and *Pseudanthias pascalus* would intermingle with the *C. acares*. Small fish diversity seemed low at this site; however, *Ctenochaetus flavicauda* became more of a dominant species here, as far as acanthurids went, joining *C. cyanocheilus* as 1 of the 2 most common surgeonfishes. Of note were off-transect sightings of *Cheilinus undulates* and 12 *Lethrhinus* sp.

SWA-03
11º05.827′ S, 171º09.116′ W
Depth Range: 11.2–13 m
This site was located on the west side of the forereef at Swains. Live coral cover was 28.5%, mainly comprised of *Montipora* sp. Coralline algal cover represented 28.5% and macroalgae 35%, namely *Microdictyon*, of the benthos. A total of 6 coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 1 case of bleaching, 2 cases of coralline fungal disease, and 19 cases of predation (*Drupella* and *Acanthaster*) in a survey area of 300 m^2. *Microdictyon umbilicatum* dominated this site, while additional macroalgae identified in the photoquadrats included crustose coralline red algae, cyanophytes, turf algae, *Lobophora variegata*, *Peyssonnelia*, and *Rhipilia orientalis. Dictyosphaeria versluysii* and *Caulerpa serrulata* were recorded on the random swim survey. *Saron* shrimp, vermetids, and *Drupella* snails were observed here. Small fishes dominated this site with overwhelming numbers of *Chromis acares* hovering above the reef. *Lepidozygus tapeinosoma* was fairly common here as well, present in both color phases. Of note was an off-transect sighting of 1 midsize *Cheilinus undulatus* and 1 *Triaenodon obesus*. An additional *T. obesus* was recorded within the survey area.

SWA-16
11º05.084′ S, 171º09.224′ W
Depth Range: 13–14 m
This site was a new REA site on the northwest corner of Swains. Live coral cover was 16%, mainly made up of *Montipora* sp. Coralline algal cover represented 7.8% of the benthos. Of interest was the elevated abundance of a green didemnid tunicate, which represented over 75% of the living benthos. A total of 6 coral genera were recorded within this site's belt transects, and *Pocillopora* and *Montipora* were the most abundant taxa. Coral disease and health assessments revealed 1 case of tissue loss and 1 case of coralline fungal disease in a survey area of 150 m^2. Only a qualitative algal survey was done here. The survey area was dominanted by an invasive green tunicate that seemed to thrive not only on live coral but crustose coralline red algae, *Rhipilia orientalis, Dictyosphaeria versluysii*, and *Dictyosphaeria cavernosa. Lobophora variegata* and *Peyssonnelia* were noted as well. Further examination of this green tunicate, which was removed from crustose coralline red algae at this site, revealed that red filamentous

alga seem to live between the tunicate and CCA layer. *Saron* shrimp were abundant here. In terms of fish, this site seemed relatively depauperate compared with other forereef sites, potentially because of the high coverage of the substrate by the previously mentioned tunicate. However, this tunicate coverage did not seem to impede the amazing *Chromis acares*, *Pseudanthias pascalus*, and *Lepidozygus tapeinosoma*. Otherwise, this site was unremarkable and comparatively low in diversity.

SWA-55
11º03.911′ S, 171º04.370′ W
Depth Range: 21–26 m
This site is located on the west fringing reef of Swains. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had medium coral cover with medium reef complexity. Many large fishes were observed here, including large *Cheilinus undulatus* and a whitetip reef shark.

SWA-56
11º03.987′ S, 171º05.024′ W
Depth Range: 2–5 m
This site is located on the west fringing reef of Swains. It was established by the REA fish team as a new sampling location in the forereef shallow stratum. This site had high coral cover with medium reef complexity. Many large titan triggerfish and macolor snapper were observed.

SWA-57
11º03.277′ S, 171º05.510′ W
Depth Range: 2–6 m
This site is located on the southwest fringing reef of Swains. It was established by the REA fish team as a new sampling location in the forereef shallow stratum. This site had medium coral cover with medium reef complexity. Many large fishes were observed here, mostly macolor snapper.

SWA-58
11º03.035′ S, 171º05.535′ W
Depth Range: 20–24 m
This site is located on the northeast fringing reef of Swains. It was established by the REA fish team as a new sampling location in the forereef deep stratum. This site had low coral cover with medium reef complexity. This site was experiencing an overgrowth of didemnid tunicates. Some large fishes were observed here, mostly large *Naso* sp.

F.3. Benthic Environment

F.3.1. Algae

Quantitative algal surveys were conducted at 7 sites around Swains, American Samoa. A total of 9 species of macroalgae were recorded along survey transects: 5 species of green algae, 3 species of red algae, and 1 species of brown algae, as well as crustose coralline red algal, turf algae, and

cyanophyte functional groups (Table F.3.1.1). Additionally, one qualitative survey was performed at the REA site SWA-16, where an invasive green tunicate was noted

Table F.3.1.1.--Algal genera or functional groups recorded in the photoquadrats around Swains. Numbers indicate the percentage of photoquadrats in which an alga occurred.

Division	SpeciesName	SWA-03	SWA-04	SWA-05	SWA-06	SWA-07	SWA-08	SWA-10
	Cyanophyte	8.33	41.67	66.67	8.33	83.33	16.67	16.67
	turf algae	16.67		41.67		41.67	33.33	33.33
Chlorophyta	*Bryopsis pennata*		16.67					
Chlorophyta	*Caulerpa serrulata*		16.67	8.33				
Chlorophyta	*Dictyosphaeria versluysii*		8.33		41.67	16.67	66.67	66.67
Chlorophyta	*Microdictyon umbilicatum*	100	16.67		41.67	83.33	25	25
Chlorophyta	*Rhipilia orientalis*	16.67	66.67	25	50	66.67	66.67	66.67
Ochrophyta	*Lobophora variegata*	50	58.33	75	33.33	16.67	16.67	16.67
Rhodophyta	*crustose coralline red algae*	91.67	100	91.67	91.67	100	91.67	91.67
Rhodophyta	*Galaxaura filamentosa*			50				
Rhodophyta	*Peyssonnelia* sp.	75	8.33				33.33	33.33

F.3.2. Corals

Coral REA surveys were conducted March 16–18, 2008 at 8 forereef sites around Swains (Fig. F.2.1). Of the 8 sites surveyed in 2006, 6 were resurveyed in 2008. One new site, SWA-16, was added on the northwest forereef. Survey depths ranged between 11 and 16 m. Coral population surveys were conducted by Jason Helyer (Coral Reef Ecosystem Division) and coral disease and health assessments were conducted by Bernardo Vargas-Ángel, PhD (CRED).

F.3.2.1. Percent Benthic Cover

Percent benthic cover surveys around Swains were conducted in concert with the fish, coral population, algae, and invertebrate REA surveys at 7 different sites established prior to CRED ASRAMP cruises in 2002 and 2004, plus 1 new additional site established in 2008. At each site, line-point intercept methodology was conducted (except for SWA-16) along 2 end-to-end 25-m belt transects (51 points per transect) for a total of 756 points along 375 m of forereef coral communities. Foul weather precluded REA activities along the east and southeast facing shores, and, thus, a new REA site, SWA-16, was established on the west-northwest sector of this island.

The range of survey transect depths was ~ 11–14 m for all locales visited. Patterns of intraisland variability in percent benthic cover, derived from the 8 independent REA surveys in 2008, are reflected in Figure F.3.2.1.1. Islandwide, scleractinian corals, coralline algae, a didemnid tunicate, and macroalgae were the primary benthic components 35% (SE 6), 24.0% (SE 6.5), 16.3% (SE 9.0), and 10.2% (SE 4.9) of total benthic component cover. The greatest values for live coral cover were observed at 2 REA sites along the north-facing shore, SWA-08 and SWA-06 at 66.7% and 59.8%. Highest values of coralline algal cover were found at SWA-04 (66%, east) on the southwest facing shores. A green didemnid tunicate was conspicuously abundant along the northwest and north facing shores, particularly at SWA-16 where it had 76% cover). Of the 5 scleractinian genera enumerated along the line-point intercept transects, 3 of them—*Montipora*, *Pocillopora*, and *Porites*—contributed nearly 98% of the scleractinian cover, accounting for 71%, 18%, and 9%.

Figure F.3.2.1.1.--Mean percent cover of selected benthic elements derived from 9 independent REA surveys around Swains during during the HI-08-02 ASRAMP cruise, March 16–18, 2008. CORL: live scleractinian and hydrozoan stony corals; CALG: coralline algae; MALG: macroalgae; TALG: turf algae (on pavement, rubble, and dead coral); CYAN: cyanophyte; TUNI: didemnid tunicate; RUBB: coral rubble; and SAND: sand.

The quantitative data above documents important characteristics of the coral reef benthic assemblages, providing the opportunity to monitor for change in response to alterations in the reef environment. An abridged comparison of percent live coral cover based on surveys conducted in 2006 and 2008 is illustrated in Figure F.3.2.1.2 on the next page. For all sites visited in 2006 and 2006, except for SWA-08, percent live coral cover decreased in the order of 5% to 12%. Because of the lack of permanent stations at most of the REA sites surveyed, a rigorous statistical comparison of results is precluded.

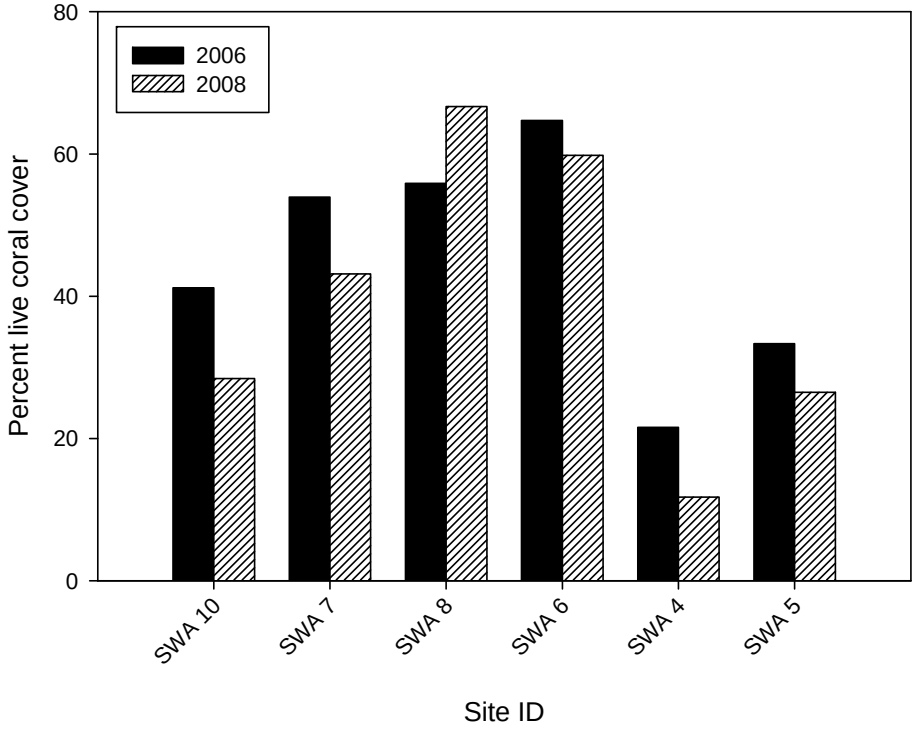

Figure F.3.2.1.2.--Percent live coral cover for 8 of the REA sites around Swains, contrasted for ASRAMP 2006 and 2008.

F.3.2.2. Coral Populations

A total of 4408 coral colonies belonging to at least 14 cnidarian taxa (11 scleractinian genera, 2 octocorals, and one hydrozoan) were enumerated within 375 m^2 of reef surveyed around Swains (Table F.3.2.2.1). Members of the genera *Montipora* and *Poccillopora* were the most abundant coral taxa in terms of number of colonies, contributing 64.4% and 26.5% of the total number of colonies recorded around Swains. Density values at individual sites ranged from 7.8 colonies m^{-2} at SWA-05 to 15.6 colonies m^{-2} at SWA-08. Generic richness values ranged from 6 coral genera recorded at SWA-03 and SWA-16 to 12 coral genera observed at SWA-08. Inspection of size histograms for corals in the genus *Pocillopora* between 2006 and 2008 shows an increase in recruitment and a more evenly distributed population structure (Fig. F.3.2.2.1).

Table F.3.2.2.1.--Number of corals, by genus, enumerated along belt transects in coral REA surveys during ASRAMP 2008. Genera contributing more than 10% of the total number of colonies are highlighted in bold.

Coral Taxon	# of Colonies	% of Total
Acropora	3	0.1
Coscinaraea	6	0.1
Favia	12	0.3
Fungia	33	0.7
Heliopora	3	0.1
Leptoseris	31	0.7
Montipora	**2838**	**64.4**
Palythoa	5	0.1
Pavona	35	0.8
Pocillopora	**1168**	**26.5**
Porites	167	3.8
Protopalythoa	3	0.1
Psammocora	46	1.0
Stylophora	58	1.3
Total	**4408**	**100**

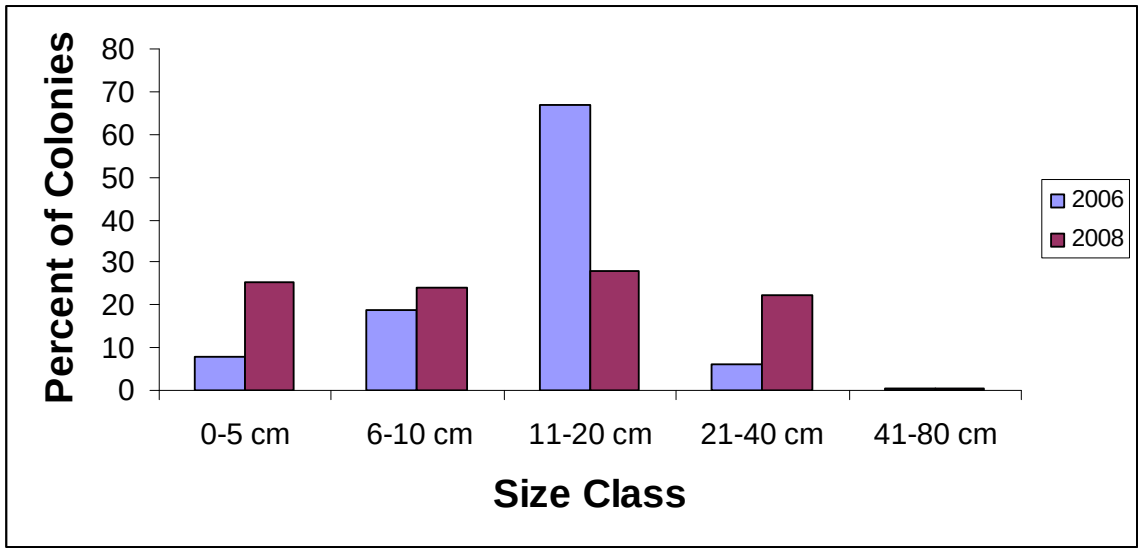

Figure F.3.2.2.1.--Size histogram of *Pocillopora* colonies enumerated within belt transects around Swains during the surveys of ASRAMP 2006 and 2008.

F.3.2.3. Coral Health and Disease

In 2008, a total area of ~ 2200 m^2 across 8 sites was surveyed for coral and coralline algae disease during REA surveys. Coral disease occurrence and abundance were low; a total of 52 cases of 9 categorized diseases and afflictions were tallied. A summary of disease occurrence, relative abundance, and taxa affected is presented in Figures F.3.2.3.1 and F.3.2.3.2. Disease of coralline algae was the most common and abundant anomaly (76% cases).

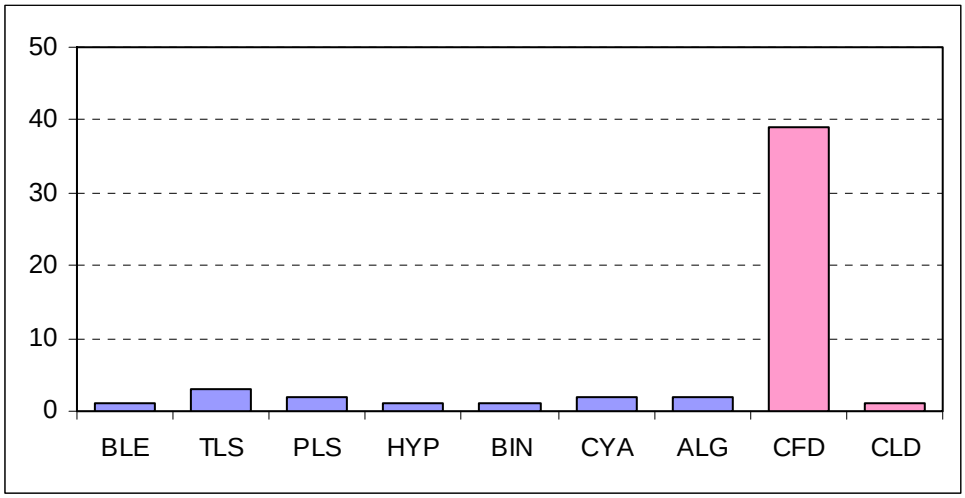

Figure F.3.2.3.1.--Number of cases of coral (blue bars) and coralline algal (pink bars) disease enumerated during REA surveys of the HI-08-02 ASRAMP 2008 cruise around Swains. BLE: bleaching; TLS: tissue loss; PLS: pink line/spot syndrome; HYP: hyperpigmented irritations; DIS: other discolorations; BIN; barnacle infestation; CYA: cyanophyte infections; ALG: algal infections; CFD: coralline fungal disease; and CLD; coralline lethal disease.

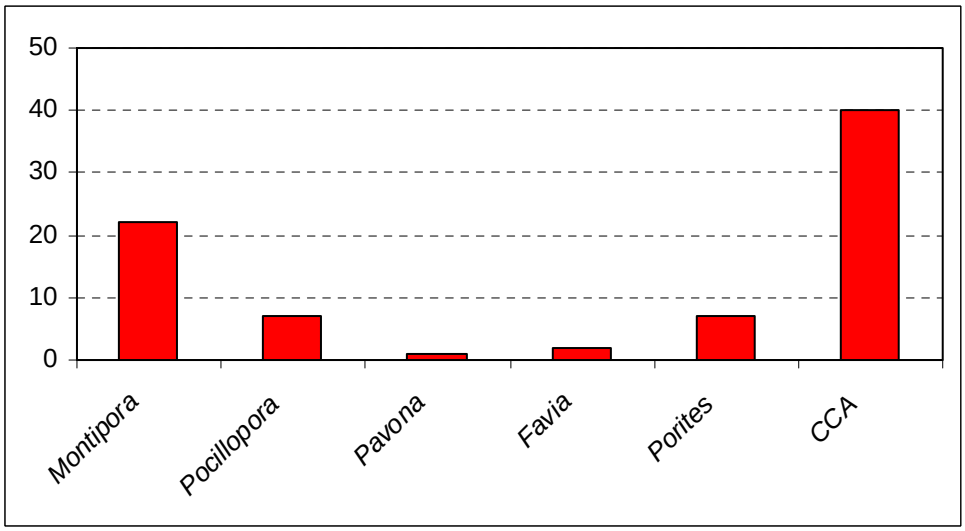

Figure F.3.2.3.2.--Percent occurrence of disease affecting coral and coralline algal taxa. CCA: crustose coralline algae.

F.3.3. Macroinvertebrates

Macroinvertebrate surveys were conducted across all sites at Swains, except SWA-07. Noncryptic invertebrates were generally found in low numbers around Swains. Few echinoderms were encountered on transect: only 2 crown-of-thorns seastars (*Acanthaster planci*), 1 each at SWA-03 and SWA-05; 1 urchin (*Diadema savignyi*); and several cryptic brittle stars at some sites. *Tridacna* clams were not found at the REA sites around Swains. Trapezid crabs and small hermit crabs, predominantly *Calcinus minutus* and another member of this same genus, were common at most sites (0.28 and 0.22 crabs m^{-2} average density across all sites for trapezids and hermits). Muricid snails were also very common at most sites around Swains. *Drupella* snails were found at an average density of 0.35 snails m^{-2} across all sites except SWA-06 (1.14 snails m^{-2}), often with clusters of individuals at feeding scars on *Montipora*. Shrimps of the genus *Saron* were highly abundant and conspicuous at most sites. Vermetids were also observed in high numbers at SWA-03 and SWA-05. As noted above in the benthic composition section, a green didemnid tunicate possibly of the genus *Diplosoma* was invasively abundant along the northwest- and north-facing reef, particularly at SWA-16 with 76% cover.

F.3.3.1. Urchin and Giant Clam Measurements

Urchins and giant clams were not measured around Swains as no clam and only 1 urchin (*Diadema savignyi*, 5.5 cm in diameter, SWA-04) were encountered near transects at forereef sites where invertebrate REA surveys were conducted.

F.3.4. Towed-diver Benthic Surveys

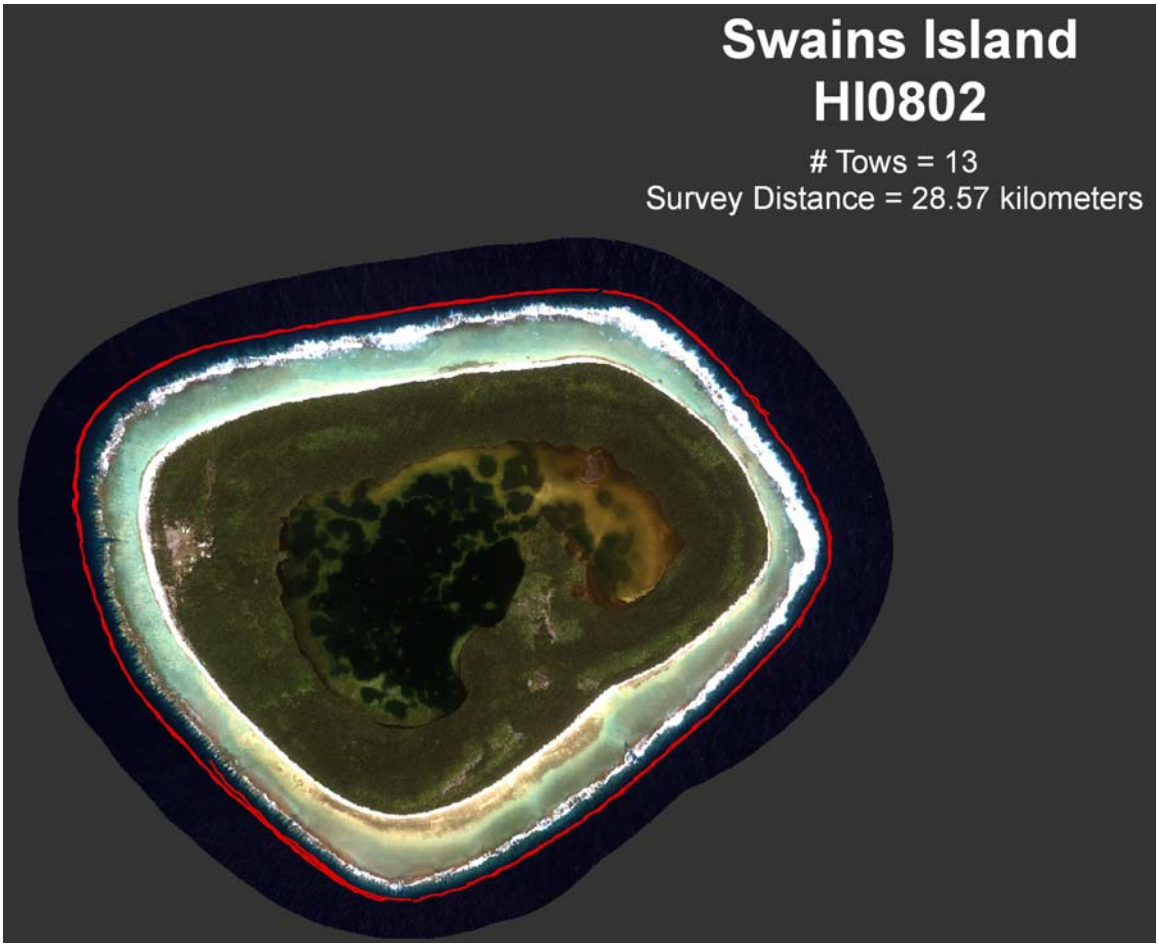

Figure F.3.4.1.--Towed-diver surveys completed around Swains.

A total of 13 towed-diver benthic surveys covering 28.57 km of benthic habitat were completed along the forereefs around Swains (Fig. F.3.4.1). The average total hard coral cover for all pooled surveys was 36.53% (range: 5.1%–75%). The highest average coral cover for any single towed-diver survey was 56.56% along a 900-meter stretch of the northeast corner (range: 40.1%–75%; 4 towed-diver segments only). Additional high levels of coral cover were recorded at 55.5% (in a range: 40.1%–75%) during a shallow-water survey (mean depth of 7.5 m) along the east-northeast side of the island, with 4 time segments of 5-min each recording hard coral cover between 62.5% and 75%. A shallow-water survey along the north coast (mean depth of 8.1 m), ending near the northwest corner, recorded 50.75% hard coral cover (range: 30.1%–75%). Coral cover was conspicuously higher during the first 6 time segments (range: 50.1%–75%), before dropping to a range of 20.1%–40% as the survey progressed towards the northwest corner of the island. The dominant coral observed during these surveys was *Montipora aequituberculata*, with *Pocillopora* (particularly in shallow water) and *Porites* (especially in deep water) also having significant benthic components. No soft coral was sighted around Swains, aside from the recording of a range of 0.1%–1% cover during a single time segment.

Hard coral stress levels averaged 6.53% for all pooled surveys (range: 0.1%–20%), and the highest stress for any single towed-diver survey was noted at an average of 11.5% (range: 1.1%–20%) along the north coast ending near the northwest corner.

The presence of an unidentified tunicate was noted in almost every towed-diver survey in both shallow (average of 7–10 m) and deep (12–20 m) surveys (Fig. F.3.4.2). This tunicate was initially identified as a Didemnidae, likely *Drumpella*, but additional examination of collected samples will be necessary for a final determination. While several large areas were affected, the highest concentrations appeared to be located along the north coast and at the northwest corner of the island. While benthic cover averages for this tunicate reached as high as 62.5% in the towed-diver segment along the northwest corner, certainly smaller areas had been completely overgrown by this tunicate to the point that it accounted for nearly 100% of bottom cover (see section F.3.2.3, "Coral Health and Disease"). Growth of this tunicate appeared to occur over live coral, macroalgae (*Microdictyon*), and coralline algae in many places, indicating a high level of aggressiveness for this tunicate

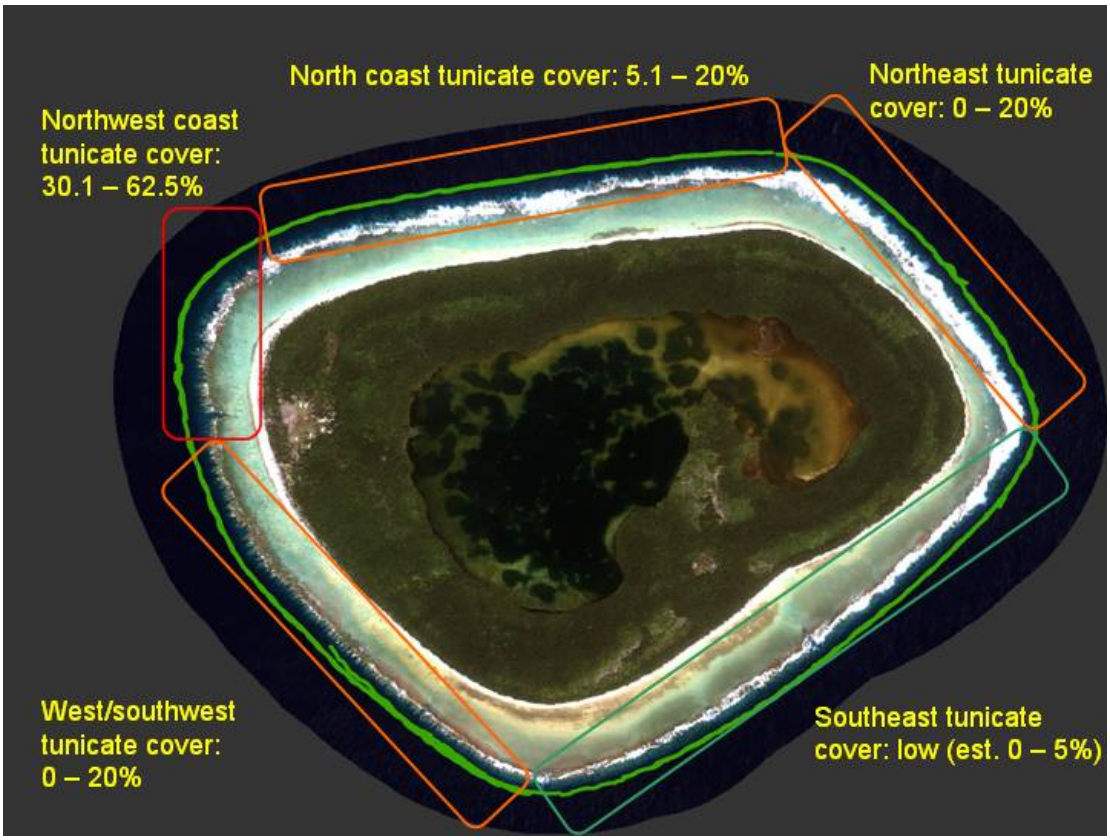

Figure F.3.4.2.--Unidentified tunicate distribution around Swains. The largest concentration of benthic growth appears to be located in the northwest, ranging from 9.1 to 18.3 feet.

Macroalgal cover averaged 30.18% for all pooled surveys (range: 1.1%–75%), and the highest macroalgae average was 48.13% (range: 10.1%–75%) for a survey completed at a depth of ~ 18 m along the leeward (west) side, passing Taulaga and ending near the south point. The predominant genus was *Microdictyon*, although other surveys noted the presence of *Dictyosphaeria (c.f. versluii)*, especially during shallow surveys. Another interesting observation was of several abrupt transitions, along the west side, between macroalgal cover and coralline algal cover, where the benthos changed from high levels of macroalgae and low levels of coralline algae to low levels of macroalgae and high levels of coralline algae. Coralline algal cover averaged 18.36% for all pooled surveys (range: 1.1%–62.5%). The highest cover at an average 35.63% (range: 10.1%–62.5%) was recorded during a survey along the southern tip of the island; however, the survey was truncated down to 2 time segments only because of weather conditions. The highest coralline algal cover recorded during a full 50-min towed-diver survey was noted during a shallow-water benthic calibration dive (between both benthic towed-divers) along the west-southwest portion of the island at an average depth of 10 m. Coralline algal cover averaged 30.25%, within a range of 10.1%–62.5% (diver 1), and 27%, within a range of 10.1%–50% (diver 2).

In general, macroinvertebrates were observed around Swains in low abundance, with only 1 giant clam, 1 free urchin, and 1 sea cucumber recorded. Crown-of-thorns seastars (COTS), however, were present, with a total of 93 individuals counted, or an average of 3.26 individuals ha^{-1} for all pooled surveys. The highest concentration of COTS was recorded at 8.09 COTS ha^{-1} at a depth of 17 m along the west-southwest coastline.

F.4. Fish

F.4.1. REA Fish Surveys

Stationary-Point Count Data (new methodology)

A total of about 34 individual stationary-point count surveys were conducted across 17 sites around Swains (site depths: 8 forereef mid, 5 forereef deep, and 4 forereef shallow). Surgeonfishes (Acanthuridae) were the largest contributor to total biomass with 1.55 kg 100 m^{-2}. Snappers (Lutjanidae) and jacks (Carangidae) were also relatively abundant with a biomass of ~ 1.0 kg $100m^{-2}$ (Table F.4.1.2 and Fig F.4.1.1).

Belt-transect Data

During this survey period, about 34 belt-transect surveys were conducted across 17 sites around Swains. Two separate milkfish (*Chanos chanos*) sightings are responsible for the elevated overall biomass recorded for this species (2.29 kg 100 m^{-2}). Snappers (Lutjanidae) and surgeonfishes (Acanthuridae) were the second and third largest contributors to total biomass with ~ 0.9 kg 100 m^{-2} (Table F.4.1.1).

Overall Observations

A total of 182 species were observed by all divers. The average total fish biomass at the sites around Swains during this ASRAMP 2008 cruise was 0.70 t ha^{-1} for the stationary-point count surveys (Table F.4.1.2) and 0.68 t ha^{-1} for the belt-transect surveys (Table F.4.1.1).

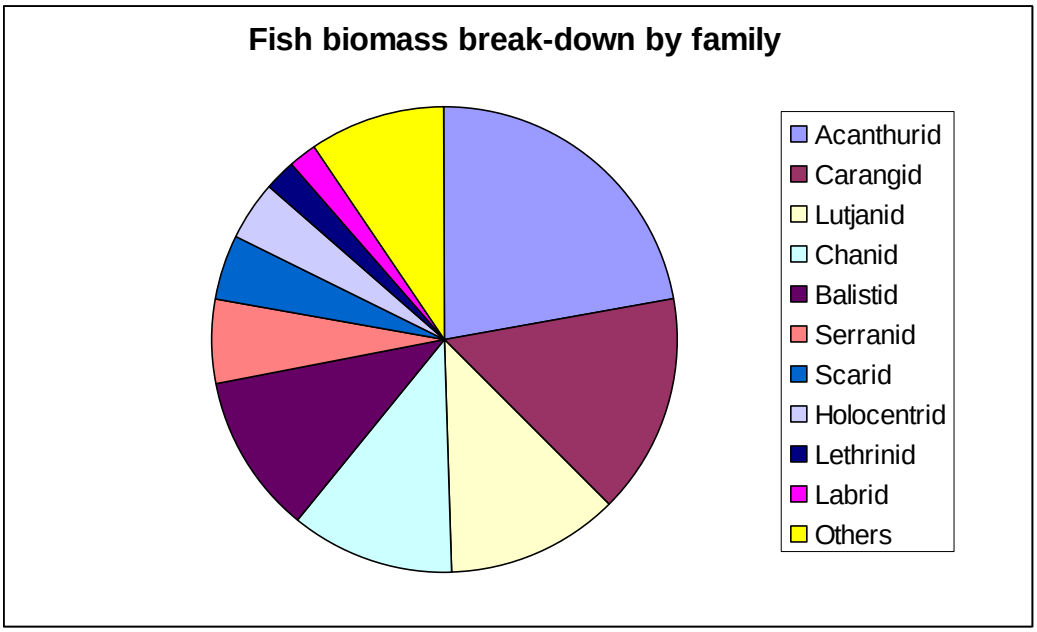

Figure F.4.1.1.--Total fish biomass composition by family, measured by the stationary-point count surveys.

Table F.4.1.1.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Swains as measured by belt-transect surveys.

Stratum Depth	Site	Total	Acanthurid	Lutjanid	Scarid	Chanid	Balistid	Serranid	Carangid	Holocentrid	Lethrinid	Labrid	Others
Forereef—Deep	SWA-50	3.90	0.58	1.84	0.00	0.00	0.38	0.11	0.00	0.34	0.00	0.03	0.62
	SWA-53	6.73	0.44	2.98	0.15	0.00	0.51	0.33	0.00	1.76	0.00	0.09	0.47
	SWA-54	4.22	0.49	1.78	0.00	0.00	0.42	0.29	0.16	0.16	0.00	0.08	0.85
	SWA-55	7.31	2.01	3.52	0.00	0.00	0.41	0.54	0.00	0.14	0.00	0.06	0.62
	SWA-58	6.08	1.78	0.45	0.86	0.00	0.16	0.11	0.00	0.72	0.00	0.19	1.82
Forereef—Mid	SWA-03	5.66	0.43	0.00	0.00	0.00	0.06	0.67	0.00	0.00	0.00	0.11	4.39
	SWA-04	2.26	0.31	0.21	0.47	0.00	0.11	0.10	0.00	0.39	0.00	0.12	0.54
	SWA-05	26.96	1.86	0.28	0.13	21.91	0.15	0.85	0.67	0.07	0.00	0.22	0.82
	SWA-06	10.69	1.79	0.03	0.00	0.00	0.14	0.00	7.86	0.00	0.00	0.04	0.83
	SWA-07	3.33	0.26	1.44	0.36	0.00	0.26	0.08	0.00	0.00	0.00	0.10	0.82
	SWA-08	1.66	0.01	0.00	0.00	0.00	0.11	0.29	0.00	0.00	0.00	0.13	1.12
	SWA-10	1.95	0.20	0.00	0.00	0.00	0.34	0.05	0.56	0.05	0.00	0.05	0.70
	SWA-16	1.18	0.17	0.00	0.00	0.00	0.34	0.29	0.00	0.00	0.00	0.10	0.28
Forereef—Shallow	SWA-51	19.66	0.60	0.00	0.27	17.06	0.79	0.10	0.00	0.00	0.27	0.30	0.27
	SWA-52	5.31	1.01	2.05	0.65	0.00	0.72	0.13	0.00	0.29	0.00	0.35	0.10
	SWA-56	5.67	0.31	0.31	0.00	0.00	3.86	0.10	0.00	0.00	0.00	0.65	0.45
	SWA-57	3.38	1.79	0.00	0.21	0.00	0.66	0.05	0.26	0.00	0.00	0.31	0.11
Average		**6.82**	**0.83**	**0.88**	**0.18**	**2.29**	**0.55**	**0.24**	**0.56**	**0.23**	**0.02**	**0.17**	**0.87**

Table F.4.1.2.--Coral reef fish biomass (kg 100 m^{-2}) at sites around Swains as measured by stationary-point count surveys.

Stratum Depth	Site	Total	Acanthurid	Lutjanid	Scarid	Chanid	Balistid	Serranid	Carangid	Holocentrid	Lethrinid	Labrid	Others
Forereef—Deep	SWA-50	9.98	2.19	2.35	0.78	0.00	2.38	0.52	0.00	0.13	0.51	0.06	1.05
	SWA-53	7.14	0.41	2.80	0.01	0.00	0.73	0.33	0.00	2.32	0.00	0.06	0.48
	SWA-54	3.58	1.18	0.92	0.00	0.00	0.41	0.32	0.00	0.12	0.09	0.04	0.50
	SWA-55	8.21	1.90	2.61	0.00	0.00	0.34	0.75	0.00	0.12	1.73	0.03	0.72
	SWA-58	7.84	2.41	1.28	0.87	0.00	0.25	0.71	0.00	1.05	0.00	0.17	1.10
Forereef—Mid	SWA-03	1.84	0.45	0.04	0.00	0.00	0.43	0.29	0.08	0.00	0.00	0.06	0.49
	SWA-04	3.02	0.59	0.52	0.00	0.00	0.35	0.60	0.00	0.42	0.00	0.09	0.46
	SWA-05	5.14	1.86	0.88	0.21	0.00	0.32	0.64	0.38	0.07	0.00	0.10	0.67
	SWA-06	24.29	9.28	0.14	0.37	0.00	0.28	0.15	13.29	0.12	0.06	0.07	0.53
	SWA-07	2.16	0.25	0.54	0.05	0.00	0.26	0.26	0.00	0.04	0.00	0.08	0.69
	SWA-08	3.76	0.05	0.00	0.46	0.00	0.18	0.28	0.21	0.00	0.00	0.06	2.52
	SWA-10	2.17	0.23	0.43	0.05	0.00	0.47	0.19	0.27	0.05	0.00	0.07	0.41
	SWA-16	1.88	0.93	0.00	0.00	0.00	0.11	0.40	0.00	0.00	0.00	0.11	0.33
Forereef—Shallow	SWA-51	17.50	0.68	0.61	0.11	13.58	1.28	0.44	0.00	0.00	0.00	0.33	0.48
	SWA-52	9.46	1.03	0.69	1.52	0.00	1.65	0.48	3.31	0.36	0.00	0.20	0.22
	SWA-56	5.98	0.69	0.50	0.00	0.00	2.70	0.39	0.28	0.05	0.38	0.65	0.34
	SWA-57	4.86	2.27	0.00	0.86	0.00	0.90	0.20	0.24	0.00	0.00	0.19	0.19
Average		**6.99**	**1.55**	**0.84**	**0.31**	**0.80**	**0.77**	**0.41**	**1.06**	**0.28**	**0.16**	**0.14**	**0.66**

F.4.2. Towed-diver Fish Surveys

Table F.4.2.1.--Towed-diver survey report for Swains.

			Survey Length (km)				Mean Depth
		N	Min	Max	Median	Sum	Average (m)
Swains Island	**03/16/08**	6	1.97	2.78	2.34	14.02	-14.73
	03/17/08	3	0.53	2.27	1.44	4.32	-14.86
	03/18/08	4	2.09	2.96	2.56	10.24	-8.64
	All	13	0.53	2.96	2.20	28.57	-12.89

N = number of surveys conducted.

Depth readings are taken at 5-s intervals during each 50-min survey and are reported as a mean depth per survey. Mean Depth Average is the median mean depth value for all surveys on a given day.

A total of 19 species of large fishes (> 50 cm in total length) representing 12 families were observed around Swains during the survey period (March 16–18, 2008). The mean number of fishes (all species pooled) observed by divers was 15.37 fish ha^{-1}. Figure F.4.2.1 presents the 7 species most frequently recorded. The blackfin barracuda (*Sphyraena qenie*) was the most abundant species observed during the quantitative surveys with a mean number of 6.77 fish ha^{-1} observed. The rainbow runner (*Elagatis bipinnulata*) was the second most abundant fish species encountered during this survey period with 2.28 fish ha^{-1} recorded. It should be noted that both of these species were observed in large schools, a circumstance that accounts for their high density. The sleek unicornfish (*Naso hexacanthus*) was the third most frequently recorded species, but it did not occur in large schools.

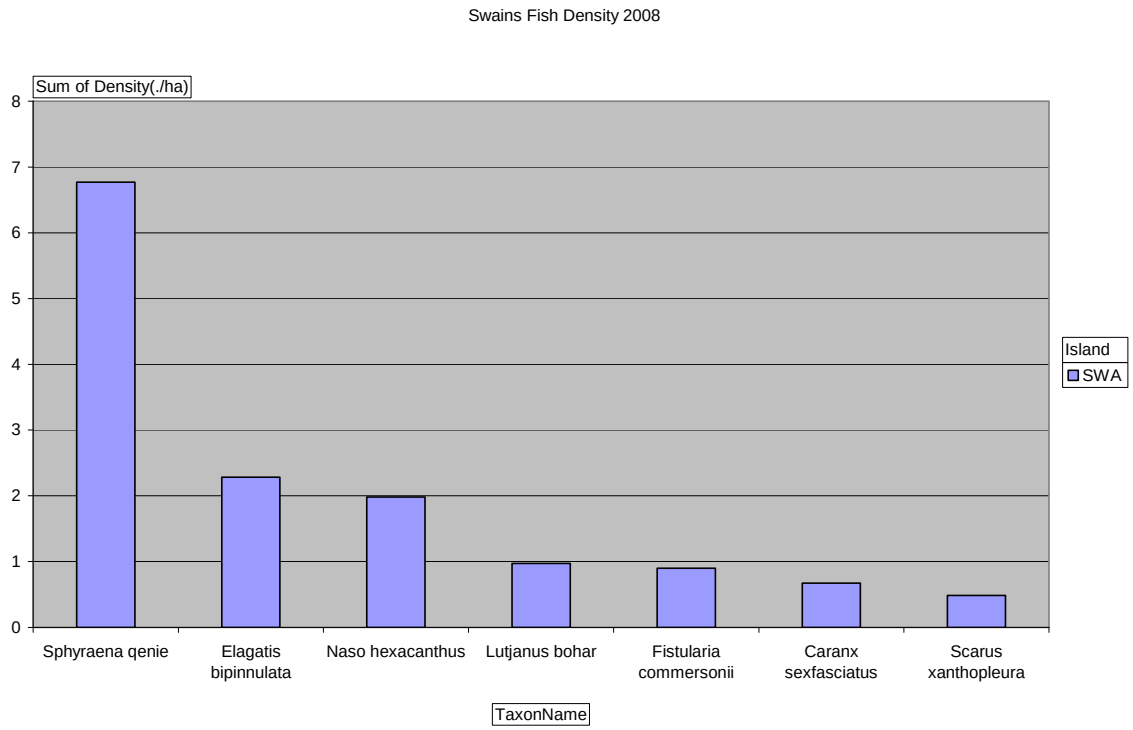

Figure F.4.2.1.--Density of the 7 species most frequently recorded around Swains.

The grand mean biomass density of fish observed on the shallow reefs (< 30 m) around Swains during this survey period was 0.044 t ha^{-1}. The blackfin barracuda (*Sphyraena qenie*) and the tawny nurse shark (*Nebrius ferrugineus*) together accounted for 57% of the total mean biomass (Fig. F.4.2.2). One very large tawny nurse shark measuring 2.3 m was recorded, and its large size put it second in terms of largest biomass observed around Swains.

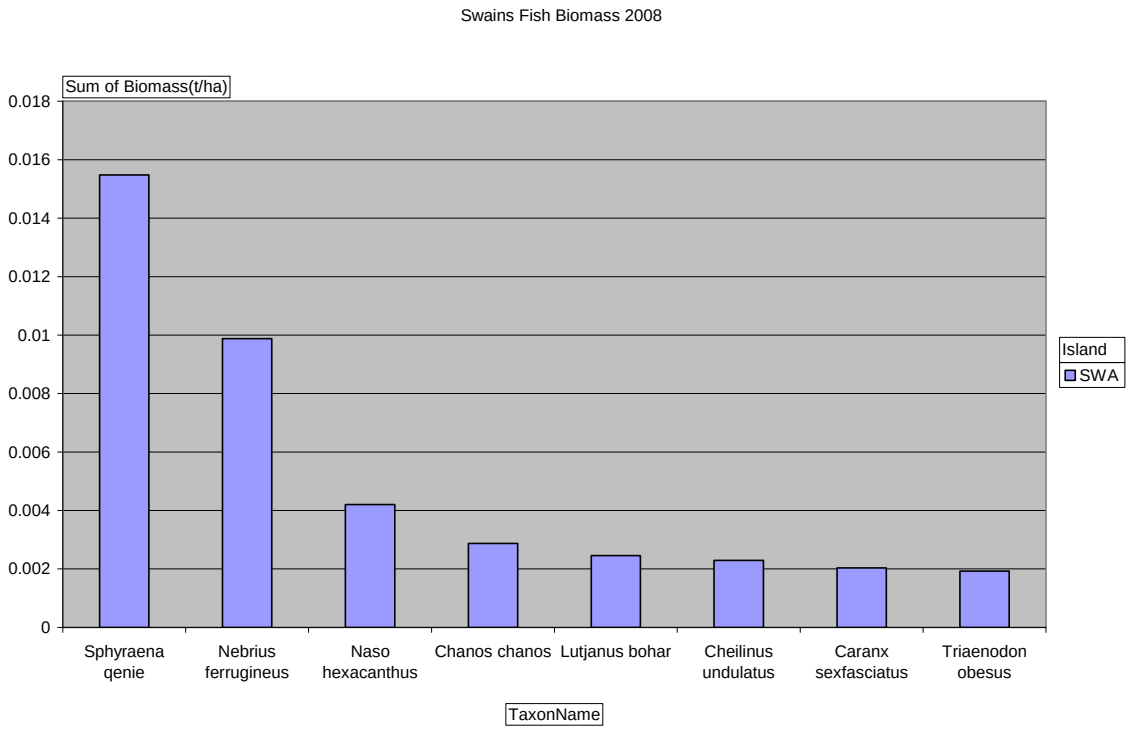

Figure F.4.2.2.--The 8 species with the highest biomass around Swains.