CRUISE REPORT[1]

VESSEL:	*Hi`ialakai*, Cruise 06-01 (Fig. 1)
CRUISE PERIOD:	15 January-6 February 2006
AREA OF OPERATION:	Johnston Atoll, Howland and Baker Islands (U.S. Phoenix Islands)
TYPE OF OPERATION:	Personnel from the Coral Reef Ecosystem Division (CRED), Pacific Islands Fisheries Science Center, National Marine Fisheries Service (NMFS), NOAA, conducted reef assessment/monitoring and mapping studies in waters surrounding Johnston Atoll and the U.S. Phoenix Islands.

ITINERARY:

15 January — Start of cruise. Embarked Craig Musburger (fish), Sarah McTee (fish), Paula Ayotte (fish), Jim Maragos (coral), Bernardo Vargas Angel (coral disease), Molly Timmers (invertebrates), Peter Vroom (algae), Meghan Dailer (algae), Ben Richards (towboard/fish), Stephane Charette (towboard/fish), Elizabeth Keenan (towboard/habitat), Amy Hall (towboard/habitat), Ron Hoeke (moorings), Kyle Hogrefe (moorings), Jamie Gove (moorings), Joyce Miller (mapping), Jeremey Jones (mapping), Joe Chojnacki (mapping), LeeAnn Woodward (terrestrial), Chris Eggleston (terrestrial), Suzy Cooper Alletto (data manager), Rocky Heikkenin (chamber operator). Departed Aloha Tower at 1000 and cruised at a 200-m isobath from Honolulu Harbor towards Barber's Point to calibrate oceanographic instrumentation. An introductory meeting was held for all scientific personnel and new crew members at 1300, followed by ship's drills in the late afternoon. The terrestrial team conducted pelagic bird surveys during daylight hours.

16 January — Transit day. A dive safety meeting was organized by CRED dive masters at 0900. At 1300, scientific divers who had never been inside a decompression chamber were mustered for a 10-minute stint in the chamber. This was followed by an injured diver drill that involved all scientific personnel. At 1500, all scientific personnel and ship's crew with

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equator-crossing experience gathered for an equator-crossing planning meeting. The Operations Officer (Sarah Jones), the chief boatswain (Mark O'Connor), oceanography team lead (Kyle Hogrefe), and Chief Scientist (Peter Vroom) met to discuss coxswain issues between the *Hi`ialakai* and oceanography team. The terrestrial team conducted pelagic bird surveys during daylight hours.

17 January	Transit day. At 1300, a planning meeting for our 7 days at Johnston Atoll was held. The terrestrial team conducted pelagic bird surveys during daylight hours.
18 January	A deepwater conductivity-temperature-depth (CTD) cast to 2500 m was conducted southeast of Johnston Atoll at ~0200. Arrived at Johnston Atoll ~0600. The tow team completed five tows: three on the west to northwest backreef, and two on the west to northwest forereef. The fish and benthic rapid ecological assessment (REA) teams monitored three established sites (JOH-01, JOH-02, and JOH-03) located in lagoonal areas north of Johnston Island. The oceanography team retrieved a wave and tide recorder (WTR) southwest of Johnston Island and replaced it with a new one. The sea surface temperature (SST) buoy deployed in 2004 was missing, but a new one was deployed at the site of the missing buoy. The *Acoustic Habitat Investigator (AHI)* mapped the north to northwest forereef of the atoll at depths from 10 to 250 m. The terrestrial team landed on the north side of Johnston Island for a 3-day census of seabird populations. Multibeam mapping from the *Hi`ialakai* was conducted during overnight.
19 January	Continued work at Johnston Atoll. One deepwater CTD was collected during early morning hours. The tow team completed five tows along the northern forereef, and conducted one camera test dive. The REA teams assessed three new sites on the northern forereef (JOH-14, JOH-15, JOH-16), although because of strong surge, the algae team only collected quantitative data from two sites. The oceanography team completed 12 CTD casts long the northern forereef and conducted water sample profiles at 2 of these cast sites. They also installed a subsurface temperature recorder (STR) on the anchor of the SST. The *AHI* mapped the north to northeast forereef of the atoll at depths from 10 to 250 m and continued some mapping along the south reef slope. Multibeam mapping from the *Hi`ialakai* was conducted during overnight. The terrestrial team remained on shore on Johnston Island.
20 January	Continued work at Johnston Atoll. One deepwater CTD was collected during early morning hours. The tow team completed

three tows along the northeast forereef, and had to abort two tows south of Johnston Island because of poor visibility and heavy sea conditions. The REA teams monitored three established sites southeast of Johnston Island (JOH-06, JOH-07, JOH-08). The oceanography team completed 10 CTD casts and conducted a water sample profile at one of these sites; they also replaced two STRs. The *AHI* mapped the south side of the atoll at depths from 10 to 250 m. Multibeam mapping from the *Hi`ialakai* was conducted during overnight. The terrestrial team remained on shore on Johnston Island.

21 January — Continued work at Johnston Atoll. One deep water CTD was collected during early morning hours. The tow team completed four tows along the north backreef. The REA teams monitored three established sites: two southeast and south of Johnston Island (JOH-09, JOH-11), and one north of the main channel (JOH-12). The oceanography team completed 11 CTD casts, 1 water sample profile, and replaced 2 STRs. They also picked up the terrestrial team from Johnston Island and transported them back to the *Hi`ialakai*. The *AHI* mapped one gap on the east side of the atoll at depths from 10 to 250 m and continued circumnavigating the island. The terrestrial team was picked up from Johnston Island, and they reported that they surveyed boobie, frigate Bird, tropic Bird, and tern populations on the east end of the island. Boobie populations rose from ~0 in 2004 to hundreds during this 2006 survey. The terrestrial team also checked the condition of existing seawalls and reported that some along the north shore of the island have degraded considerably. Multibeam mapping from the *Hi`ialakai* was conducted during overnight.

22 January — Continued working at Johnston Atoll. One deepwater CTD was collected during early morning hours. The tow team completed five tows: three in the southern middle portion of the lagoon, and two on the west end of the atoll. The REA teams monitored three established sites in the northern lagoon (JOH-04, JOH-05, JOH-10). The oceanography team completed five CTD casts and conducted a water sample profile at each site (2 samples per profile for a total of 10 nutrient and 10 chlorophyll samples collected). They also provided transit support to and from Sand Island for the U.S. Fish and Wildlife Service (USFWS) terrestrial team. The *AHI* finished mapping gap fills around the atoll. The terrestrial team visited Sand Island to survey bird populations. Night time operations consisted of one acoustic Doppler current profiler (ADCP) box transect with a deepwater CTD at each corner (four total). Nutrient and chlorophyll samples were collected at each deep water CTD station.

23 January	Continued working at Johnston Atoll. The tow team completed four tows in the west and east sections of the lagoon. The REA teams assessed three new sites located on the western forereef (JOH-17), the north side of Johnston Island (JOH-18), and the northern backreef (JOH-19). The oceanography team completed one CTD cast, provided transit support to and from Hikina Island for the USFWS terrestrial team, and helped Jim Maragos reassess three of his permanent transect sites. The *AHI* filled in additional gaps around the island, and the mapping team on the *Hi`ialakai* mapped a southern gap during daylight hours. The terrestrial team assessed bird populations on Hikina Island and noted that there was a large population of sooty terns. The terrestrial team also inspected seawalls. Departed for Howland Island.
24 January	During early morning hours, we veered slightly off-course to pass over Hutchinson Seamount (~115 kilometers south of Johnston Atoll) where we collected ADCP and mapping data. Continued transit to Howland Island. The terrestrial team conducted pelagic bird surveys during daylight hours. At 1000, a meeting with scientific personnel was conducted to discuss cruise report responsibilities and dive master issues. At 1300, Vroom, Miller, Hogrefe, the CO, and FOO met to discuss planned operations for Howland and Baker Islands. At 1900, an equator-crossing planning meeting was held.
25 January	Continued transit to Howland Island. The terrestrial team conducted pelagic bird surveys during daylight hours. A man overboard drill was held mid-afternoon. At 1930, an equator-crossing planning meeting was held.
26 January	Continued transit to Howland Island. The terrestrial team conducted pelagic bird surveys during daylight hours. A man overboard drill was held at sunset. At 1930, an equator-crossing planning meeting was held.
27 January	Continued transit to Howland Island. The terrestrial team conducted pelagic bird surveys during daylight hours. We arrived at Howland Island ~1700 and commenced 8 deepwater CTDs, 5 deepwater sample profiles (5 samples per profile for a total of 25 nutrient and 25 chlorophyll samples), and 2 ADCP transects. At 1900, an equator-crossing planning meeting was held.
28 January	Began field operations at Howland Island. The tow team completed three tows along the western side of the island, but had

to abort two tows at the northern and southern tips because of unsafe oceanographic conditions. The REA teams monitored three established sites on the west side of the island (HOW-14P, HOW-05P, and HOW-11P). The oceanography team assisted getting the terrestrial team ashore. The terrestrial team was ferried to the island in an inflatable by a ship's coxswain but needed additional assistance. The oceanography team then completed 25 CTD casts and conducted water sample profiles at 3 sites (4 samples per profile for a total of 12 nutrient, 12 chlorophyll, and 3 microbiota samples collected). The *AHI* successfully mapped 10- to 300-m depths around the island. Multibeam mapping from the *Hi`ialakai* was conducted during morning hours. During evening hours 4 deepwater CTDs were conducted, water sample profiles collected (5 samples per profile for a total of 20 nutrient and 20 chlorophyll samples), and 3 ADCP transects completed.

29 January

Continued field operations at Howland Island. The tow team finished circumnavigating the island by completing three tows along the eastern side. They then picked up Jim Maragos from the 10-m boat and helped him deploy permanent transect pins at one of his long-term monitoring sites. The REA teams monitored three established sites: two on the west side (HOW-16, HOW-08), and one on the south side (HOW-10). Current at HOW-10 picked up substantially during the dive, making the return to the boat difficult. The oceanography team completed 4 CTDs and conducted water sample profiles at each CTD site (4 samples per profile for a total of 16 nutrient, 16 chlorophyll, and 4 microbiota samples collected). The oceanography team also searched for two STRs placed on the north and east sides of the island in 2004. The eastern STR was probably washed away, but the northern STR is probably still in place. However, it was unreachable because of a 2-3+-knot current. Multibeam mapping from the *Hi`ialakai* was conducted during morning hours. The *AHI* was not deployed. The terrestrial team was picked up from Howland Island by ship's crew and reported that their bird survey found the island very dry with few birds. There were many young chicks dying of hunger. The terrestrial team was also able to get Global Positioning System (GPS) base stations charted. Evening operations consisted of multibeam mapping before leaving for Baker Island. An ADCP transect was run during transit.

30 January

Arrived at Baker Island. One deepwater CTD was conducted in early morning hours before daily field operations began. The tow team completed six tows, successfully circumnavigating the island. The REA teams monitored three established sites on the eastern and southern sides of the island (BAK-16P, BAK-09, BAK-02), although strong current at BAK-16P prevented quantitative algal data from being collected. The oceanography team swapped an Ocean Data Platform (ODP) on the eastern shelf, and replaced three STRs. The *AHI* circumnavigated the island four times, thus completing shallow water multibeam mapping operations, and conducted one deepwater CTD. The *Hi`ialakai* also circumnavigated the island three times while conducting daytime multibeam mapping. The terrestrial team was put ashore during mid-morning hours by the ship's crew. Five deep water CTDs were conducted during evening hours, and water sample profiles collected (5 samples per profile for a total of 20 nutrient and 20 chlorophyll samples).

31 January — Continued field operations at Baker Island. The tow team completed two tows on the eastern and southern parts of the island, and then conducted four site familiarization dives on the western side of the island. The REA teams attempted to conduct two REA dives on the north shore, but currents proved too strong. Instead, three established sites on the western side of the island (BAK-07, BAK-05P, and BAK-11P) were surveyed. The oceanography team placed two 250-lb. SST anchors on the eastern shelf of the island. Then they completed 26 CTD casts and conducted water sample profiles at 4 sites (4 samples per profile for a total of 16 nutrient, 16 chlorophyll, and 4 microbiota samples collected). One line of multibeam mapping was conducted from the *Hi`ialakai* during early morning hours. The terrestrial team remained on shore.

1 February — Continued field operations at Baker Island. The tow team completed two tows on the eastern bank of the island, and took video of sites on the western side. The REA teams conducted a deep dive (30.5 m) off site 5P on the western side of the island to collect sediment samples from under chains and anchors for the USFWS. The REA team then monitored two established sites on the southern side of the island (BAK-03, BAK-06). The oceanography team deployed an SST buoy on the eastern shelf of the island, placed a pinger on the ocean data platform (ODP), and replaced an STR on the southern side of the island. The ship's crew picked up the terrestrial team from shore during mid-afternoon hours. The terrestrial team fixed the "Baker Island" sign, surveyed the bird population, collected moray eels from shallow areas for contaminant analysis, established two GPS basesites, and took multiple GPS readings from landmarks discernable from aerial photographs. As on Howland Island, Frigate Birds are faring poorly. Sooty Terns are abundant, but have yet to begin nesting. No multibeam mapping was conducted

	from the *Hi`ialakai* or *AHI*. Departed for Pago Pago. Equator-crossing ceremonies commenced in the evening.
2 February	Continued transit to Pago Pago. At 1000, a meeting with scientific personnel was conducted to discuss cruise report responsibilities and issues to bring up during the debriefing meeting to be held with the ship. Equator-crossing activities commenced at 1830.
3 February	Continued transit to Pago Pago. Equator-crossing activities commenced at 1830.
4 February	Continued transit to Pago Pago. A post cruise debriefing was held with all scientific personnel, the XO (Matt Wingate), FOO (Sarah Jones), Chief Engineer (Bob Dennis), Chief Bosun (Mark O`Conner), and ET (Mike Crumley). Fire and abandon ship drills were held in the late morning. Equator-crossing activities commenced at 1530.
5 February	Arrived in Pago Pago, American Samoa at ~0900. Disembarked Musburger, McTee, Ayotte, Maragos, Vargas Angel, Timmers, Vroom, Dailer, Richards, Charette, Keenan, Hall, Hoeke, Hogrefe, Gove, Miller, Jones, Chojnacki, Woodward, Eggleston, Cooper Alletto, and Heikkenin.

Table 1: Cruise statistics for Johnston Atoll and the U.S. Phoenix Islands.

	Johnston Atoll	Howland Island	Baker Island
Towed Diver Habitat/Fish Surveys	27	6	10
Combined tow lengths (km)	52.52	12.05	19.1
Fish Rapid Ecological Assessments	18	6	8
Benthic Rapid Ecological Assessments	18	6	8
Wave and Tide Recorders (WTR) Recovered	1	0	0
Wave and Tide Recorders (WTR) Deployed	1	0	0
Ocean Data Platforms (ODP) Recovered	0	0	1
Ocean Data Platforms (ODP) Deployed	0	0	1
SST buoys recovered	0	0	0
SST buoys deployed	1	0	1
STRs recovered	4	2	4
STRs deployed	5	3	4
CREWS buoys recovered	0	0	0
CREWS buoys deployed	0	0	0
Shallow water sample profiles taken (1 profile consists of chlorophyll and nutrient samples at 1 to 4 depths as depth allows, and a microbiota sample at the shallowest depth)	9 (26 chlorophyll, 26 nutrient, 6 microbiota samples)	7 (28 chlorophyll, 28 nutrient, 7 microbiota samples)	4 (16 chlorophyll, 16 nutrient, 4 microbiota samples)
Deep water sample profiles collected (5 samples per profile)	4 (20 chlorophyll, 20 nutrient samples)	9 (45 chlorophyll, 45 nutrient samples)	5 (25 chlorophyll, 25 nutrient samples)
Deepwater CTDs (from *Hi`ialakai* or *AHI*)	14	15	7
Shallow water CTDs	39	29	26
ADCP lines run	5	5	3
Multibeam mapping (sq. km)	992	221	256
SCUBA dives	220	80	128

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 Johnston Atoll, Howland Island, and Baker Island.

B. Conduct benthic habitat mapping of the reefs and submerged banks surrounding Johnston Atoll, Howland Island, and Baker Island using ship-based and launch-based multibeam echosounders and underwater towed cameras.

C. Deploy an array of Coral Reef Early Warning System buoys, SST buoys, subsurface ODPs, subsurface WTRs, and STRs to allow remote long-term monitoring of oceanographic and environmental conditions affecting coral reef ecosystems of Johnston Atoll, Howland Island, and Baker Island.

D. Collect water samples for analysis of nutrient and chlorophyll levels.

E. Conduct shipboard CTDs to a depth of 500 m, shallow water CTDs from small boats to a depth of ~30 m, and shipboard ADCP surveys around reef ecosystems to examine physical and biological linkages supporting and maintaining these island and atoll ecosystems.

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

G. Collect ADCP data during all transits. The ADCP unit shall be configured to collect narrow-band data in 16 meter bins (deepwater mode).

RESULTS:

See Appendices A Through D.

SCIENTIFIC PERSONNEL:

Peter Vroom, PhD, Chief Scientist, Benthic Team – Algae, University of Hawaii (UH)-Joint Institute for Marine and Atmospheric Research (JIMAR), Pacific Islands Fisheries Science Center (PIFSC)-Coral Reef Ecosystems Division (CRED)
Meghan Dailer, Benthic Team – Algae, UH-Botany
Molly Timmers, Benthic Team – Invertebrates, UH-JIMAR, PIFSC-CRED
James Maragos, PhD, Benthic Team – Corals, U.S. Fish and Wildlife Service (USFWS)
Bernardo Vargas Angel, PhD, Benthic Team – Coral disease, UH-JIMAR, PIFSC-CRED
Craig Musburger, Fish Team, UH-JIMAR, PIFSC-CRED
Paula Ayotte, Fish Team, UH-Hilo
Sarah McTee, Fish Team, UH-Zoology

Ben Richards, Towboard Team – Fish, UH-Zoology
Elizabeth Keenan, Towboard Team – Habitat, UH-Botany
Stephane Charette, Towboard Team – Fish, UH-JIMAR, PIFSC-CRED
Amy Hall, Towboard Team – Habitat, UH-JIMAR, PIFSC-CRED
Jamison Gove, Mooring Team, UH-JIMAR, PIFSC-CRED
Kyle Hogrefe, Mooring Team, UH-JIMAR, PIFSC-CRED
Ronald Hoeke, Mooring Team, UH-JIMAR, PIFSC-CRED
Jeremey Jones, Mapping Team, UH-JIMAR, PIFSC-CRED
Joyce Miller, Mapping Team, UH-JIMAR, PIFSC-CRED
Joe Chojnacki, Mapping Team, UH-JIMAR, PIFSC-CRED
LeeAnn Woodward, PhD, Terrestrial Team, USFWS
Chris Eggleston, Terrestrial Team, USFWS
Susan Cooper Alletto, Data Manager, UH-JIMAR, PIFSC-CRED
Rocky Heikkenin, Chamber Operator, U.S. Army

DATA COLLECTED:

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

(/s/Scott Ferguson) for

Submitted by: ____
Peter S. Vroom, Ph.D.
Chief Scientist

(/s/David Kennedy)
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David Kennedy
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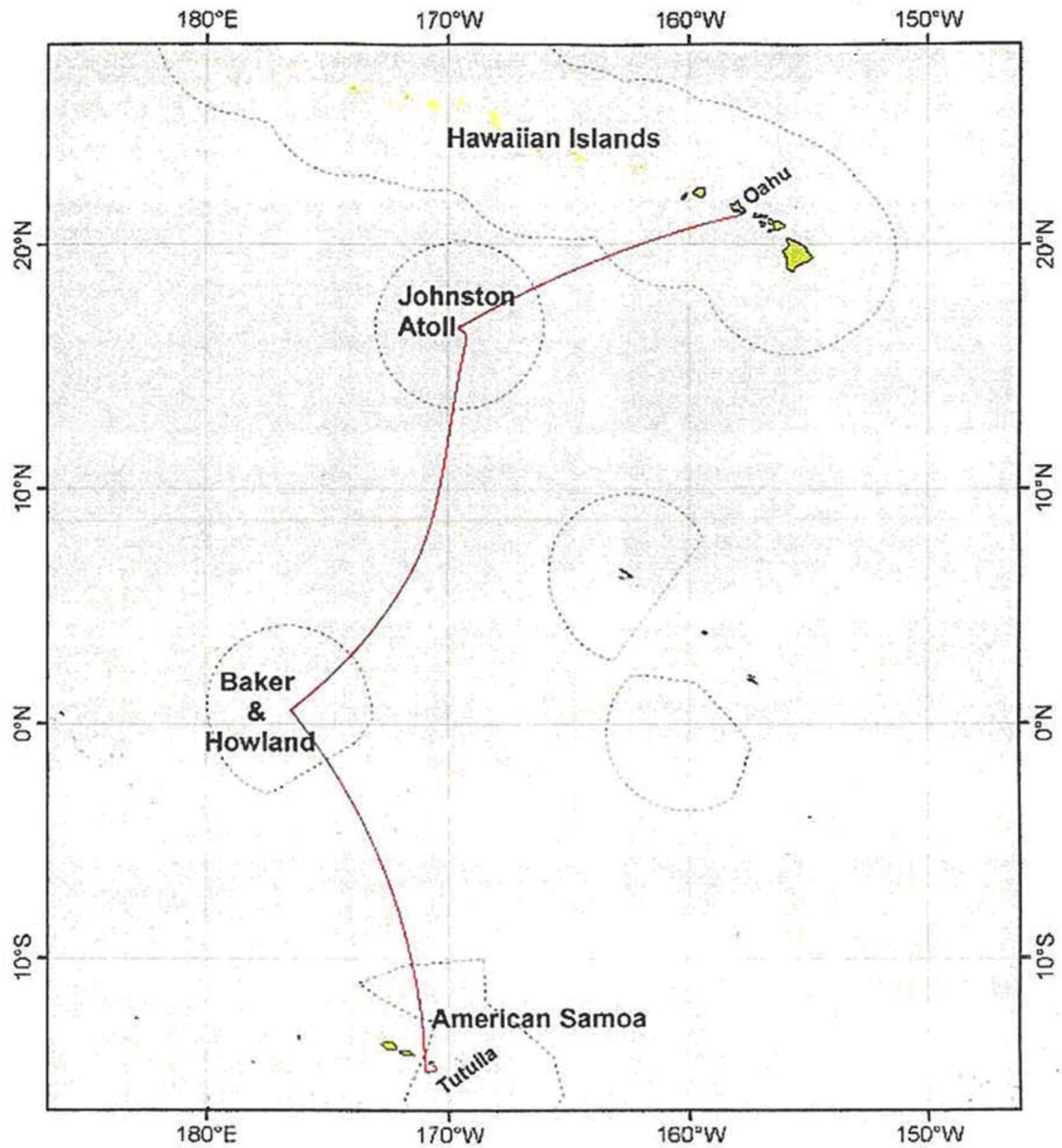


Figure 1. Track of the *Hi`ialakai* HI-06-01, January 15 – February 6, 2006.

Appendix A: Methods

A.1 Benthic Habitat Mapping Methods
(*Joyce Miller, Joe Chojnacki, and Jeremey Jones*)

Multibeam mapping operations on HI0601 were conducted using the NOAA ship *Hi'ialakai's* EM300 and EM3002D multibeam sonars as well as the Reson 8101ER sonar aboard the R/V *AHI*. Shipboard mapping was done at night when possible; however, for safety reasons and because Johnston Atoll, Howland Island, and Baker Island are very small and steep islands, mapping within 0.8 nmi of shore had to be conducted during daylight hours. The R/V *AHI* was deployed from the ship during the day in order to map shallow areas (10-250 m) where the ship cannot operate safely. Conductivity-temperature-depth (CTD) casts were done using the ship's Seabird 911 unit and the *AHI*'s Seabird 19 unit in order to provide sound velocity profiles for corrections to the multibeam data.

The performance of both shipboard multibeam sonars was superior to that observed on previous cruises. While both sonars still suffer from bubble sweep down when going into rough seas, the range of the EM300 was much improved. The EM3002 was not used extensively because of operational constraints, but its performance was also improved. On previous cruises, it was not possible to survey deeper than about 3000 m or at speeds greater than 7-8 knots; on HI0601 we were able to survey using the EM300 down to 4800+ m (the manufacturer's advertised range) and at speeds up to 10 knots. The hypothesized reason for this improvement, since no changes were made to either hardware or software, is that the ship's hull was cleaned only days before departure; the transducers may have been extremely fouled on previous cruises, thus restricting the sonars' ranges.

A.2 Oceanography & Water Quality Methods
(*Kyle Hogrefe, Ronald Hoeke, Jamison Gove, Susan Cooper Alletto*)

A. Monitoring and assessment methodology

The Coral Reef Ecosystem Division (CRED) has been conducting multidisciplinary research at Johnston Atoll since 2004 and around Howland and Baker Islands 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 an ongoing effort of monitoring and assessment. During HI0601, the oceanography team utilized both well established and new methods to monitor long-term trends and assess oceanographic conditions.

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

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

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

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

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

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

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

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

2. Oceanographic assessments are accomplished by:

a. Shallow Water CTD casts (max 30.5 meters), including turbidity measurements, are performed using an SBE 19+ at regularly spaced intervals around each island/atoll/shoal. These casts sample vertical water profiles of water properties providing indications for water mass movement and local sea water chemistry changes.

b. Water samples are collected during both shallow-water and deepwater (below) CTD casts. Water sample profiles are conducted as a subset of the shallow water CTD casts. Water samples are collected using a hand deployed Niskin bottle string at depths of 30 m, 20 m, 10 m and 1 meter as allowed by the depth at each cast site. Water is collected for nutrient and chlorophyll concentration sampling at each depth depending on the samples type(s) desired from each site.

c. Deepwater CTD casts (max 500 m) including fluorometry measurements are performed at evenly spaced intervals around each island/atoll. Water samples are collected at 150 m, 125 m, 100 m, 80 m and at the surface. These casts sample vertical water profiles of water properties providing indications for water mass movement, local sea water chemistry changes, and chlorophyll concentration.

d. Acoustic Doppler Current Profiler (ADCP) transects provide information concerning overall oceanographic structure. ADCP box transects were conducted in conjunction with deepwater CTDs around each island/atoll as well as during transits and most other vessel activity.

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

3. Chlorophyll Sampling

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

Lab preparation**:**

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

Field preparation:

Use the uniquely labeled brown rectangular 125-ml HPDE bottles for seawater sample collection. These bottles have been precisely measured for volume. Store the bottles for sample collection in the cooler marked "Water Sampling" with available "blue ice" packages. Ensure that each bottle has been thoroughly rinsed 3 times with deionized water (DIW). It is important to have brown bottles to limit further light exposure to the samples and use the "blue ice" to keep the samples cool and slow the metabolic activities of organisms present within the sample. Four Niskin bottles, four messengers, and the ~35-m deployment rope are needed to take grab samples at depth. The entire setup for water sampling can be stored in the plastic red tub. Samples are recorded on the Mooring team data log sheet for CTD and water sample casts.

Sample collection:

5.0-L Niskin bottles, deployed from a small boat, are used to collect seawater samples at various depths. The standard sampling depths are 1 m, 10 m, 20 m, and 30 meters deep, and the deployment line is marked as such. The seawater collected in each Niskin bottle is then subsampled and collected in the uniquely labeled brown rectangular 125-ml HPDE bottles. Ensure that each sample bottle is filled to the brim. The seawater samples are filtered/processed in the ship's laboratory later that night. The balance of the seawater in the Niskin bottle is discarded. On the data log sheet annotate the CTD cast ID, the PRR file(s), latitude and longitude, date, time, water depth and sample bottle number, and sample depth. For "small boat" grab samples, sample labels are constructed as follows:

a) the first three letters of the location from which the sample was taken, b) the CTD cast number - sequential for work site, c) the sample bottle number, and d) the depth at which the sample was taken. The depth notation will follow a convention of 1-m samples = "A", 10-m samples = "B", 20-m samples = "C", and 30-m samples = "D". (Example: a sample taken from Howland Island from CTD cast 003 in HPDE bottle C01 from 1 meter would be denoted HOW003C01A.) Deepwater water samples may also be taken from Niskin bottles mounted on the Ship's CTD rosette with water samples being collected from 150 m, 125 m, 100 m, 80 m and 3 meters. These "shipboard" grab samples labels are constructed as follows: a) cruise number, b) CTD cast number – sequential for entire cruise, c) the sample bottle number and depth. (Example: a sample taken during HI0601 from the 21st cast of the cruise collected in HPDE bottle C16 from 125 meters would be denoted HI0601021C16_125.)

Sample processing:

Once back in the lab with the seawater samples, prepare individual labels for each sample on lab tape, identifying the sample ID, using the label convention mentioned above. Place one label on one chlorophyll tube. Prepare the vacuum system by thoroughly rinsing the filtration funnels and filter grids with DIW. Using forceps, which are DIW rinsed and dried with Chemwipes, place one 25-mm GFF filter per filter grid and secure the filtration funnel on top of the filter/filter grid assembly. Pour the seawater sample from the 125-ml bottle into the funnel and turn on the vacuum to draw water through the filter. Rinse the 125-ml bottle with DIW, shake and pour the rinse into the filter funnel to be filtered as well. Also, rinse the sides of the funnel with DIW to ensure that the entire sample has passed through the filter. The vacuum system CRED has is an in-line three-filter system which allows three samples to be drawn at the same time. The vacuum draw on each funnel can be controlled with a nozzle control found at the base of each funnel. After the entire sample has been filtered, turn off the pump and disconnect the funnel. Remove the filter with DIW rinsed forceps, fold it twice so that it fits in the tube and place the sample filter in its appropriately labeled chlorophyll tube. Be careful not to cross contaminate the samples while folding the filters and placing them in the tube. This can be done by restricting your touch on the filter to the edges and by not touching the middle of the filter. Once all four filters from a water sample profile (five from a deepwater "shipboard" cast) are placed in their respective tubes, close the tubes with plastic caps and wrap all tubes from the profile in a large piece of aluminum. Label the outside of the aluminum package with just the site identifier and cast number (Example from above: Shallow-water – HOW003, Deepwater – HI0601021). The purpose of the aluminum foil is to shield the filters and samples from light. Place the samples into the ship's -30°C freezer for storage.

Logbook/Computer recording:

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

Sample turnover for analysis:

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

A.3 Rapid Ecological Assessment Methods

(Fish: Craig Musburger, Paula Ayotte, and Sarah McTee; Corals: James Maragos and Bernardo Vargas Angel; Algae: Meghan Dailer and Peter Vroom; Invertebrates: Molly Timmers)

The survey methodology used during HI0604 is the same as previously used during rapid ecological assessment (REA) surveys conducted in 2004, when long-term monitoring sites were selected and surveyed by the full REA team (fish, corals, algae, and other invertebrates). At each REA site, three 25-m transect lines were laid out by the fish team, separated from each other by approximately 2–3 m. At most sites, transects were laid out at 12.2–13.7 m except for a few shallow locations (3.7-10.7 m). REA methods for each specific discipline are as follows.

A.3.1 Fish

Fish survey methods followed the same protocols that have been used during the period from 2000 to the present in the NWHI; at the Pacific Remote Island Areas

(PRIAs) (Howland, Baker, and Jarvis Islands; Palmyra and Kingman Atolls), at American Samoa, Swains Reef, and Rose Atoll; and in Guam and the Commonwealth of the Northern Mariana Islands (CNMI). At each station, two of the three divers surveyed all of the non-cryptic fishes (day-active, > 2-cm Total Length, TL) observable within three, 25-m long belt (strip) transects totaling 600 m^2 area. The third diver simultaneously conducted four 5-min Stationary Point Counts (SPCs) totaling about 1250 m^2 for larger-bodied fishes > 25 cm TL. Divers rotated between belt transect and SPC tasks on successive dives in order to distribute unavoidable biases among tasks. The quantitative tallies were complemented by "roving diver swims" throughout the general station area (2000–3000 m^2, depending on underwater visibility). All observations were used to generate station-specific species lists.

A.3.2 Algae

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

A.3.3.1 Corals

Two coral scientists accompanied the NOAA ship *Hi'ialakai* during her visit to Johnston Atoll National Wildlife Refuge (NWR) on January 18-23, 2006. Dr. Bernardo Vargas Angel of Pacific Islands Fisheries Science Center, CRED, focused on the analysis of coral diseases and collection of line intercept transect data to quantify the coverage of benthic habitats including live coral. Dr. Jim Maragos of the U.S. Fish and Wildlife Service (USFWS) focused on coral population counts at both REA and permanently marked transect sites. In January 2004, Maragos accomplished similar investigations as part of the first NOAA-sponsored visit to Johnston Atoll, and was accompanied by Dr. Greta Aeby, now of the University of Hawaii, who accomplished the 2004 coral disease assessments. Both 2006 coral scientists also collected digital photographs and coral specimens for biodiversity, disease, and genetic analyses to be reported elsewhere. This section of the report covers the results of coral population investigations. Earlier coral studies (Maragos and Jokiel, 1986; Coles, 1996; Maragos, 2004 unpubl.) have reported about 40 species from the atoll.

Before 1998, neither Howland nor Baker Islands had been surveyed for corals. Maragos identified about 30 species of corals from specimens collected by USFWS biologist John Schmerfeld in 1998. Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division and the USFWS sponsored field studies at both islands in early 2000, 2001, 2002, and 2004, and through 2004 Maragos has listed approximately 30 genera and 90 species at each island. Before the 2004 visit, coral surveys focused on the collection of biodiversity information and the relative abundance of each coral species at REA sites, but in January 2004, coral population data were collected at Howland and Baker Islands following the methodology described in Maragos et al., 2004. The author accomplished all coral population censuses in January 2004 and was accompanied by Dr. Greta Aeby, now of the University of Hawaii, who accomplished the 2004 coral disease assessments.

The author censused corals within a meter-wide strip along the first two 25-m-long transect lines at 13 REA sites and 4 permanent transects sites, accounting for 17 of the 20 benthic sites surveyed in 2006 (except sites JOH-17, -18, and -19). Each coral whose center fell within one-half meter of either side of the transect line was assigned to a genus and one of seven size classes (1-5 cm, 6-10 cm, 11-20 cm, 21-40 cm, 41-80 cm, 81-160 cm, and > 160 cm) based upon the estimated length of each coral's long diameter. At two of the permanent sites, (JOH-01AP, -06P), the author collected photos along the line with the aid of a meter-square quadrat frame and the assistance of Susan Cooper Alletto, Ron Hoeke, and Kyle Hogrefe of the CRED Oceanographic Team. The author later censused coral populations from the quadrat photos. Additional digital photographs were collected away from the transect lines to gain information on coral species, disease, predation, etc.

Howland and Baker Islands

The author censused corals within a meter-wide strip along the first two 25-m-long transect lines at three REA sites at Howland (including all three permanent transect sites -05P, -11P, -14P) and at eight REA sites at Baker Island, including all three permanent transect sites (-05P, -11P, -16P). Each coral whose center fell within one-half meter of either side of the transect line was assigned to a genus and one of seven size classes (1-5 cm, 6-10 cm, 11-20 cm, 21-40 cm, 41-80 cm, 81-160 cm, and > 160 cm) based upon the estimated length of each coral's long diameter. The author succeeded in coral censuses in situ at four permanent transect sites and collected quadrat photos along the lines with the aid of a meter-square quadrat frame at two permanent sites (HOW-05P, BAK-16P). The author did not have time to census coral populations from the quadrat photos at the time of this report, but all past and present censuses, both in situ and photoquadrats will be evaluated and reported later. Additional digital photographs were collected away from the transect lines to gain information on coral species diversity, disease, predation, etc. Coral census data were used to calculate percent coral cover, frequency (numbers per m^2), mean diameter (cm), generic richness, and size class distributions for each site and coral genus/species.

The total reef areas censused for coral populations at Howland and Baker Islands were 200 m^2 and 450 m^2, respectively. Site descriptions and the Global Positioning System (GPS) locations of all these sites are presented elsewhere in this report. Additionally, a deeper dive survey at site BAK-05 was accomplished to collect photos and sediment samples for toxicity analyses; this site is one of two historic anchorages and small boat landings used by guano miners in the 19th century and military forces during the mid 20th century.

A.3.3.2 Coral Disease

The first two, 25-m transect lines, previously laid out by the fish team were surveyed for coral colonies by maximum diameter, genus, and health. All corals whose colony center fall within 0.5-1 meter on either side of the transect line were enumerated and assigned to one of seven size classes: < 5 cm, 6−10 cm, 11−20 cm, 21−40 cm, 41−80 cm, 81−160 cm, and >160 cm. Transect data will be used to estimate population size classes, mean diameter, frequency/density, diversity, percent cover, and other quantitative coral parameters. In addition, surveys were conducted along and beyond the first two transect lines to document incidence of coral bleaching and/or disease, and additional species of corals not occurring within transects. Relative abundance of all coral species and overall percent coral cover were visually estimated over the broader area.

A.3.4 Macroinvertebrates

The purpose of the activities for HI-06-01 was to select sites surveyed during previous rapid ecological assessments for long-term monitoring. Selection of sites was based on their year-round accessibility and their representation of the habitats present at each site. Surveys focusing on marine invertebrates other than corals were performed in conjunction with surveys of coral and macroalgae, collectively termed the benthic survey. This benthic survey was conducted collaboratively with fish surveys. This report will cover the non-coral invertebrates encountered and from this point forward any mention of marine invertebrates will mean this particular group.

Quantitative counts for specific target marine invertebrates were done along two separate 2 X 25 meter belt transects. This was followed by a zigzag pattern that extended 5 meters on either side of the transect line that was done for each of the two lines to record species not within the belt transect. The counts from these two 10 X 25 quadrats were combined for a 10 X 50 meter area.

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

These target species were:

CNIDARIA
Zoanthids – rubber corals
Actiniaria - Anemones

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

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

CRUSTACEA
hermit crabs, lobsters, large crabs and shrimp

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

The marine invertebrate species recorded and identified during the course of the field operations for HI-06-01 represent the non-cryptic fauna of the reef habitat and should not be considered the only species present at each site. There is an abundance of other organisms, both cryptic and non-cryptic, that dwells in these habitats that are not included in the rapid assessment scheme, which will be included in a final species inventory at a later date.

A.4. Towed-diver Survey Methods
(Benjamin Richards, Elizabeth Keenan, Stephane Charette, Amy Hall, Jamison Gove (alt), Ron Hoeke (alt))

The fish towboard, outfitted with a forward-looking digital video camera, recorded fish distribution and habitat complexity. The diver on this board recorded fishes larger than 50 cm total length along a 10-m swath during a 50-minute survey. The downward looking benthic towboard, affixed with a high-resolution digital camera with dual strobes, photographed the benthic substrate every 15 seconds. The diver on this board calculated substrate percentage every 5 minutes, recorded habitat type and complexity, and tallied the quantity of macroinvertebrates. Each towboard was equipped with an SBE 39 which recorded temperature and depth every 5 seconds along the tow. A Garmin GPS76Map GPS was used to record position at 5-second intervals along each tow track to georeference the collected data.

Towed-diver surveys were conducted across multiple habitats including the forereef, backreef, lagoon, and insular shelf. During the survey period, a large strong east wind greatly impacted visibility in the east central and southeast sections of the lagoon and southern insular shelf, limiting access to these areas.

A.5. Terretrial Survey Methodologies

(*LeeAnn Woodward and Chris Eggleston)*

Not provided by USFWS.

Appendix B: Johnston Atoll

B.1. Benthic Habitat Mapping

Shipboard multibeam surveys were conducted around Johnston Atoll on the nights of January 18-23 and during the day on January 23, and the *AHI* was deployed for daytime operations on January 19-23. A total of 992 sq. km were surveyed at Johnston Atoll. It was possible to map into 10-15-m water depths on the steep north, east, and west sides of the island using the *AHI*. On the larger, more gradual bank to the south, some areas in the 20-25-m depth range were not mapped because of limited *AHI* operational time. In general, the outer perimeter was mapped to depths of ~3000 m with excellent results. Two grids were created from the multibeam data: a 60-m grid of the entire data set with depths ranging from 4 to 4000+ m (Fig. B.1-1); and a 5-m grid of the shallower area limited to a lower depth of 150 m (Fig. B.1-2). The deeper grid shows a steep slope with extensive mass wasting particularly on the north and east sides of the atoll and a more gradual slope on the western side of the bank. The shallower, higher resolution grid provides detailed information showing the extent and location of rough, possibly coral rich areas.

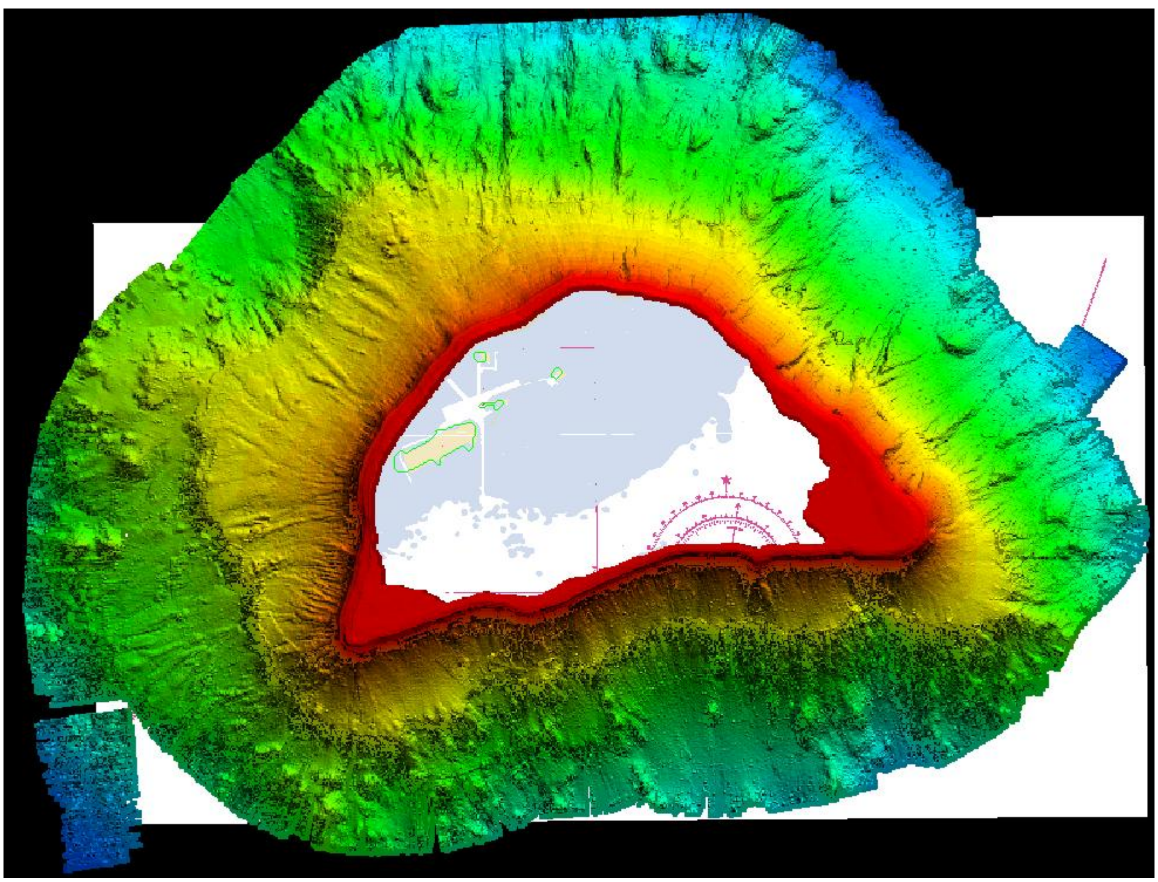


Figure B.1-1. A 60-m grid of Johnston atoll multibeam data. Depth range 4-4000 m. Extensive evidence of mass wasting is evident on slopes surrounding island.

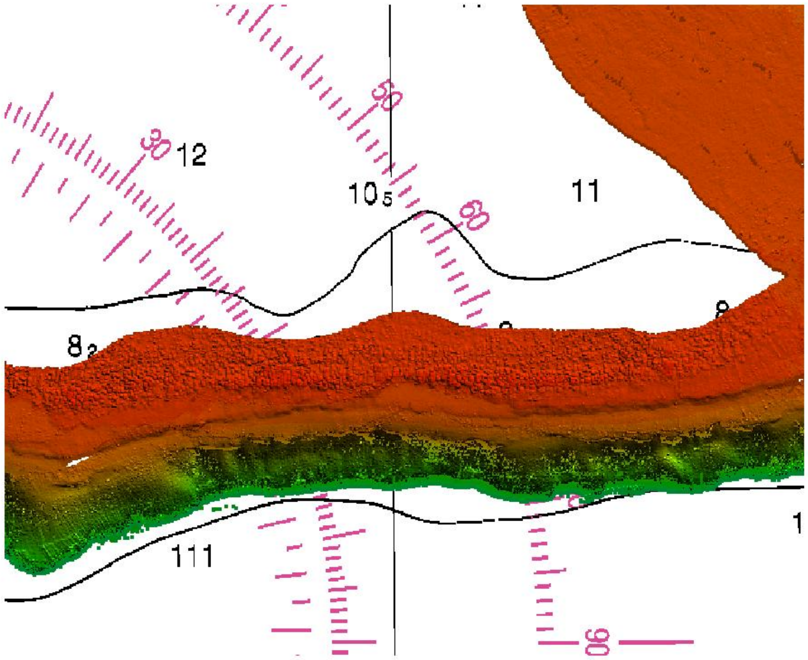


Figure B.1-2. Detail from shallow (4-150 m depth), high resolution (5-m cell size) grid of Johnston Island showing areas of high rugosity and potential coral richness.

B.2. Oceanography and Water Quality

A new ATI-sea surface temperature (SST) buoy was deployed at the established site; the previously deployed SST chaffed through the mooring line and was not recovered. This deployment was the first time the oceanography team deployed an ATI-SST with a newly configured rigging system. Because of concerns of the instrument's buoyancy, the SST is tethered to a large primary float shackled to the mooring line. One wave and tide recorder (WTR) and four subsurface temperature recorders (STRs) were recovered and replaced. An additional STR was deployed on the SST anchor to provide data for temperature profiling to enhance oceanographic monitoring and modeling (Fig. B.2-1).

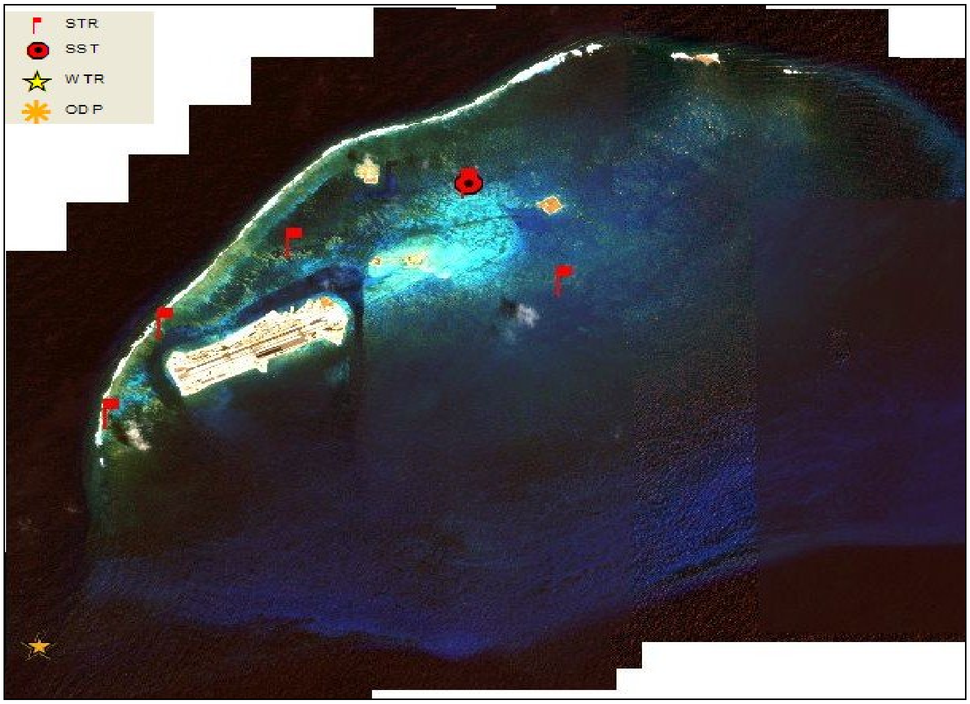


Figure B.2-1: Oceanographic instrumentation at Johnston Atoll.

Thirty-nine shallow water conductivity-temperature-depth (CTDs) were conducted around the periphery and in central locations of the shoal in 15 to 40 m of water. Water sample profiles were conducted at nine of these sites with a total of 26 chlorophyll, 26 nutrient and 6 microbiota samples being collected. Four deepwater CTD/water sample profile casts were conducted along an acoustic Doppler current profiler (ADCP) box transect around the atoll during night operations with casts conducted at the mid-point of each side of the box for a total of 20 chlorophyll and 20 nutrient samples collected. In support of the mapping effort (for the primary purpose of surface velocity profiles), five deepwater CTDs were conducted from the NOAA ship *Hi'ialakai* and six were conducted from the *AHI* to 200 m.

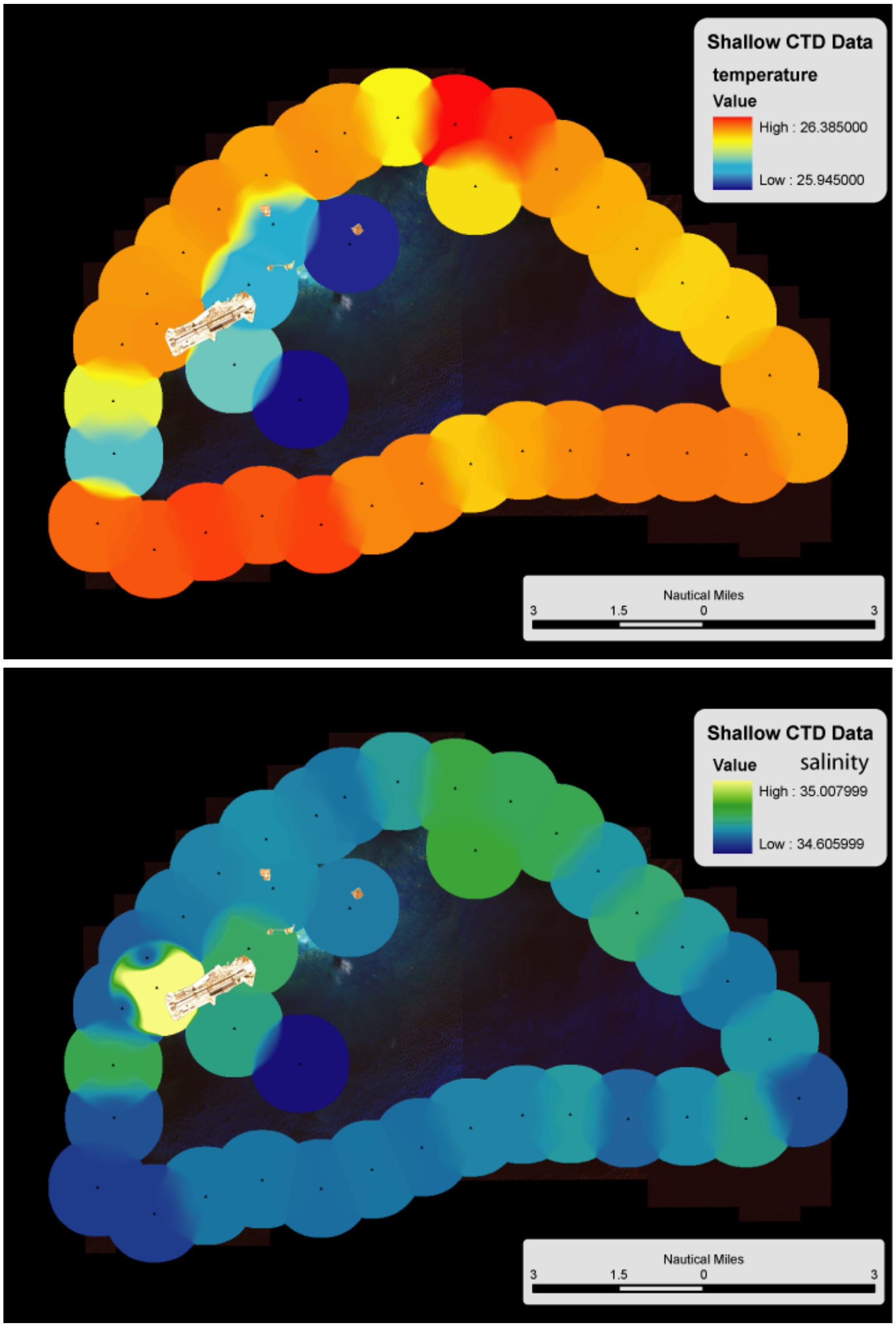


Figure B.2-2 - Interpolation of Shallow CTD casts at Johnston Atoll. Upper panel: water temperature (C°), 2-m depth bin; lower panel: salinity (psu), 2-m depth bin.

Summary analysis of the shallow water CTD data at Johnston Atoll indicate a predominance of relatively uniform well-mixed water in forereef areas, not surprising becaue of the relatively high swell and strong trades during operations (Fig. B.2-2). Surface waters at CTD sites within the lagoon and the southern reef platform were few tenths of degrees cooler than in the forereef areas, probably as a result of relatively higher latent and sensible heat loss. This cooler water appears to be exiting the lagoon near the southwest terminus of the atoll.

B.3. Benthic environment

B.3.1. Algae

- Algal surveys during 2006 reveal little difference to have occurred in algal communities since 2004. Established, long-term monitoring sites yielded almost identical species lists between the two sampling periods, and relative abundance of macroalgae or algal functional groups remained constant.
- Turf algae were the most common algal components of the benthic community in the majority of the surveyed sites.
- Green algae (*Caulerpa*, *Dictyosphaeria*, and *Ventricaria*) were the most common fleshy macroalgae found at sites in the lagoon.
- Macroalgal cover was very low, supporting the expectations for healthy coral reef environments.
- Forereef sites were assessed for the first time and revealed highly scoured reef slopes with few macroalgal species.

B.3.1.1. Algal Rapid Ecological Assessment (REA) Site Descriptions

JOH-01 1/12/04

This site was a patch reef north of Johnston Island near a dredged channel. Depth ranged from 1.5 to 7.6 meters. The site was dominated by *Acropora cytharea* and had white silt channels between coral ridges. *Ventricaria ventricosa* and *Dictyosphaeria versluysii* were the only macroalgae seen. Turf algae dominated most photoquadrats. A green crustose organism also recorded in 2004 was identified as a tunicate and not an alga.

JOH-02 1/12/04

This site was a patch reef north of Sand Island with depths ranging from 4.3 to 9.1 meters. Coral dominated this site with *Acropora* spp. being the most dominant. As in 2004, turf algae were very common in photoquadrats. A large, pinkish, pillow-like species of blue-green algae common in 2004 was still common in 2006.

JOH-03 1/13/04

Lagoon reef on the northeast side of the atoll; depths ranged from 6.1-13.7 meters. The site was characterized by coral ridges with deeper sand channels. *Halimeda teanicola*, *Microdictyon* sp., and *Dasya kristeniae* were discovered during the random swim while turf algae, crustose coralline algae, and *Lobophora variagata* were common in the photoquadrats.

JOH-14 1/19/2006

Forereef located north of Johnston Island with depths ranging from 13.7-16.8 meters. The site showed signs of heavy scour and high surge because of wave sets rolling inshore above us making photoquadrats impossible. The worn benthos contained relatively little live coral cover and was dominated by turf and crustose coralline red algae. Macroalgae observed during qualitative surveys included *Halimeda*, *Neomeris*, *Caulerpa serrulata*, *Dictyosphaeria*, and *Dictyota*.

JOH-15 1/19/2006

Forereef located north of Akau Island with depths ranging from 12.2-15.5 meters. Like JOH-14, the site showed signs of heavy scour. Although surge was still high, quantitative photoquad sampled was completed. The substrate was dominated by algal turf, crustose coralline red algae, and an encrusting brown alga (*Lobophora*?). A species of *Halimeda* and a diminutive, filamentous green alga were observed in photoquadrats sampled. No other macroalgae were found.

JOH-16 1/19/2006

Forereef located close to the northern pass with the camera stand, with depths ranging from 15.2-16.8 meters. This site was littered with the skeletons of massive, dead Acroporid table corals. Many living Acroporids were also seen. The upturned table corals and surrounding substrate were covered with crustose coralline red algae, turf, and the same encrusting brown alga commonly observed at JOH-15. A species of *Halimeda* and *Caulerpa serrulata* were recorded in some photoquadrats.

JOH-06 1/20/2006

This site was a lagoonal reef on the south ocean-facing side of the atoll with depths ranging from 14.9 to 16.5 meters. Photoquadrats sampled contained primarily turf and crustose coralline red algae, although *Halimeda* sp., *Peysonnelia* sp., *Caulerpa serrulata*, and *Caulerpa webbiana* were also encountered.

JOH-07 1/20/2006

This site was a lagoonal reef on the south ocean-facing side of the atoll with depths ranging from 10.4 to 16.8 meters. The site was characterized by coral ridges with deep sand channels, and (as was also observed in 2004) contained draperies of *Caulerpa macrophysa* (?) festooned across the substrate. Vertical walls of this reef were completely blanketed by this alga. In addition to *C. macrophysa*, photoquadrats contained turf, crustose coralline red algae, and encrusting brown alga (probably *Lobophora variegata*), *Halimeda* sp., and *Caulerpa serrulata*. As during 2004, *Caulerpa taxifolia* was found during the random swim.

JOH-08 1/20/2006

This site was a leeward lagoonal reef close to Hikina Island, and was characterized by ridges of calcified pavement with sand channels between as well as overturned *Acropora* heads. Crustose coralline red algae, turf, *Halimeda* sp., *Lobophora variegata*, *Caulerpa cupressoides*, and *Dictyosphaeria versluysii* were found in the photoquadrats. During the random swim, we found *Caulerpa macrophysa*.

JOH-09 1/21/2006

This reef was a leeward open lagoonal patch reef south of Sand Island with depths ranging from 7.9 to 11.3 meters. The site was characterized by crustose coralline algal ridges over dead *Acropora* heads separated by silt sand channels. As in 2004, crustose coralline red algae and turf algae were the dominant algae found in photoquadrats. *Caulerpa macrophysa*, *Caulerpa urvilleana*, *Caulerpa serrulata*, a species of *Halimeda*, and cyanophytes were also recorded. *Caulerpa taxifolia*, *Chrysymenia*, and *Halimeda taenicola* were found during the random swim.

JOH-11 1/21/2006

This site was a lagoonal reef located south of Johnston Island with depths ranging from 7.0 to 9.8 meters. The reef exhibited high rugosity and many recently broken *Acropora* table corals most likely as a result of high current or swell. In the photoquadrats, turf algae, crustose coralline red algae, an encrusting brown (most likely *Lobophora variegata*), *Dasya* sp., and *Bryopsis pennata* were seen.

JOH-12 1/21/2006

This site is a lagoonal patch reef directly north of the navigational channel and exhibited depths ranging from 3.4 to 10.7 meters. The site was coral dominated with very few macroalgae. In the photoquadrats, we observed turf algae, crustose coralline red algae, *Lobophora variegata*, *Ventricaria ventricosa*, and a cyanophyte.

JOH-04 1/22/2006

Lagoon reef near Akau Island; survey depths ranged from 6.7 to 7.9 meters. Reef was a linear reef with sand channels on either side. In the photoquadrats, only turf algae and crustose coralline red algae were recorded. We found *Ventricaria ventricosa*, *Dictyosphaeria versluysii*, *Caulerpa serrulata*, *Lobophora variegata*, and a cyanophyte during the random swim.

JOH-10P 1/22/2006

This site was a lagoonal reef located east of Akau Island under a white mooring buoy. Jim Maragos put in new permanent transect pins. We worked at depths between 13.1 and 15.5 meters although portions of the reef extended to about 3.1 meters below the surface. As stated in the 2004 site description: "The site was extremely coral rich and dominated by *Acropora* table corals and *Montipora* spp. Macroalgae were extremely scarce and much of the open space was occupied by a deep green tunicate that mimicked algae (what we initially referred to as "green slime"). Turf algae and a small *Ventricaria ventricosa* were found in the photoquadrat areas while a small *Caulerpa serrulata* was collected during the random swim." During this 2006 survey, we also recorded an encrusting brown (likely to be *Lobophora variegata*), crustose coralline red algae and *Dictyosphaeria versluysii* in the photoquadrats.

JOH-05P 1/22/2006

This site was a lagoonal reef next to Akau Island near a mooring buoy with survey depths ranging from 9.5 to 13.7 meters. Very large *Acropora* table corals, as well as the green slime that has now been determined as a tunicate, dominated this site. The photoquadrats contained primarily turf algae, *Ventricaria ventricosa,* and crustose coralline red algae, although some encrusting brown algae (*Lobophora variegata*?) and *Dictyosphaeria versluysii* were also observed. *Galaxaura filamentosa* was collected during the random swim.

JOH-17 1/23/2006

This forereef site was located on the extreme western side of the atoll, southwest of Johnston Island. Depths ranged from 13.7 to 15.5 meters, and strong current and murky conditions made diving a bit unpleasant. The substrate looked scoured, with lots of colonies of fire coral. All photoquadrats mainly contained a mixture of turf, crustose coralline red algae, and an encrusting brown alga. A little *Dictyota* was found during the random swim.

JOH-18 1/23/2006

This shallow reef was located adjacent to the northern edge of Johnston Island. Healthy Acroporid table corals and other coral species were dominant, and algae inside photoquadrats was essentially limited to turf, encrusting brown, crustose coralline red, and blue-green algae, although on the photoquadrat contained a minute *Caulerpa serrulata*. A species of *Dictyota* and *Dictyosphaeria versluysii* were found during the random swim.

JOH-19 1/23/2006

This was the only backreef site surveyed at Johnston Atoll. Beautiful coral colonies dominated the rugose substrate, and algae was scarce. Photoquadrats contained turf algae, crustose coralline red algae, cyanophytes, *Ventricaria ventricosa*, *Dictyosphaeria versluysii*, encrusting brown algae, and *Galaxaura filamentosa*. *Caulerpa serrulata* was f ound during the random swim.

	JOH-01	JOH-02	JOH-03	JOH-04	JOH-05	JOH-06	JOH-07	JOH-08	JOH-09	JOH-10	JOH-11	JOH-12	JOH-15	JOH-16	JOH-17	JOH-18	JOH-19	Island Average
GREEN ALGAE																		
Bryopsis											**8.3** 4.0							NA
Caulerpa				*		**33.3** 3.5	**75.0** 2.6	**16.7** 3.0	**33.3** 3.3	*				**8.3** 3.0		**8.3** 4.0	**8.3** 4.0	**10.9** (20.6) 2.9 (0.4)
Dictyosphaeria				*	**8.3** 3.0			**8.3** 5.0		**16.7** 2.0						*	**16.7** 2.5	**3.1** (5.9) 2.5 (1.5)
Halimeda						*	**8.3** 3.0	**50.0** 3.2	**8.3** 3.0				**83.3** 3.9	**66.7** 3.8				**13.5** (27.2) 2.8 (0.1)
Microdictyon			**8.3** 4.0					*										NA
Ventricaria					**66.7** 2.1					**16.7** 3.5		**8.3** 3.0					**25.0** 2.7	**7.3** (17.4) 2.3 (0.7)
RED ALGAE																		
Chrysymenia									*									
Dasya			**8.3** 4.0								**8.3** 3.0							**8.3** (0) 2.3 (2.1)
Galaxaura					**8.3** 1.0											*	**8.3** 3.0	**8.3** (0) 1.3 (0.7)
Gelidiopsis			**8.3** 5.0															NA

Laurencia/Chondrophycus			**8.3** 6.0															NA
Peyssonnelia						**83.3** 1.4												NA
branched upright coralline								**8.3** 4.0										NA
crustose coralline	**8.3** 2.0	**16.7** 1.5	**75.0** 2.0	**33.3** 2.0	**16.7** 3.0	**83.3** 2.5	**91.7** 1.5	**83.3** 1.4	**91.7** 1.5	**8.3** 4.0	**83.3** 2.7	**16.7** 2.5	**100.0** 2.5	**91.7** 1.5	**100.0** 2.8	**16.7** 2.5	**8.3** 2.0	**56.8** (38.5) 2.0 (2.8)
BROWN ALGAE																		
Dictyota															*			
encrusting brown				*	**41.7** 2.2		**8.3** 4.0	**25.0** 3.3		**41.7** 2.0	**75.0** 2.0	**75.0** 2.0	**91.7** 2.5	**75.0** 3.1	**100.0** 2.3	**50.0** 2.2	**16.7** 2.0	**50.0** (35.0) 2.3 (0.9)
Lobophora		**8.3** 2.0	**66.7** 3.0				**8.3** 4.0											**5.2** (16.6) 2.3 (1.7)
CYANOPHYTES	**8.3** 2.0	**8.3** 3.0		*				*	**8.3** 3.0			**8.3** 2.0				**8.3** 1.0	**16.7** 2.0	**3.1** (5.2) 1.9 (0.6)
TURF	**91.7** 1.0	**83.3** 1.1	**83.3** 1.0	**100.0** 1.0	**100.0** 1.0	**91.7** 1.8	**91.7** 1.5	**91.7** 1.5	**100.0** 1.4	**91.7** 1.0	**100.0** 1.0	**100.0** 1.0	**100.0** 1.0	**91.7** 1.0	**100.0** 1.0	**91.7** 1.0	**75.0** 1.0	**93.2** (7.6) 1.1 (0.5)

Table B.3.1.-1: Algae of Johnston Atoll. Bold numbers indicate the number of photoquadrats in which an alga occurred, below which is the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviations of the island averages are given in parentheses. Asterisks indicate algae found during the random swim that were not present in sampled photoquadrats.

B.3.2. Corals

Full REA surveys were conducted at 18 sites (JOH01–JOH12, and JOH14–JOH19) around Johnston Atoll by the benthic team between January 18, 2006 and January 23, 2006. Relatively good weather conditions allowed the REA team to survey a variety of habitats, including several north-northwest forereef and backreef sites, as well as shallow lagoon patch reefs protected from large northwest swells. The extended stay at Johnston Atoll (6.5 days) also allowed the REA team to visit three new sites (JOH-17 through JOH-19). These included a west forereef site, one offshore site north of Johnston Island, and one west-northwest backreef site. Dive depths ranged from 3.7 to 18.3 m. Coral species inventories, colony counts, and size class distribution were conducted by Dr. Jim Maragos, U.S. Fish and Wildlife Service (USFWS). Coral bleaching, predation, and disease assessments were conducted by Dr. Bernardo Vargas Angel, Coral Reef Ecosystems Division (CRED). REA surveys indicated that the Montiporid corals were the most abundant, particularly *Montipora capitata* and *M. patula*. Other salient coral taxa included: *Acropora cytherea*, *A. valida*, *Pocillopora*, *Pavona*, and *Porites*.

B.3.2.1 Coral populations

The total reef area censused for corals, including adjustments for high bottom rugosity at several of the sites (JOH -03,-07, -08, -09), was 1,050 m^2, including 200 m^2 at four permanent transect sites (-05P, -10P, -1AP, and -06P) originally established and surveyed in 2000. Site descriptions and the Global Positioning System (GPS) locations of all these sites are presented elsewhere in this report, and comparisons to 2000 censuses at the four permanent transects will be covered later. Coral census data were used to calculate percent coral cover, frequency (numbers per m^2), mean diameter (cm), generic richness, and size class distributions for each site and coral genus/species.

Live corals censused in 2006 at Johnston Atoll accounted for 15 of the 17 genera/species groups (except *Psammocora, Leptoseris*) known from the atoll, totaled more than 8,700 corals, and covered 171 m^2 of the bottom, and 20% of the total benthic habitat at 17 REA and permanent transects. Coral frequencies and mean diameters were smallest and generic diversity highest at the four new ocean-facing forereef REA sites (JOH-14, -15, -16, -17).

Evidence of persistent wave action and active predation by *Acanthaster planci* (crown-of-thorns sea star) were observed in the forereef and are likely the cause of reduced coral abundance. Sea star counts during the surveys yielded 4-5 per 100 m^2 at all three sites. Coral populations in protected lagoon habitats showed low generic diversity, many small colonies, and moderate diversity levels (JOH-01,-05, -12, -18). Corals at sites south of Johnston and Hikina Islands showed signs of sedimentation stress (JOH-10, -11). Corals varied at southern open lagoon sites, depending on local habitats. Mound and pinnacle habitats (JOH-03, -

07, -08, -09) supported corals from small to large size and diversity, while one site (JOH-06) supported a huge complex of Elsey's staghorn coral (*Acropora elseyi*). Backreef habitats supported the largest range of coral sizes, high coral cover, and large mean colony size (JOH-01P, -06P, -19). Most unusual about Johnston Atoll is that the otherwise prolific Pacific coral genera of *Porites* and *Pocillopora* contribute only minor fractions of the coral fauna compared to *Montipora, Acropora,* and to a lesser extent *Pavona.*

Comparisons of coral populations at the same 2004 and 2006 REA sites revealed substantial decline in corals during the past 2 years. Of the 12 sites surveyed during both visits, all showed declines in mean coral diameter, most showed major losses of larger corals, and all but one showed declines in coral cover that averaged nearly 50% at each site (Tables B.3.1-1 and B.3.1-2). The largest table corals (*Acropora cytherea*) declined from 25 in 2004 to 12 in 2006, and all but one of the 41 largest *Montipora* colonies and the 4 *Pavona* disappeared or fragmented into smaller colonies (Table 3). Despite the large increase in small *Montipora* colonies in the northern lagoon (JOH-04, -05P, -08, -09, -11, -12), all were collectively insufficient to offset the loss of many larger colonies at the same sites. All but two species declined in abundance during the 2-year period, with the exceptions being minor genera (*Fungia, Pocillopora*), barely holding their own (Table B.3.1-2).

Discussion

The decline in coral populations at Johnston Atoll between 2004 and 2006 is not easily explained. Sites during the earlier surveys may not have been exactly the same as those of the latter sites, raising the possibility of small scale spatial heterogeneity contributing to some of the lower numbers. On the other hand, all sites consistently showed smaller and less abundant corals. Although four of the eight permanently marked transects established in 2000 have now been resurveyed in 2006, analysis of the earlier data has not yet been accomplished which may support or refute the declining trends observed to date. Moreover, several adjustments were necessary to bring the total survey area for 2004 sites in line with those of the 2006 sites because the 2004 sampling areas were greater at each site and the transect protocols were not identical to those of the latter surveys. Nevertheless, most of the adjustments served to reduce the sampling areas (and number of counted corals) of the 2004 surveys, and without these corrections the declining coral trend would have been further exaggerated. Another possible explanation is that one or more periods of high waves between 2004 and 2006 preferentially injured or destroyed larger corals. Also, the possibility exists that the current sea star predation on corals in forereef habitats may have earlier affected other reef habitats at the atoll. Another possibility is that Johnston Atoll experienced a coral bleaching event since 2004 and preferentially affected genera and species known to be susceptible to warm sea surface temperatures (*Acropora, Montipora, Pavona*). Certainly the degree of observed decline warrants careful monitoring and assessment of causes during upcoming visits to Johnston Atoll National Wildlife Refuge (NWR).

Table B.3.1-1. Mean diameter of corals censused at the same 12 survey sites at Johnston Atoll NWR in 2004 and 2006 (after Maragos 2004, 2006)

site	JOH-01	JOH-02	JOH-03	JOH-04	JOH-05	JOH-06	JOH-07	JOH-08	JOH-09	JOH-10	JOH-11	JOH-12
2004	34.4	25.5	26.7	15.1	48	43.1	23.4	19.5	14.7	32	50.6	46.1
2006	22.1	18.6	16.7	8.8	20.6	36.9	16.1	7.9	10.2	18.3	23.5	21.5

Table B.3.1-2. Cover (m2) of coral genera/species at Johnston Atoll NWR for 2004 and 2006 at the same 12 sites (after Maragos 2004, 2006)

Genera/species	2004	2006
Acropora cytherea	66.57	33.77
Acropora other spp	9.72	8.35
Fungia/Cycloseris	0.007	0.03
Leptastrea/Cyphastrea	0	0.002
Millepora	3.53	0.21
Montipora capitata	75.92	37.42
Montipora patula	94.71	53.68
Montipora other spp	3.85	3.39
Pavona	21.25	3.39
Pocillopora	3.12	3.17
Porites	0.07	0.052
Sinularia	0.0007	0
TOTALS	278.7	143.5

Table B.3.1-3. The numbers of the largest corals (>160 cm diam) observed at the same 12 survey sites in 2004 and 2006 (after Maragos 2004, 2006)

Genera/species	2004	2006
Acropora cytherea	25	12
Acropora other spp	0	4
Millepora	1	0
Montipora capitata	25	1
Montipora patula	16	0
Pavona	4	0
TOTALS	70	17

B.3.2.2. Coral Disease

General observations on coral health condition. Percent live coral cover varied greatly among sites. Exposed, forereef sites exhibited relatively low percent coral cover ranging between 2 and 15 %. In contrast, some protected lagoon patch reefs and backreef sites exhibited live coral cover as high as 65 and 80%. Coral health and disease assessments were conducted along the 25-m transect line, as well as 1 m of each side of the transect line. In 2006, corals exhibiting gross morphological changes, indicative of potential health afflictions were observed at 14 of 18 sites. In 2006, we surveyed 1,750 m^2 of reef and a total of 97 different cases of 'disease' were detected; 50% of all cases occurred at two sites, JOH-05 and JOH-11. Two main types health afflictions were observed in 2006, namely tissue loss, and skeletal growth anomalies. These are in conformity with a prior health assessment conducted by Dr. Greta Aeby for 2004 (see below). Our surveys detected 27 cases of tissue loss; 60% of these occurred in *Acropora cytherea*, the rest in *Montipora* spp. Skeletal growth anomalies were more common than tissue loss lesions. A total of 70 different cases were observed, particularly affecting *Monitpora patula*, *M.capitata*, *M. incrassata*, and *M. cf. verrilli*. In species of *Montipora*, skeletal anomalies exhibited a circular or annular morphology and were generally located along colony boundaries in areas of competitive interaction with other benthic organisms (mostly algae and crustose coralline algae). In some cases, tumors were also found in the central portions of colonies. The gross morphologies of skeletal growth anomalies varied greatly among species; however, some common features included change in normal texture (rough or smooth), change in normal coloration (white, pink or blue), and protruding morphology. During our 2006 surveys, we also observed evidence of coral predation, particularly by *Acanthaster* and *Drupella*, at stations JOH-14 through JOH-17, and JOH-06, respectively.

Comparison with 2004 CruiseData. In 2004, Aeby reported over 120 cases of coral disease at 11 of 12 stations surveyed at Johnston Atoll, including (1) plague-like signs, (2) tumors, (3) patchy necrosis, (4) ring syndrome, and (5) bleaching. In 2006, we reported two main types of afflictions: tissue loss and skeletal growth anomalies. We believe that our designation of tissue loss encompasses the gross morphologies that Aeby described as 'plague-like signs, and 'patchy necroses'. Additionally, based on our observations we also think that our designation of skeletal growth anomalies groups the morphologies described by Aeby as tumors and ring syndrome. In our 2006 surveys we also observed pale coral tissues at a few sites, particularly in shallow, lagoon patch reefs. However, since coral species exhibit ample ranges of color variation, we regarded such pale appearance as a photo-adaptive mechanism, and not as evidence of bleaching. At this time, comparison between the 2004 and 2006 coral disease data is precluded, because of the need of a consensus regarding disease characterization and terminology.

B.3.2.3. Coral REA Site Descriptions

JOH-01
GPS 16° 44.369N; 169° 23.076W
Depth range 4.6-6.1 m

West-northwest lagoon patch reef. Live coral cover averaged 40%. Colony density averaged 9.7 col/cm^2; dominant coral species in descending order were *Montipora capitata, M. patula, and Acropora cytherea*. Coral Disease assessment: One colony of *M. patula* presented recent tissue loss (see pictures), and two *Acropora cytherea* with abnormal growth (Samples collected). Tissue growth anomalies were commonly observed on the underside of the tabular *Acropora cytherea*.

JOH-02
GPS 16° 44.985N; 169° 30.689W
Maximum depth 6.7 m
North–northwest lagoon patch reef. Northwest side of Sand Island. Overall live coral cover averaged 32% and mean colony density was 11.7 col/m^2. Dominant corals on the line transect in descending order were *Montipora capitata,* and *M. patula.* Disease assessment: One large colony of *Acropora cytherea* exhibited growth anomalies. Also, one large colony of *Pocillopora eydouxi* exhibited interesting morphology; reduced number of verrucae on branches

JOH-03
GPS 16° 46.247N; 169° 28.907W
Maximum depth 9.5 m
North lagoon patch reef. Overall coral cover averaged 25% and mean colony density was 7.5 col/m^2. Dominant corals on the line transect were *M. patula* and *M. capitata* which represented close to 61% of all coral taxa on the transect. Other scleractinians present in lesser abundance included *Pavona clavus*, *Montipora tuberculosa*, *Acropora cytherea*, and *A. valida*. Colonies of *Pavona varians* were also observed within 2 m along side of the transect. Disease assessment: Two colonies of *M. patula* exhibited annular white-colored growth anomalies generally surrounding dead areas or small lesions.

January 19, 2006
JOH-14
16° 445.513N; 169° 29.720W
Depth 15.2 m
West–northwest forereef site. Mean colony density was 1.6 col/m^2 and percent live coral cover was short of 2%. Crustose coralline algae were an important component of this community, representing 49% of the benthic cover. Vargas-Angel recorded six species of scleractinian corals at this site (*Fungia*, *Porites*,

Montipora patula, *Pocillpora verrucosa*, *Acropora cytherea, and* A. *gemmifera*). Additionally, two species of calcifying hydrozoa *Millepora* and *Distichopora* were observed. A fair number (visual estimate 1 m^2) of coral recruits (*Acropora cytherea* and *Montipora*) were observed, mostly in cracks and crevices, protected from *Acanthaster* predation. No diseased corals were observed 1–2 m on either side of the transect line.

JOH-15
GPS 16° 47.029N; 169° 29.404W
Depth range 14.0-15.5 m
North–northwest forereef. Percent live coral cover averaged 2.9 % and mean colony density was 3.6 col/m^2. Crustose coralline algae accounted for 43% of the live benthic cover. A relatively high number of coral recruits (*Acropora cytherea* and *Montipora*) were observed, mostly in cracks and crevices, protected from *Acanthaster* predation. This site was comparable to JOH-14. Disease assessment: No signs of disease.

JOH-16
GPS 16° 47.290N; 169° 28.435W
Depth 14.6-17.1 m
North forereef. Mean coral cover averaged 12%. Mean colony density was 0.8 col/m^2. At one time, the coral community at this site was dominated by tabular acroporids (*Acropora cytherea*). At present, most of the *Acropora* is dead, broken down, or toppled. Large dead colonies of *A. cytherea*, in growth position, were covered by crustose coralline algae, which was quite abundant at this site, and represented 83% of the benthic cover. One colony of *Acropora cytherea* exhibited signs of predation by *Acanthaster*. A salient characteristic of this site was the presence of *Acanthaster* and the relatively low percent of coral cover. Disease assessment: No diseases observed.

January 20, 2006
JOH-06
GPS 16° 41.882N; 169° 29.199W
Depth 16.5-17.7 m
South; open central lagoon; moderate current and turbid water. Coral ridges separated by sand. Transect 1 exhibited impressive thickets of *Acropora* cf. *elesyi*, while Transect 2 exhibited low live coral cover. Mean live coral cover was15% and colony density was 1.4 col/m^2. Dominant coral species at this site was *Acropora* cf. *elseyi*, followed by *A. cytherea*, *A. valida*, *A. gemmifera*, *Porites lutea/lobata/solida*. Disease assessment: No evidence of coral diseases observed. Instead, significant *Drupella* predation was observed on the *Acropora elseyi*.

JOH-07
GPS 16° 42.688N; 169° 28.799W
Depth 9.8-13.4 m

South, open central lagoon, coral ridges. Dominant coral species were *Montipora patula* and *Pavona clavus/duerdani,* and average colony density was 9.5 col/m^2. Increased water turbidity was a salient characteristic at this site. Coral cover averaged 27%. Disease assessment: One colony *M. incrassata* with blue abnormal growths (samples 013 and 060 sick and control).

JOH-08
GPS 16° 43.909N; 169° 28.977W
Depth 4.9-6.7 m

Center, open lagoon. This site exhibited elevated population of the green alga *Caulerpa* sp. and old, dead *Acropora cytherea* tables encrusted by coralline algae. Increased water turbidity was also a prominent characteristic at this site. Mean colony density was 13.6 col/m^2 and coral cover averaged 17%. Dominant coral species were *Montipora patula* and *M. capitata*. Disease assessment: One large colony of *A. cytherea* with two different types of growth anomalies (smooth and rough; see photos, one, smooth and blue, the other one pink and thorny; Sample No. 056,57, 055 healthy). Also observed were one colony of *M. patula* with growth abnormalities/irritations and one colony of *M. incrassata* with purple growth abnormalities/irritations on tips and regions of contact with algae.

January 21, 2006
JOH-09
GPS 16° 43.716N; 169° 29.139W
Depth range 6.4-12.8 m

South central lagoon. Network of coral ridges and sand channels. Percent live coral cover averaged 27% with *Montipora capitata* and *M. patula* being the dominant species and mean colony density was at 15.2 col/m^2.This community was formerly dominated by tabular *A. cytherea*; at present, mostly dead, bioeroded, and collapsed. Increased sedimentation and sediment accumulation over corals. *Caulerpa* algae were commonly present at this site. Disease assessment: Some pale morphs of *M. capitata* observed; however, bleaching not suspected. Predation marks observed on *M. patula*. Also, one colony of *M. patula* exhibiting tissue loss/bleaching along edge, as well as at some areas of interaction with algae. Also observed was one colony of *M. incrassata* with bright blue growth abnormalities/irritations on tips, as well as on areas of contact with algae.

JOH-11
GPS 16° 43.312N; 169° 31.443W
Depth range: 7.0-8.2 m

Central lagoon patch reef; south of Johnston Island. Only one transect surveyed for percent cover and disease because of lack of time. Coral cover averaged 65% and mean colony density was 10.8 col/m^2. Dominant coral species were *Montipora patula* and *M. capitata*. Adequate visibility during dive. Disease assessment: This site presented the single highest number of cases of coral growth anomalies. It's proximity to Johnston Island rises the question as to whether the high prevalence of coral growth anomalies may be related to historical human impacts. At this site, 27 cases of Montiporid growth anomalies were observed particularly in *Montipora patula*, as well as 3 cases of *Acropora cytherea* tissue loss.

JOH-12
GPS 16° 44.834N; 169° 31.432W
Depth range: 5.5-10.7 m

West-northwest, protected lagoon patch reefs, north of Johnston Island. Mountains of *Montipora*. Low sediment, clear, good visibility. Overall coral cover averaged 66 %. Dominant corals in descending order are *Montipora capitata, M. patula,* and *Acropora cythere*, and colony density was 12.5 col/m^2. Other scleractinians present on the transect included *Pavona clavus*, *Pocillopora eydouxi*, *Pocillpora verrucosa*, and *Millepora*. Disease assessment: two colonies of *M. patula* with annular growth anomalies, two cases of *M. incrassata* with growth anomalies, one growth anomaly in *Pocillopora eydouxi*, and one case of *A. cytherea* tissues loss.

January 22, 2006
JOH-14
GPS 16° 45.513N; 169° 29.720W
Depth 6.4 m

JOH04: Edge of dredged channel northeast lagoon. West side of Hikina Island. Live coral cover averaged 26% and colony density was 42.5 ind/m^2. Dominant coral species were *M. capitata* followed by *M. patula*. Disease assessment: five colonies *M. patula* exhibited growth anomalies, four colonies of *M. capitata* exhibited growth anomalies/irritations at points of competitive interactions; one colony of *A. cytherea* exhibited tissue loss.

JOH-10P
GPS 16° 45.795N; 169° 30.722W
Depth 13.4 m

Protected north lagoon in "Blue Hole" channel dredged in 1960s and now consisting of table coral mounds, east of North Island, near 2nd buoy, one of Maragos permanent sites. Mean colony density was 7.1 ind/m^2, and dominant corals in descending order were *A. cytherea, M. capitata,* and *M. patula*. Coral cover averaged 45%. Disease assessment: eight colonies of *M. patula* exhibited growth anomalies, one colony of *M. patula* paling, and four colonies *A. cytherea* exhibited tissue loss.

JOH-05P
GPS 16° 45.581N; 169° 30.704W
Depth 10.4 m

Protected north Lagoon, near blue hole. One of J. Maragos's permanent sites. Wall of *Montipora* corals and a few scattered *Acropora cytherea*. Other corals present included *Pocillpora verrucosa*, *Pavona varians*, and *Porites* sp. Live coral cover averaged 43% and mean colony density was 18 col/m^2. Disease assessment: 10 cases of growth anomalies in *M. patula* were observed. Additionally, several cases of tissue loss were detected, including two colonies of *Acropora cytherea,* two colonies of *M. patula*, and five colonies of *M. capitata*.

January 23, 2006
JOH-17
GPS 16° 41.779N; 169° 33.139W
Depth range: 15.5-18.3 m

New site; Forereef west. Mean coral cover was 7.8% and average colony density was 1.5 col/m^2. Carbonate pavement heavily grazed by echinoderms and low population of scleractinian corals probably controlled by *Acanthaster* predation. Salient corals included *Millepora*, *Motipora*, and *Distichopora*. No coral diseases were observed on the transect or along the 1-m belt off each side of the transect line.

JOH-18
GPS 16° 43.864N; 169° 32.367W
Depth 5.5 m

New site, sallow backreef site, just offshore northwest of Johnston Island. Community dominated by tables of *Acropora cytherea*. Mean percent live coral cover was 22.5% and average colony density was 1.6 col/m^2. Fair amount of dead *A. cytherea* colonies at this site; however only two cases of Acroporid tissue loss and one case of Acroporid growth anomaly were observed in the 1-m corridor along each side of the transect lines. Also one case of abnormal tissue skeletal growth was observed in *M. patula*.

JOH-19
GPS 16° 44.683N; 169° 32.182W
Depth 3.7 m

New site; shallow backreef, north of Johnston Island. Community dominated by *Montipora capitata*. Percent live coral cover on T1 was 80% and near 50% on T2; 65% on average, similar to JOH12. This site was characterized by extensive areas carpeted with *M. capitata*. Colony boundaries were difficult to discern; therefore, colony density measurement was not attempted. Several species of *Montipora* were observed along the transect, including *M.capitata, M. incrassata*, and *M. pletioformis*. *Pocillpora eydouxi* was also present in the transect. Disease assessment: three cases of Acroporid (*A. cytherea*) tissue loss and two cases of Acroporid growth anomalies. There were four cases of growth anomalies in *Monitpora* cf. *pletiformis*?

B.3.3 Macroinvertebrates

B.3.3.1. Macroinvertebrate REA site descriptions

Site narratives

JOH-01, Lagoon Reef, Max:Depth: 8.5 m, Location: North-northeast side of Johnston Island
GPS: 16 44.396, 169 32.067
Acropora and *Montipora* dominated lagoon reef habitat with high coral cover and broad sand patches. Overall low macroinvertebrate presence, with the exception of vermetid mollusks. The echinoderms, *Echniothrix calamais* and *Ecinometra mathaei*, and the holothuroid, *Bohadshia paradoxa*, were rare. The black sea cucumber, *Holothuria atra*, was common. A green didemnid tunicate was abundant throughout the site.

JOH-02, Lagoon Reef, Max Depth: 7.6 m, Location: Northeast channel near Sand Island
GPS: 16 44 985, 169 30 689
Acropora and *Montipora* dominated lagoon reef habitat with high coral cover and broad sand patches. Overall low macroinvertebrate presence, with the exception of vermetid mollusks. The collector urchin, *Tripneustes gratilla*, and the black sea cucumber, *Holothuria atra*, were rare. The paradoxical sea cucumber, *Bohadshia paradoxa*, was common. A green didemnid tunicate was abundant throughout the site.

JOH-03, Lagoon Reef, Max Depth: 14.0 m, Location: Northeast Lagoon
GPS: 16 46 247, 169 28 907
Acropora and *Montipora* dominated lagoon reef habitat with high coral cover and broad sand patches. Overall low macroinvertebrate presence, with the exception of vermetid molluscs. The holothuroids, *Holothuria atra*, *Actinopyga obesa*, and *Holothuria edulis*, and the echinoids, *Tripneustes gratilla* and *Echinometra mathaei,* were rare. The paradoxical sea cucumber, *Bohadshia paradoxa*, was common.

JOH-04, Lagoon, Max Depth: 7.6 m, Location: Northeast Lagoon near Akau Island
GPS: 16 45.513, 169 29.720
Acropora and *Montipora* dominated lagoon reef over broad sand expanses. Low abundances of macroinvertebrates with the exception of vermetids. There was a rare occurrence of the sacoglossan sea slug *Plakobranchus ocellatus*, the cone snail, *Conus leopardus*, and the holothuroids, *Holothuria atra*, *Actinopyga obesa*, and *Holothuria edulis*. The holothuriod, *Bohadshia paradoxa,* was common. Empty shells of the bivalve, *Trchycardium orbita*, were common. A green didemnid tunicate was abundant throughout the site.

JOH-05, Lagoon, Max Depth: 15.0 m, Location: South side of Akau Island
GPS: 16 45.581, 169 30.704
This site followed a wall dredge to create Akau Island. It is an *Acropora* and *Montipora* dominated reef with high coral cover. The presence of macroinvertebrates was extremely low, with the exception of vermetids. There was a rare occurance of the Chromodorididaen, *Risbecia imperialis* and the holothuriod, *Holothuria edulis*. The winged box jellyfish, *Carybdea alata* was seen in the water column along the transect. A green didemnid tunicate was abundant throughout the site.

JOH-06, Lagoon, Max Depth: 17.7 m, Location: South Lagoon
GPS: 16 41 882, 169 29 119
Acropora dominated reef. Large sand/rubble patches. *Tripneustes gratilla* was the dominate echinoid and *Actinopyga obesa* was the dominate holothuroid. The gastropod, *Morula ova* was common as well as several *Calcinus sp*. There was a high abundance of *Drupella sp*. on *Acropora elseyi*.

JOH-07, Lagoon, Max Depth: 15.9 m, Location: South Lagoon
GPS: 16 41 882, 169 42 688
High relief habitat dominated by coralline algae and *Montipora*. Overall low abundance of macroinvertebrates. *Echinothrix diadema* was the dominant echinoid followed by *Echinometra mathaei*.

JOH-08, Lagoon, Max Depth: 9.8 m, Location Central Lagoon near Hikina Island
GPS: 16 43 909, 169 28 977
High relief habitat dominated by coralline algae and *Montipora* and characterized by calcified pavement with sand channels. Overall low abundance of macroinvertebrates. The gastropod, *Morula ova,* was common. The teated and plump sea cucumbers, *Holothuria whitmaei* and *Actinopyga obsesa*, and the asteroid, *Acanthaster planci*, were rare.

JOH-09, Lagoon, Max Depth: 10.7 m, Location: South Lagoon
GPS: 16 43.716, 169 29.139
Montipora dominated with moderate coral cover, high coralline algal cover, and high relief. Low abundance of macroinvertebrates with the exception of vermetid mollusks. Fire coral, *Millepora sp*., the spiny brittle star, *Ophiocoma erinaceaus*, the gastropod, *thaidid sp*., and the echinoids, *Echinotrix sp*. and *Tripneustes gratilla* were rare.

JOH-10, Lagoon, Max Depth: 15.9 m, Location: East of North Island
GPS: 16 45.795, 169 30.722
This *Acropora* and *Montipora* dominated reef had high coral cover and high relief with several small sand patches interspersed. This is a permanent transect site of Jim Maragos at USFWS. Holothuroids were the dominant macroinvertebrate. Several species were recorded including *Holothuria atra*, *Holothuria whitmaei*,

Actinopyga obesa, *Holothuria edulis*, *Bohadshia paradoxa*, and the chocolate chip *Holothuria sp*. *Bohadshia paradoxa* was the most abundant. *Tripneustes* and *Echinothrix* were rare. A green didemnid tunicate was noted throughout the site.

JOH-11, Lagoon, Max Depth: 10.1 m, Location: S. side of Johnston Island
GPS: 16 43.312, 169 31.443
A high relief *Montipora* dominated reef. Low abundance of macroinvertebrates with the exception of vermetid molluscs. Common echinoid species seen were *Echinothrix diadema* and *Heterocentrotus mammilatus*.

JOH-12, Lagoon, Max Depth: 13.7 m, Location: Northeast side of Johnston Island
GPS: 16 44.834, 169 31.432
Montipora and *Acropora* dominated reef with a mix of *Pocillopora*. High coral cover and high relief. *Heterocentrotus mammilatus* were common. An unidentified holothuroid sp. was recorded. The plump sea cucumber, *Actinopyga obesa*, was rare. A green didemnid tunicate was abundant throughout the site. *Coraliophilidae* were abundant within large *Pocillopora* heads. The trapezoid crab, *Trapezia flavopunctata* was seen within the same *Pocillopora* heads.

JOH-14, Forereef, Max Depth: 16.8 m, Location: West of Akau Island
GPS: 16 46 212, 169 31 176
Low coral cover on calcified pavement. *Heterocentrotus mammilatus* was the dominate macroinvertebrate followed by *Tripneustes gratilla*. *Acanthaster planci* were common. The black and plump sea cucumbers, *Holothuria atra*, and *Actinopyga obesa*, and the pearl oyster, *Pinctada margaritifera* were rare.

JOH-15, Forereef, Max Depth: 16.2 m, Location North-northwest Forereef
GPS: 16 47 029, 169 29 404
Low coral cover on calcified pavement dominated by coralline algae. *Heterocentrotus mammilatus*. *Tripnuestes gratilla*, and *Acanthaster planci* were abundant. Fire coral, *Millepora sp*., was common. The black sea cucumber, *Holothuria atra*, and the rock-boring urchin, *Echinometra mathari*, were rare.

JOH-16, Forereef, Max Depth: 17.7 m, Location North forereef
GPS: 16 47 290, 169 28 435
Acropora dominated forereef habitat with low coral cover. Much *Acropora* was overturned and dead encrusted with coralline algae. Overall, there was a low abundance of macroinvertebrates. *Acanthaster planci* were common. The echinoids, *Hetercentrotus mammilatus* and *Diadema paucispinum*, were rare.

JOH-17, Max Depth: 18.6 m, Location: Forereef lagoon outside of channel
GPS: 16 41.779, 169 33.639
This low relief pavement habitat had low coral cover but an abundance of boring bivalves. Fire coral, *Millepora sp*., and the black sponge, *Chrondrosica chucalla*, were common. The dominant macroinvertebrates were echinoids. *Tripneustes gratilla* were abundant, *Heterocentrus mammillatus* were common, and

Echinothrix sp. were rare. The black and plump sea cucumber, *Holothuria atra* and *Actinopyga obesa*, the purple lace coral, *Dishchopora sp*., and *Acanthaster planci* were rare.

JOH-18, Max Depth: 4.6 m, Location: West side of Johnston Island
GPS: 16 43. 865, 169 32.368
Acropora dominated reef over broad sand expanses. Low abundance of macroinvertebrates with the exception of vermetid molluscs. *Drupella* snails, *thaidids*, and boring bivalves from the family *Arcidae* were common. Several shells from the families, *Crypreaeidae* and *Tonidae,* were present.

JOH-19, Max Depth: 5.8 m, Location: Northwest Backreef
GPS: 16 44.683, 169 32.182
Montipora and *Acropora* dominated reef had high coral cover and high relief. The holothuroid, *Holothuria atra,* was abundant. *Echinothrix* sp. were common. *Coraliophilidaes* were abundant within large *Pocillopora eydouxis*. In addition, *Ophiocoma erinaceaus*, hermit crabs sp. and trapezids such as *Trapezia tigrina*, were common within the large *Pocillopora eydouxis*. Veremtid molluscs were abundant as well as a green didemnid tunicate. The gastropod, *Charonia tritonis***,** and cephalopod, *Octopus sp*., were rare.

B.3.4 Towed-diver Benthic Surveys

We observed the dominant habitats along the forereef slope to consist of continuous reef. Along the backreef and adjacent lagoonal environments, we observed the dominant habitats to be both continuous reef and patch reef. Within the insular shelf along the south side, the dominant habitats were rubble and sand flats. Along the eastern insular shelf, the dominant habitats consisted of spur and groove and continuous reef. The dominant habitats in the southeast insular shelf consisted of rubble flats and pavement. For the 27 towed-diver habitat surveys, ~ 1.16% of the coral habitat appeared pale and ~0.23% appeared white. Along the southwest forereef, we witnessed a high abundance of fire coral (*Millipora sp.*). Over 150 man-made objects were recorded, which included everything from tires to steel frames and pipes. A total of 157 crown-of-thorns starfish (*Acanthaster planci*) were observed, 66.2% of which were observed along the forereef.

B.4. Fish

B.4.1. REA Fish Surveys

From January 18 to 23, 2006, the fish REA team (Craig Musburger, Paula Ayotte, and Sarah McTee) surveyed 18 sites around the atoll. Most sites were situated within the protected lagoon, but four sites were surveyed on the exposed outer reef, and one site was situated on the backreef at the west side of the atoll. Six of the eighteen sites were new sites for the CRED team and all twelve sites that were previously surveyed by CRED were revisited as monitoring sites. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys (for species presence) were conducted at each site, using the same methodology as in previous years. The benthic team (corals, algae, invertebrates) followed the fish team at all survey sites. Because of weather conditions, the survey effort was most concentrated within the protected lagoon of the atoll, but conditions were less dubious than in 2004 allowing for the REA team to visit several new sites in less protected areas. Water temperature was consistent at ~25.6 degrees Celcius.

FISH FAMILY SUMMARIES

A total of 120 species of coral reef fishes were documented at Johnston Atoll by the fish REA team. Following is a brief synopsis of selected families.

Parrotfish (Scaridae):

Six species of parrotfish were recorded. The bullethead parrotfish (*Chlorurus sordidus*) was seen at every site and was numerically the most abundant fish observed. The palenose parrotfish (*Scarus psitticus*) was also very abundant, though similarities between the bullethead and palenose parrot juveniles made identification to species level difficult. The largest individuals from this family recorded were the spectacled parrotfish (*C. perspicillatus*), with sizes ranging up to 40 cm TL. Less commonly seen were the stareyed parrotfish (*Calatomus carolinus*) and the redlip parrotfish (S. *rubroviolaceus*).

Damselfishes (Pomacentridae):

A total of eight species of damselfish were observed at Johnston Atoll. At less exposed sites the most common species were the Hawaiian dascyllus (*Dascyllus albisella)* and the blue-eye damsel (*Plectroglyphidodon johnstonianus),* while on outer reef and exposed sites, the most common species were the dwarf chromis (*Chromis acares)* and the agile chromis (*C. agilis)*. The diversity and abundance of damselfishes were remarkably low compared to other islands surveyed by CRED. Also of note was the lack of new damselfish recruits. Particularly noticeable were the species *D. albisella* and *P. johnstonianus* which consisted almost entirely of large specimens.

Surgeonfish (Acanthuridae):

Surgeonfish were common and relatively abundant at Johnston Atoll and constituted a major proportion of fish observed at all of our sites. Overall numbers in this family, as with other families we observed, appeared to be greatest on the outer reef slope rather than on the inner portions of the atoll. The blue-lined surgeonfish (*Acanthurus nigroris)* was by far the most common species observed in this family, followed by goldring surgeonfish (*Ctenochaetus strigosus)* and orange-spine unicornfish (*Naso lituratus)*. Other species commonly encountered were Achilles tang (*A. achilles),* ringtail surgeonfish (*A. blochii),* and the yellow tang (*Zebrasoma flavescens).* Sailfin tang (*Z. veliferum),* bluespine unicornfish (*N. unicornis),* paletail unicornfish (*N. brevirostris),* and the difficult to distinguish grey unicornfish (*N.*

caesius) and sleek unicornfish (*N. hexacanthus)* were observed, but in low abundances overall.

Wrasses (Labridae):

Wrasses appeared to constitute the most species rich family at Johnston Atoll, with 17 species of wrasses observed. The saddle wrasse (*Thalassoma duperrey*) was recorded at every site and had the highest abundance of the labrids. Hybrids of the saddle wrasse that crossed with the sunset wrasse (*T. lutescens*) as well as with the fivestripe wrasses (*T. quinquevittatum*) were observed in relatively high numbers, as were ornate wrasses (*Halichoeres ornatissimus*) and bird wrasses (*Gomphosus varius*). Other species of note included the ringtail wrasse (*Oxycheilinus unifasciatus*) and the slingjaw wrasse (*Epibulus insidiator*), both of which were present at every site. The belted wrasse (*Stethojulis balteata*) was fairly common, with most individuals recorded being juveniles. Less commonly seen were the Hawaiian hogfish (*Bodianus bilunulatus*), the yellowtail coris (*Coris gaimard*), the Hawaiian cleaner wrasse (*Labroides pthirophagus*), and on rare occasions the shortnose wrasse (*Macropharyngodon geoffrey*), the blacktail wrasse (*T. ballieui*), and members of the Pseudocheilinus genus were recorded.

Butterflyfish (Chaetodontidae):

This particular family was well represented at Johnston Atoll, with a total of 12 species recorded. Within this family, the chevron butterflyfish (*Chaetodon trifascialis)* was the most common and abundant fish observed. Most individuals observed were of adult size, but new recruits were present on a transect at site JOH-19. Moderately common species included the threadfin butterflyfish (*C. auriga),* the saddleback butterflyfish *(C. epihippium),* and the oval butterflyfish (*C. lunulatus)*. The speckled butterflyfish (*C. citrinellus)* was relatively rare and the reticulated butterflyfish (*C. reticulatus)* was only observed at site JOH-17. During a roving diver survey at JOH-04, we ran across a butterflyfish that appeared to be a hybrid between two different species of this family. Video and photos were taken of this individual for later reference.

Goatfish (Mullidae):

Six species of goatfish were recorded, with the yellowstripe goatfish (*Mulloidichthys flavolineatus*) being most abundant, many times observed in schools of 10 or more. The multibar goatfish (*Parupeneus multifaciatus*) and the doublebar goatfish (*P. insularis*) were also commonly seen. There were occasional sightings of the blue goatfish (*P. cyclostomus*) and the yellowfin goatfish (*M. vanicolensis*), and the sidespot goatfish (*P. pleurostigma*) was rarely seen.

Triggerfish (Balistidae):

Members of this family were moderate contributors to the overall fish abundance and species diversity with 5 species observed over 18 dives. Species of the genus *Melichthys* were the most abundant members of this family, with black durgon (*M. niger)* being slightly more abundant that pinktail durgon (*M. vidua)*. Other members of this family observed at Johnston Atoll included the lei triggerfish (*Sufflamen* *bursa)*, the lagoon triggerfish (*Rhinecanthus aculeatus)*, and the guilded triggerfish (*Xanthichthys auromarginatus)*.

Jacks (Carangidae):

Jacks were fairly common, but not abundant at Johnston Atoll. The bluefin trevally, (*Caranx melampygus)* was the most abundant species of the Carangid family observed. A single school of seven bluefin trevally was the largest aggregation observed of this family by the REA team. The island jack (*Carangoides orthogrammus)* and the leatherback (*Scomberoides lysan)* were present at a number of sites; however, on most occasions the team usually only encountered one solitary individual of these species. The barred jack (*Carangoides ferdau)* and the greater amberjack (*Seriola dumerili)* were each observed once during our entire 6-day survey period.

Snappers (Lutjanidae):

Two species of snapper were observed by the REA Fish team. The smalltooth jobfish (*Aphareus furca)* was moderately common and the green jobfish (*Aprion virescens)* was observed on a few occasions with some individuals exceeding 40 cm TL.

Sharks & Rays (Carcharhinidae, Myliobatidae):

The grey-reef shark (*Carcharhinus amblyrhynchos)* was the only shark observed by the REA fish team at Johnston Atoll. Groups of up to four individuals were encountered, although solitary individuals were most common. The size of grey-reef sharks observed ranged from 140 to 200 cm TL, and most individuals appeared to be well fed. Spotted eagle rays (*Aetobatis narinari)* were observed on several occasions, with one exceptionally large individual estimated to have a wingspan of 150 cm observed. A single manta ray (*Manta birostris)* was observed by the REA fish team along the current-swept outside reef. This location was not utilized as an REA survey site as the dive was aborted before any transects were laid becaue of strong current.

Boxfish (Ostraciidae):

Two species of boxfish were common at almost all sites. The spotted boxfish (*Ostracion meleagris)* and the usually uncommon Whitley's boxfish (*O. whitleyi)* were observed in all habitat types surveyed.

Rudderfish (Kyphosidae):

Rudderfish were moderately common, although identification to the species level is often difficult in the field. The highfin rudderfish (*Kyphosus cinerascens)* was easily identifiable and observed occasionally, while other observations probably included individuals of both of the two similar species, the grey rudderfish (*K. bigibbus)* and the lowfin rudderfish (*K. vaigiensis)*. Most individuals observed were between 15 and 20 cm TL, and no individuals larger than 25 cm were observed.

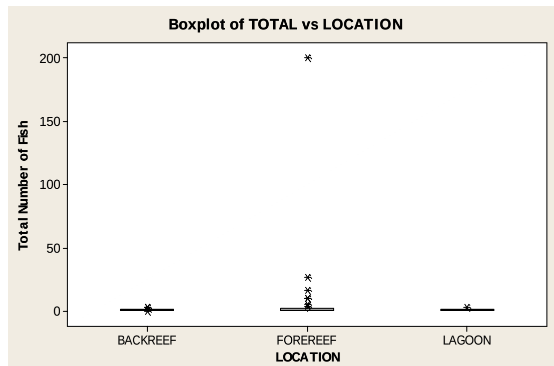
Angelfish (Pomacanthidae):

The most commonly observed angelfish was the flame angel (*Centropyge loricula*) with the Potter's angel (*C. potteri*) also observed. One sighting of the bandit angelfish (*Desmoholacanthus arcuatus*) occurred at the southwest end of the forereef at a depth of approximately 22.9 meters.

Hawkfishes (Cirrhitidae):

Hawkfish were absent from most sites surveyed. A total of three species were observed with the arc-eye hawkfish (*Paracirrhites arcatus)* being most common of the three. Also observed were the blackside hawkfish (*P. forsteri)* and the stocky hawkfish (*Cirrhitus pinnulatus)*.

B.4.2 Towed-diver Fish Surveys



A total of 349 fishes were counted over the 262,500m^2 of habitat surveyed averaging 1.3 large fishes (>50 cm) for over 1,000 m^2 of overall habitat. Numbers of fish tended to be higher on the Forereef than in the Backreef or Lagoon, but these differences were not significant in the initial analysis and were largely due to a single large school of Bluefin Trevally (*Caranx melampygus*) seen during a single tow along the forereef on the western edge of the atoll. This school also made *C. melampygus* the most commonly observed fish larger than 50 cm TL with 214 observations. Behavioral tendencies suggest this school may represent a spawning aggregation of this species.

The second most commonly observed species was the grey-reef shark, (*Carcharhinus amblyrhynchos*) with 67 observations. This species was primarily seen on the forereef along the western edge of the atoll. Our observations are consistent with other studies and anecdotal observations noting the prevalence of this species in this area of the atoll. Other notable observations included 22 cornetfish (*Fistularia commersonii*), 12 redlipped parrotfish (*Scarus rubroviolaceus*), 12 green jobfish (*Aprion variances*) and schools of black trevally (*Caranx lugubris*). Interestingly, *S. rubroviolaceus* were seen only in the southwestern portion of the atoll along the submerged reef crest. Absent this year were tiger sharks (*Galeocerdo cuvier*) and humpback whales (*Megaptera novaeangliae*), both of which were seen at Johnston Atoll during the 2004 surveys.

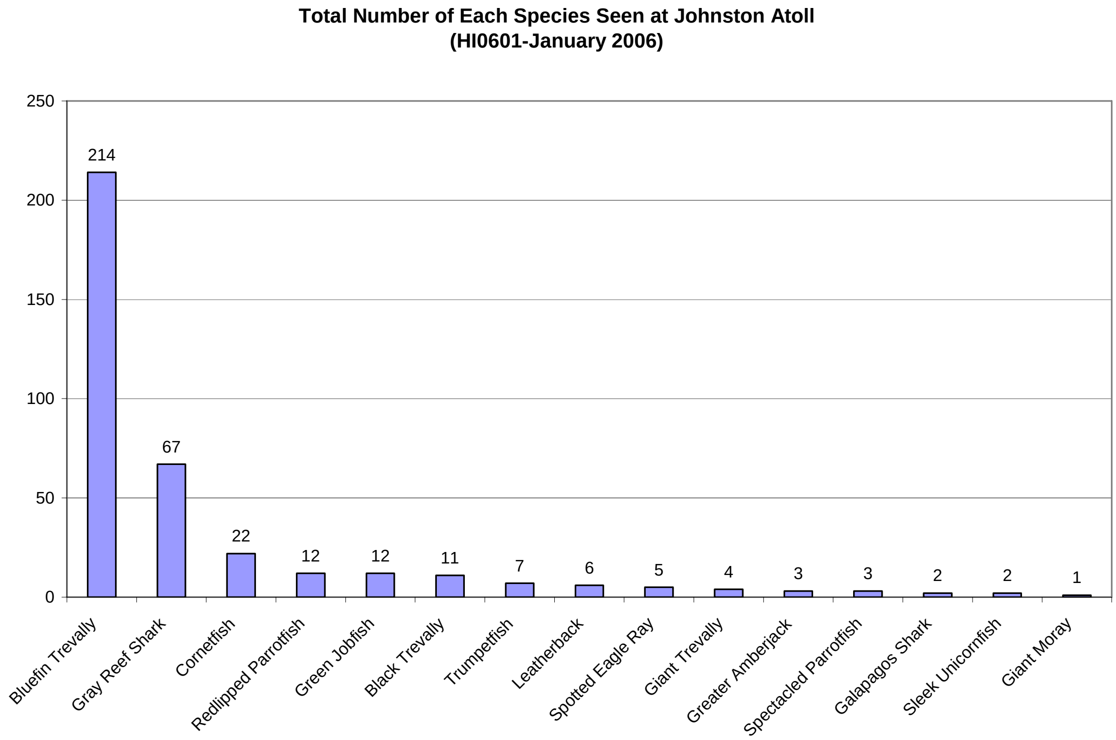


Figure B.4.2-2. Total Number of Each Species Seen at Johnston Atoll.

B. 5. Terrestrial Surveys

The Terrestrial Team consisting of Lee Ann Woodward and Chris Eggleston conducted pelagic bird and marine mammal transects 6 hours per day during the 3-day transit to Johnston Atoll. They recorded all birds and mammals sighted as well as an index of flying fish occurrence along the cruise track. No marine mammals were observed. Bird density and diversity were generally low during the transit, peaking on the last day. One notable observation on the final transit day was of one or two immature black-footed albatross seen following the ship. The area is considered south of their normal pelagic activity area. However, Laysan albatross have been recorded at Johnston Atoll, most recently was 2 years ago when three birds visited Johnston Island. While the birds were observed dancing, they did not nest. It will be interesting to see if the absence of a human population at Johnston Atoll will encourage the return of these species.

Woodward and Eggleston disembarked the *Hi'ialakai* for Johnston Island the morning of January 19, 2006. Camp was made at Point House, site of the former base commander's residence. For 4 days, from January 18 to January 21, they conducted Mean Incubation Counts of red-footed boobies, brown boobies, great frigatebirds, red-tailed tropicbirds, brown noddies, and white terns. The team found large numbers of these species nesting in the vegetation of the deserted island. For several of these species, red-footed boobies, brown boobies, and great frigatebirds, their occurrence on Johnston Island is new since the departure of the human population. However, photographs predating the human occupation of the island, circa 1934, show large numbers of great frigatebirds nesting on Johnston Island. Shorebird counts found ruddy turnstones, Pacific golden plover, and bristle-thighed curlew. Plants were identified, photographed, and cataloged according to location. Because of the long human occupancy of the island, many exotic species were identified including eggplant and oregano. A peregrine falcon was seen being harassed by white terns on January 21. Additionally, groundtruthing of satellite imagery of the seawalls and landfills was conducted. The Terrestrial Team was embarked on the *Hi'ialakai* on the afternoon of January 21, 2006. For the remaining time the ship was at Johnston Atoll, day trips to Sand Island (January 22) and East (Hikina) Island (January 23) were made. These visits allowed the team to conduct Mean Incubation Counts of red-footed boobies, brown boobies, masked boobies, great frigatebirds, red-tailed tropicbirds, brown noddies, and white terns. Shorebird counts found ruddy turnstones, and Pacific golden plover. Sooty Terns were found nesting with a range of young from eggs to fledging chicks on both Sand and East Islands; areas were GPS'd for density calculation. Christmas shearwaters were found loafing in and around burrows on Sand Island; no eggs or chicks were seen. An errant seagull was seen on the beach of Sand Island. Plants were identified, photographed, and cataloged according to location. Also, seawalls and landfills were examined for erosion. Because of an early departure for Howland and Baker Islands, North (Akau) Island in Johnston Atoll was not visited.

B.6 Maps

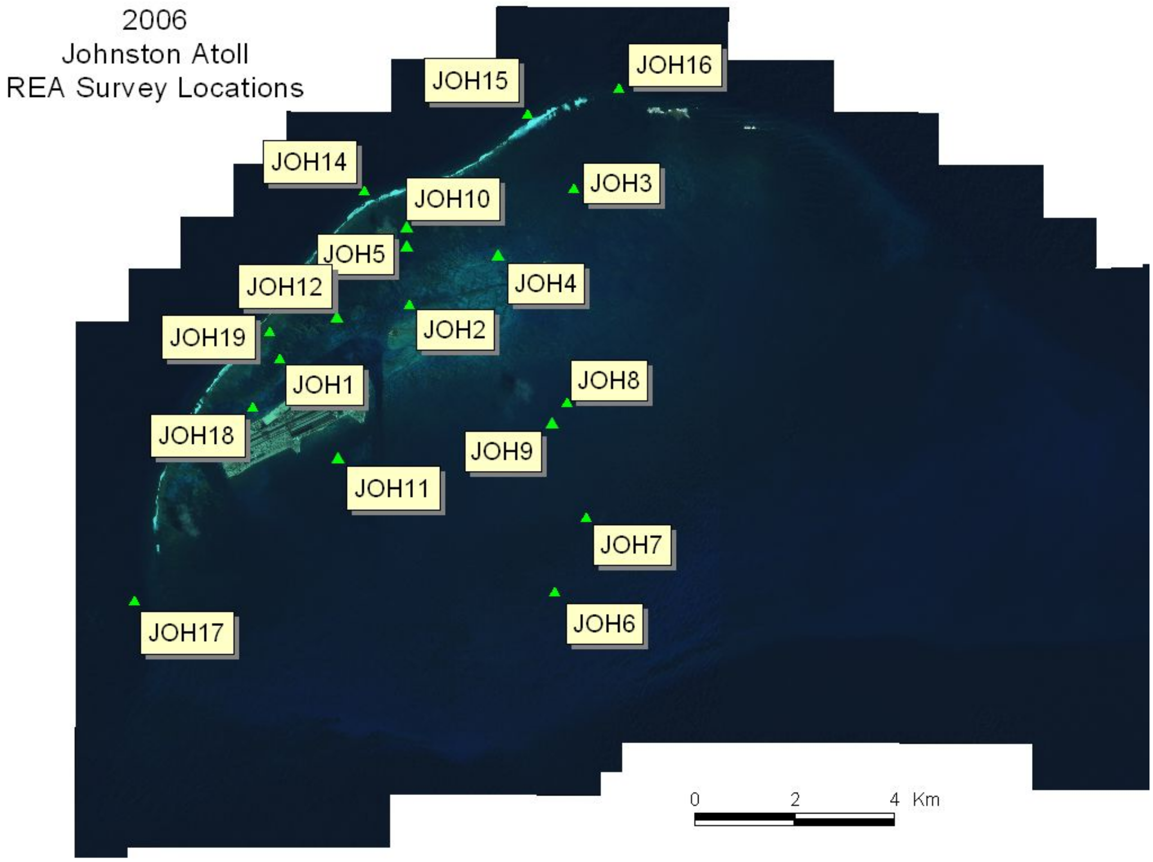


Figure B.6.1. Map showing location of established Rapid Ecological Monitoring (REA) sites at Johnston Atoll.

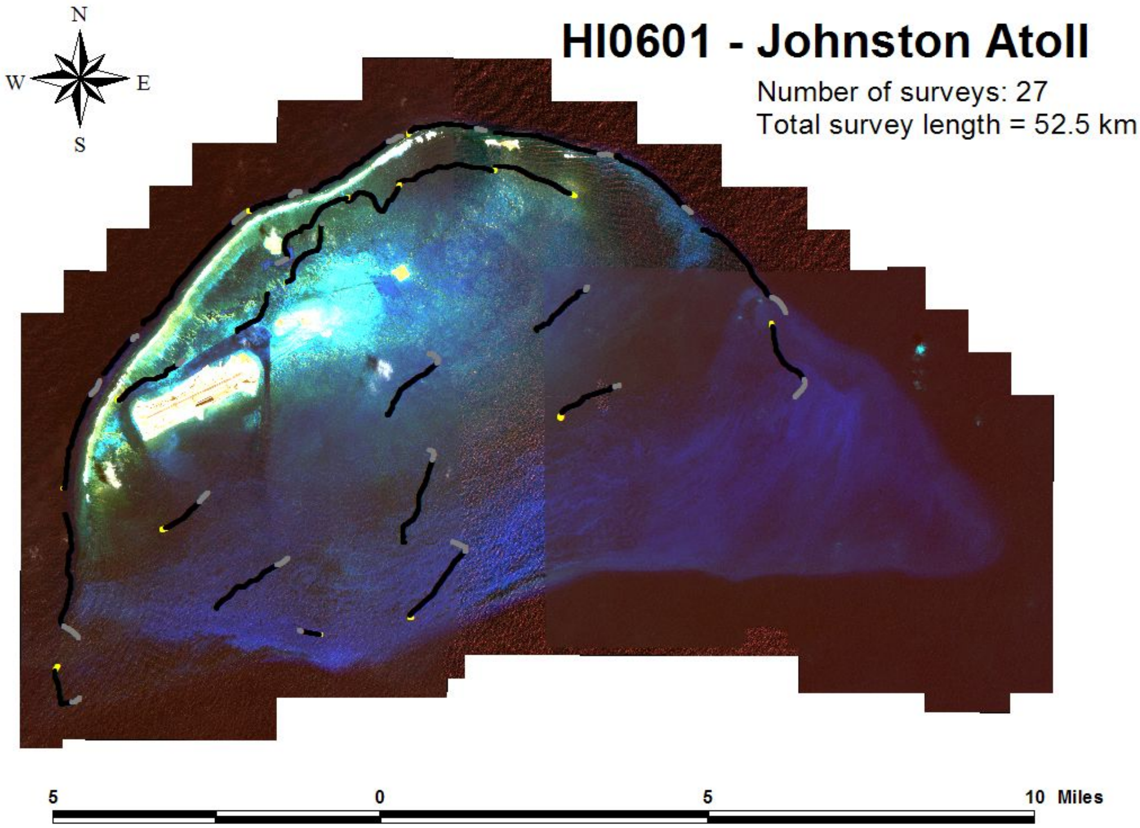


Figure B.6.2. Map showing location of towboard tracks at Johnston Atoll.

Appendix C: Howland Island

C.1. Benthic Habitat Mapping

Shipboard mapping surveys were done at Howland Island during early morning hours and at night on January 27 and during the day on January 28, 2006 (JD 27, 28, 29). Acoustic Habitat Investigator (*AHI)* mapping was completed in 1 day on January 27 in 10-300+ m water depths. Ship surveys were done primarily in water depths between 300 and 1500 m. In addition, two small areas in deeper water were surveyed; these data have been combined with an existing deep water multibeam grid that was downloaded from the web-based Seamount Catalogue. As shown in Figure C.1-1, both the east and west sides of the island have near-vertical relief with small areas of shelf at the north and south ends of the island. The area surveyed at Howland Island during HI-06-01 is 221 sq. km.

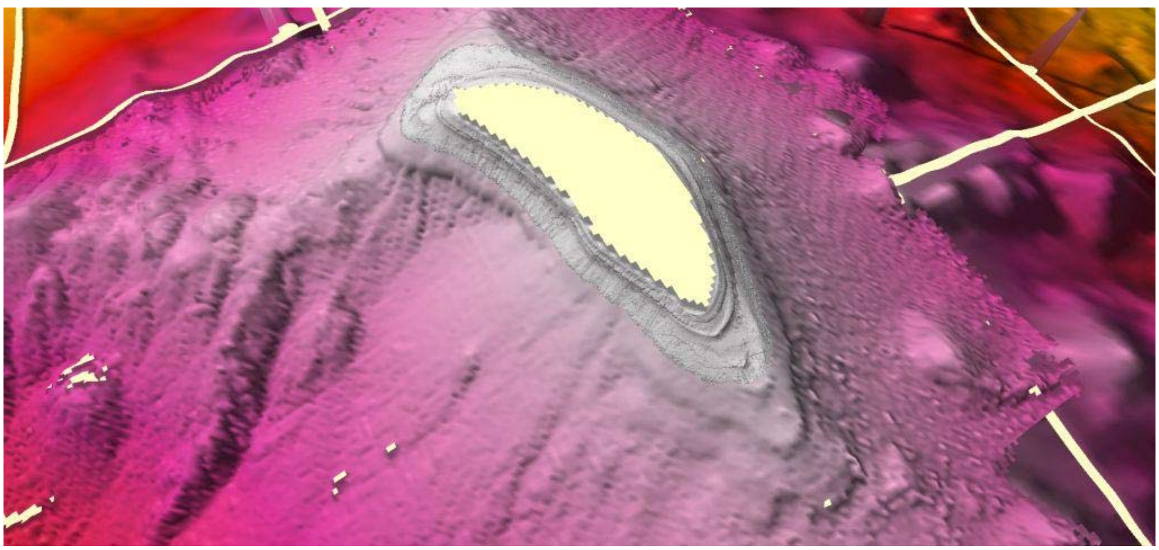


Figure C.1-1: Howland Island has steep slopes on all sides.

C.2. Oceanography and Water Quality

A replacement sea surface temperature (SST) was not deployed at Howland Island because of the loss of two previously deployed instruments, presumably due to the steep slopes of the island and the resulting extreme surf conditions (Fig. C.2-1. Two subsurface temperature recorders (STRs), deployed in a near vertical profile down the western slope of the island at 5 and 21 m of water were replaced and an additional STR was deployed at 42 m to extend this profile. Two STRs were not replaced, although retrieval was attempted because of very strong currents to the north of the island and high surf conditions along the eastern shoreline of the island. Attempts should be made on future cruises to locate these devices.

Figure C.2-1: Oceanographic instrumentation at Howland Island.

Twenty-nine shallow water conductivity-temperature-depth (CTD) casts were conducted around the periphery of the island in greater than 30 m of water. Water sample profiles were conducted at 7 of these sites for a total of 28 chlorophyll, 28 nutrient and 4 microbiota samples collected. A total of eight deepwater CTD/water sample profiles were conducted along two acoustic Doppler current profiler (ADCP) box transects (one small, one large) around the island during night operations; casts were performed on the corners of the small transect and at the mid-points of the large transect. A total of 40 chlorophyll and 40 nutrient and samples were collected along these transects. Four deepwater CTD/ water sample profiles were conducted along an east-west ADCP transect to the west of the island collecting 20 chlorophyll, 20 nutrient, and 3 microbiota samples. Two 7-mile ADCP transects were performed from west to east along the same latitude on either side of the island. In support of the mapping effort (for the primary purpose of surface velocity profiles), three CTD casts were conducted from the *AHI* to 200 m.

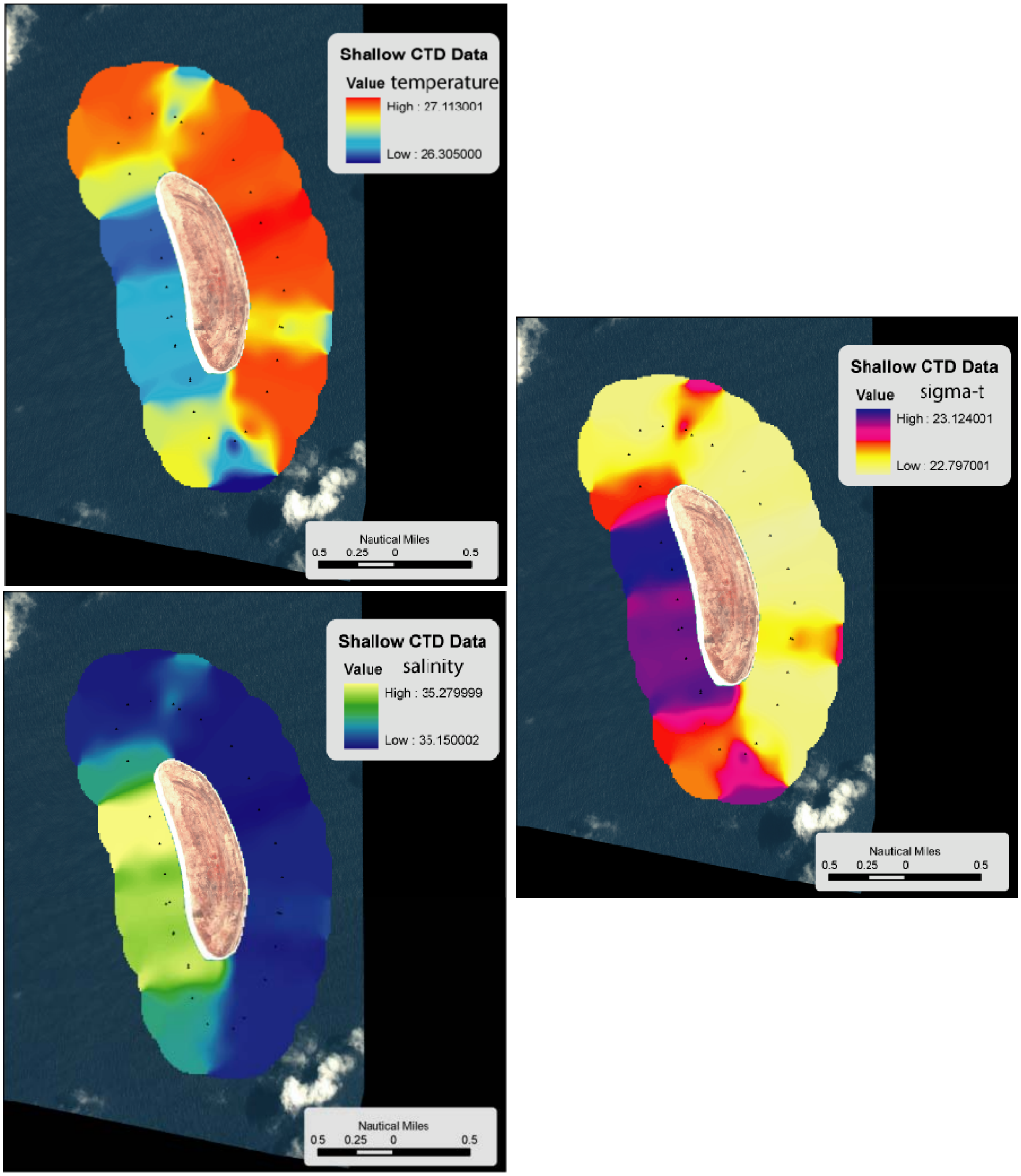


Figure C.2-2 - Interpolation of Shallow CTD casts at Howland Island. Upper left panel: water temperature (C°), 10-m depth bin; lower left panel: salinity (psu), 10-m depth bin; right panel, σ-t values (density), 10-m depth bin.

C.3. Benthic environment

C.3.1. Algae

- Pavements of pink crustose coralline algae dominate many sites at both islands.

- Macroalgal cover was very low, with most fleshy macroalgae restricted to protected areas between coral fingers.
- The algal floras appear distinct between Howland and Baker Islands, which is interesting because they are separated by only 56 kilometers. After four expeditions to these islands, *Wrangelia* sp. has only been found in abundance on Howland Island, while *Halimeda heteromorpha* has only been found on Baker Island. This may be because of limited sampling or some oceanographic regime that serves as a barrier to algal dispersal between the two islands.

C.3.1.1. Algal Rapid Ecological Assessment (REA) Site Descriptions

HOW-14P, HOW-05P, HOW-11P 1/28/2006

These sites were near island reefs and were all located on a steep reef slope on the west side of Howland Island. The area sampled had a depth ranging from 6.1 to 15.2 meters with a view of a much deeper drop-off. The site was dominated by crustose coralline red algae and coral. Additionally, *Wrangelia anastomosans*, *Halimeda fragilis*, *Lobophora variegata*, *Avrainvillea lacerata*, *Dictyosphaeria cavernosa*, *Caulerpa serrulata*, and turf algae occurred in the photoquads. A cyanophyte was found during the random swims. From a qualitative point of view, *Wrangelia anastomosans* appeared much more abundant than in previous years and occurred in almost all photoquadrats sampled.

HOW-16, HOW-08 1/29/2006

These sites were essentially identical to those visited yesterday, being located on the steep reef slope on the west side of the island. The area sampled had a depth ranging from 6.1 to 15.2 meters with a view of a much deeper drop-off. The site was dominated by crustose coralline red algae and coral. Additionally, *Wrangelia anastomosans*, *Halimeda fragilis*, *Lobophora variegata*, *Avrainvillea lacerata*, *Dictyosphaeria cavernosa*, *Caulerpa serrulata*, cyanophytes, and turf algae occurred in the photoquads.

HOW-10 1/29/2006

This site was located on the small shelf situated to the south of the island and had depths ranging from 13.1 to 14.0 meters deep. Although the algal composition was similar to all other sites surveyed at Howland Island, the flat nature of the shelf made the reef feel really different. A substantial current picked up while we were at depth, creating a rather difficult ascent back to the boat. Photoquadrats contained primarily turf algae, crustose coralline red algae, an encrusting brown (probably *Lobophora variegata*), *Halimeda fragilis*, *Dictyosphaeria cavernosa*, and a cyanophyte. *Caulerpa serrulata*, *Avrainvillea lacerata*, and *Caulerpa webbiana* were found during the random swim.

	HOW-14P	HOW-05P	HOW-11P	HOW-16	HOW-10	HOW-08	Island Average
GREEN ALGAE							
Avrainvillea	*		*		*	*	
Caulerpa	**16.7** 4.0	*	**8.3** 4.0	*	*	*	**4.2 (7.0)** 4.0 (0.0)
Dictyosphaeria		*	**8.3** 6.0	*	**16.7** 3.0	*	**4.2 (7.0)** 4.5 (2.1)
Halimeda	**58.3** 3.7	**41.7** 4.6	**75.0** 3.6	**58.3** 4.3	**33.3** 3.3	**50.0** 4.2	**52.8 (14.6)** 3.9 (0.5)
RED ALGAE							
Jania	*						
Wrangelia	**50.0** 4.3	**66.7** 4.0	**50.0** 4.0	**58.3** 3.9		**66.7** 4.1	**48.6 (25.0)** 4.1 (0.2)
BROWN ALGAE							
Dictyota		*					
Encrusting brown	**58.3** 3.6	**91.7** 2.6	**75.5** 3.2	**100** 3.0	**8.3** 5.0	**91.7** 3.1	**70.8 (34.1)** 3.4 (0.8)
TURF	**100** 1.6	**100** 1.6	**100** 1.5	**100** 1.3	**100** 1.3	**100** 1.2	**100.0 (0.0)** 1.4 (0.2)
Crustose Coralline algae	**100** 1.5	**100** 1.8	**100** 1.7	**100** 2.0	**100** 1.8	**100** 1.8	**100 (0.0)** 1.8 (0.2)
Cyanophytes			*	*	**25.0** 3.3	**8.3** 5.0	**5.6 (10.1)** 4.2 (1.2)

Table C.3.1-1: Algae of Howland Island. Bold numbers indicate the number of photoquadrats in which an alga occurred, below which is the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviations of the island averages are given in parentheses. Asterisks indicate algae found during the random swim that were not present in sample.

C.3.2. Corals

C.3.2.1 Coral populations

Four sites were survey at Howland Island on January 28-29, 2006. As it has been the case during earlier visits, onshore winds and swells prevented surveys off the eastern half of the island, except for one site near the south end (HOW-09). Moreover, strong currents off the southern and northern tips of the island continued to prevent stationary dives there as well. Thus REA surveys at Howland Island are still limited to the degree to which coral reef habitats at the island have been historically surveyed. Nevertheless, a total of 97 species and 30 genera of corals and anemones have now been reported from Howland Island, including 26 genera and 93 species of stony corals. The species totals are slightly higher but the generic totals are lower than those of neighboring Baker Island.

Of interest was the first record species and generic of *Podabacia crustacea* at Howland Island (beginning of transect line at site 16) and from the Phoenix Islands. *Podabacia* is an uncommon encrusting stony colonial mushroom coral (Family Fungiidae) that is rare in the central and east Pacific but widely distributed in the south and west Pacific and Asia.

Population studies have revealed that there has been an increase in the frequency of corals (number of corals per m^2) and a shift from larger to smaller corals during the 2 years between January 2004 and January 2006. However, overall abundance of corals remains roughly the same. Available frequency values varied between 2.9-3.9 at 2004 and 8.1-15.2 at comparable 2006 sites (HOW-16, HOW-05P). Unfortunately, much of the 2004 permanent site population data were not processed in time for this report, and only two of the 2006 REA sites were roughly at the same locales to offer clearer comparisons. At these two sites (-05P and -16) several genera reported much higher numbers of three largest size classes in 2004 compared to 2006 and higher numbers of the smaller size classes in 2006 compared to 2004 corals (*Acropora, Leptoseris, Pavona*). Moreover, several genera were substantially more common in most size classes in 2006 (*Fungia, Hydnophora, Leptastrea, Pocillopora, Psammocora*). However, preliminary indications are that 2006 coral coverage remains high and comparable to 2004. Of particular interest is the colonization of the red invasive corallimorpharian, *Rhodactis howsii*, and its rapid spread at site HOW-05P since 2004. This cnidarian is often associated with dissolved iron, including that generated by shipwrecks and other iron debris. The fact that site HOW-05P was historically used as a landing for small boats and ships may indicate that *Rhodactis* is stimulated by dissolved iron from residual anchors, boats, and other iron debris at the site.

C.3.2.2. Coral Disease

Full REA surveys were conducted at six sites (HOW14P, HOW05P, HOW11P, HOW16, HOW10, and HOW08) on January 30–31, 2006. Three of these sites were permanent transects established by Jim Maragos in 2000–2002. The REA team surveyed a variety of habitats, including several west, northwest, southwest, and south ocean fringing reef slopes. Strong swell and currents precluded any diving on the east side of the Island. Dive depths ranged between 8.5 and 14.6 m. Coral species inventories, colony counts, and size class distribution were conducted by Dr. Jim Maragos, U.S. Fish and Wildlife Service (USFWS). Coral bleaching, predation, and disease assessments were conducted by Dr. Bernardo Vargas Angel, Coral Reef Ecosystems Division (CRED). REA Surveys indicated that Pocilloporid corals were the most abundant, particularly *Pocillopora verrucosa* and *P eydouxi.* Other salient coral taxa included *Porites,* tabular, branching, and corymbose *Acropora, Pavona*, *Porites*, and *Hydnophora*.

General observations on bleaching and disease. Mean percent coral cover for all sites combined was relatively high: 51%. Carbonate pavement and encrusting red algal were also two important benthic components; they represented 14 and 26%, respectively (Table 1). Coral health and disease assessments were conducted along the 25-m transect line, along a 1-m belt of each side of the transect line, as well as 3 m off each side of the transect line. In 2006, we surveyed an area of approximately 1800 m^2 at Howland Island, and a total of five different cases of 'disease' were detected at all sites combined (mean prevalence = 0.003 cases/m^2). Three (60%) cases constituted tissue loss on *Acropora* and *Pocillopora*. The second type of affliction was skeletal growth anomalies. Two cases were detected, one on *Acropora nobilis* and the second one on a species of Favia. However, in general terms, corals and coral communities at all sites appeared in relatively good health condition with no evidence of bleaching. These findings are in agreement with a disease assessment conducted by Dr. Greta Aeby at the same sites during 2004

C.3.2.3. Coral REA Site Descriptions

January 28, 2006

HOW-14P

Northwest ocean fringing reef slope; depth range: 13.1-15.6 m. Mean coral cover was 54.7%. No evidence of bleaching or disease. The dominant corals, *Pocillopora* and *Montipora,* were abundant. Some colonies of staghorn coral, *Acropora nobilis,* were present. Disease assessment: No evidence of bleaching of disease. Scattered blemishes on *Porites*, *Hydnophora*, and *Montipora*, were observed; these most probably can be attributed to predation.

HOW-05P

West ocean fringing reef slope; depth range 12.2 m. Live coral cover averaged 28%. Disease assessment: No bleaching or signs of disease were observed. Pocilloporid corals were common at this site, as well as poritids and faviids. Also, the colonial anthozoan *Rhodactis* was quite common at this site.

HOW-11P

Southwest ocean fringing reef slope; depth range 8.5-9.5 m. Mean live coral cover at this site was 66%. *Pocillopora* and *Montipora* were the dominant genera at this site; however, other taxa present included *Acropora*, *Pavona,* and *Fungia*. Disease assessment: No signs of bleaching or disease were observed. A few blemishes were observed on colonies of Hydnophora microconnos, most probably attributable to predation.

January 29, 2006

HOW-16

Northwest ocean fringing reef slope; depth 11.3 m. Mean coral cover was 42%. The dominant coral taxa in descending order of abundance were *Pocillopora, Pavona, Porites*, *Acropora,* and *Montipora.* Crustose coralline algae were also an important component of the benthic assemblage. Disease assessment: No bleaching was detected; however, two cases of tissue loss were observed; one in *Acropora* cf *nobilis* and the other one in *Pocillopora eydouxi* (tissue samples and photographs available). Evidence of corallivory was observed on *Porites*, *Hydnophora*, *Montipora*, and *Psammocora*.

HOW-10

South ocean fringing reef slope, depth range 12.8-13.7 m. Mean live coral cover estimated was close to 59%. Salient coral taxa at this site included *Pocillopora*, *Porites*, *Acropora*. and *Hydophora*. Disease assessment: No evidence of bleaching was observed; however, we detected one case of Acroporid tissue loss (*Acropora* cf. *nobilis*) and one case of skeletal growth anomaly.

HOW-08

Southwest ocean fringing reef slope; depth range 11.9-13.7 m. Mean live coral cover estimated was close to 54%. Salient coral taxa at this site included *Pocillopora*, *Porites*, *Acropora,* and *Montipora.* Disease assessment: No bleaching or coral diseases were detected at this site.

C.3.3 Macroinvertebrates

C.3.3.1. Macroinvertebrate REA site descriptions

HOW-05P, Forereef, Max Depth: 17.4 m, Location: West side
GPS: 00 48.249, 176 37.290

The habitat was along a steep slope dominated by *Pocillpora* and favid corals and coralline algae. The Corallimorphian, *Rhodactic howseii*, was abundant throughout the site. The echinoid, *Diadema sauvignyi*, was common. *Tridacna maxima* were rare. Trapezia crabs and hermit crabs were abundant. Coral hermit crabs, *Paguritta sp.*, were abundant within *Porites sp*., and favids. The phyliddiae, *Pustulose phyillida*, was rare

HOW-08, Forereef, Max Depth: 16.2 m, Location: Southwest corner
GPS: 00 47.964, 176 37.245

The habitat was along a high coral covered reef flat. The echinoid, *Diadema sauvignyi*, was abundant. *Echinthrix sp*. were common. *Coralliophilidaes* were the common gastropod. The black sea cucumber, *Holothuria atra*, and the nudibrach, *Chromodoris lochi*, were rare. Hermit crabs were rare.

HOW-10, Forereef, Max Depth: 16.2 m, Location: South side
GPS: 00 44.392, 176 36.946

The habitat was along a fringing reef slope. The echinoid, *Diadema sauvignyi,* was abundant. *Tridacna maxima* were abundant. The Corallimorphian, *Rhodactic howseii*, was common. The banded coral shrimp, *Stenopus hispidus*, was rare.

HOW-11P, Forereef, Max Depth: 13.4 m, Location: Southwest
GPS: 00 47.933, 176 37.231

The habitat was along a steep slope dominated by *Montipora* and *Acropora* corals and coralline algae. The Corallimorphian, *Rhodactic howseii*, was common throughout the site. The echinoid, *Diadema sauvignyi*, was abundant. The only other echinoid observed was *Echinotrix sp*. Coralliophilidaes were the abundant gastropod. *Tridacna maxima* were common. Trapezia crabs and hermit crabs were common. The black sea cucumber, *Holothuria atra*, was rare. *Conus miles* was rare.

HOW-14P, Forereef, Max Depth: 14.6 m, Location: Northwest reef slope
GPS: 00 48.906, 176 37.447

The habitat was along a steep slope dominated by *Montipora* and *Pocillopora* corals and coralline algae. The echinoid, *Diadema sauvignyi*, was abundant. The only other echinoid observed was *Echinotrix sp*. *Tridacna maxima* were common. Trapezia crabs and hermit crabs were common. The black sea cucumber, *Holothuria atra*, was rare. Coral hermit crabs, *Paguritta sp*., were abundant within *Porites sp*., and favids. *Arcidae* and *Conidae* shells were common. *Drupella sp.* were rare.

HOW-16, Forereef, Max Depth: 16.5 m, Location: Northwest side
GPS: 00 48.006, 176 37.003

This fringing reef slope was dominated by coralline algae. The echinoid, *Diadema sauvignyi*, was abundant. Coralliophilidaes were the abundant gastropod. *Tridacna maxima* were common. Trapezia crabs and hermit crabs were common. The black sea cucumber, *Holothuria atra*, and the multicolored star fish, *Linckia multifora*, were rare.

C.3.4 Towed-diver Benthic Surveys

For the seven towed-diver habitat surveys conducted at Howland Island, we observed the dominant habitat to be continuous reef long the entire island. Overall, we observed 20.7% of the reef habitat to be live coral, 10.6 % covered in coralline algae, and less than 1% soft coral. Along the western shore we observed 20.1% of the continuous reef to be live coral and along the eastern shore 40.2% live coral, with *Acropora sp.* being the dominant coral. A total of 29 giant clams were recorded, with 48% observed along the western shore. No crown-of-thorns starfish were observed.

C.4. Fish

C.4.1. REA Fish Surveys

From January 28 to February 1, 2006, the fish REA team (Craig Musburger, Paula Ayotte, and Sarah McTee) surveyed 15 sites around Howland and Baker Islands. Most sites were located on the protected west and south facing exposures, but one site on the far eastern flat of Baker Island was surveyed. All of the sites were monitoring sites previously visited by CRED teams. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys (for species presence) were conducted at each site, using the same methodology as in previous years. Site 5P on the western side of Baker Island was visited twice. The first visit to this site included the usual quantitative monitoring activities, but the second visit was a deep dive performed by all REA team members where safe scuba diving limits prohibited the laying of transects or the completion of SPCs. During this dive, fish REA team members conducted roving diver surveys down to depths of 30.5 meters and were able to observe several deep dwelling species that would have otherwise gone unnoticed. The benthic team (corals, algae, invertebrates) followed the fish team at all survey sites.

FISH FAMILY SUMMARIES

A total of 210 species of coral reef fishes were documented at Howland and Baker Islands by the fish REA team. Following is a brief synopsis of selected families.

Damselfishes (Pomacentridae):

A total of 16 species of damselfish were observed at Howland and Baker Islands. At both islands, the fusilier damsel (*Lepidozygous tapeinosoma*) was one of the most abundant fish species observed. Large schools of this species along with two anthiine serranid species (see below) were observed at all sites. These three species were more abundant at Howland Island than at Baker Island, but made up a large percentage of all fish observed at both islands. Baker Island hosted several species of damselfish that were not observed at Howland Island including the goldfin dascyllus (*Dascyllus auripinnis*) the orange-fin anemonefish (*Amphiprion chrysopterus*) and the variable chromis (*Chromis xanthura*). Damselfish species abundant at both islands included the dwarf chromis (*Chromis acares),* vanderbilt's chromis (*C. vanderbilti*) the blue-eye damsel (*Plectroglyphidodon johnstonianus),* and dick's damsel (*P. dickii*). Damselfish recruits of several species were abundant at both islands including bicolor chromis *(Chromis margaritifer*) and *C. vanderbilti*.

Surgeonfish/Unicornfish (Acanthuridae):

Surgeonfish were common and abundant at all sites at Howland and Baker Islands. Among surgeonfish, the dominant species observed along transects included the bluespotted bristletooth (*Ctenochaetus marginatus*), the goldrim surgeonfish (*Acanthurus nigricans*), and the bluelip bristletooth (*Ctenochaetus cyanocheilus*). Convict tang (*A. triostegus*) were often observed in large schools, but these aggregations were usually observed shallower than the transect depth so their overall abundance may be underrepresented by the quantitative survey methods used. One surgeonfish species previously reported from Howland and Baker Islands, the striped bristletooth (*Ctenochaetus striatus*) was not observed by the REA fish team, and it is believed this previous report was a misidentification. Among unicornfish, the orange-spine unicornfish (*Naso lituratus)* was most abundant and was the only species observed very frequently, but occasional observations were made of bluespine unicornfish (*N. unicornis),* paletail unicornfish (*N. brevirostris),* the difficult to distinguish grey unicornfish (*N. caesius)* and sleek unicornfish (*N. hexacanthus),* and the whitemargin unicornfish (*N. annulatus*).

Wrasses (Labridae):

The wrasses were the most speciose family at Howland and Baker Islands, with 32 species observed. Numerically, the most abundant wrasse was the bluntheaded wrasse (*Thalassoma amblycephalum*). Many sites hosted large numbers of new recruits of this species estimated to be 2 cm and less in length. Adult individuals were rare at the depths of our surveys, but were more common in shallower water. No other wrasse species dominated across the survey sites, but many species were recorded with high frequency including three species of cleaner wrasses (*Labroides dimidiatus*, *L. bicolor,* and *L. rubrolabiatus*) the bird wrasse (*Gomphosus varius*), the sixstripe wrasse (*Pseudocheilinus hexataenia*), and the eightstripe wrasse (*P. octotaenia*). Napoleon wrasse (*Cheilinus undulatus)* were observed by the fish REA team at both Howland and Baker Islands, but were only observed within quantitative survey boundaries during one SPC at Baker Island.

Sharks & Rays (Carcharhinidae, Myliobatidae, Dasyatidae):

Four species of shark and three rays were observed by the fish REA team at Howland and Baker Islands. The grey-reef shark (*Carcharhinus amblyrhynchos)* and the whitetip reef shark (*Triaenodon obesus*) were most abundant and were recorded on BLT and SPCF surveys at both islands. Blacktip reef sharks (*C. melanopterus*) were seen at two sites and a single large great hammerhead shark (*Sphyrna mokarran*) was seen deep along the west side of Baker Island. Although quantitative comparisons have not yet been made, sharks seemed to be less abundant than reported in previous years. Manta rays (*Manta birostris*) were observed along the south shore of Baker Island, and spotted eagle rays (*Aetobatis narinari*) were seen at both islands. Two sightings of the blackblotched stingray (*Taeniurus meyeni*) were made along the west side of Baker Island.

Groupers and Anthias (Serranidae):

Two anthiine serranids (along with the fusilier damsel detailed above) made up the bulk of all fish observed at Howland and Baker Islands. Bartlett's anthias (*Pseudanthias bartlettorum*) and Whitley's splitfin (*Luzonichthys whitleyi*) were observed in dense schools at nearly every site. Both species appeared to be slightly more abundant at Howland Island, but even at Baker Island schools of thousands of individuals were encountered regularly. On rare occasions the peach anthias (*Pseudanthias dispar*) was also mixed with these schooling planktivores. Among groupers, the peacock hind (*Cephalopholis argus*), the coral hind (*C. miniata*), and the darkfin hind (*C. urodeta*) were most abundant. Peacock groupers were often quite large with individuals up to 50 cm TL being recorded. The slenderspine grouper (*Gracila albomarginata*) was also common and often observed hovering in midwater along steep dropoffs. Several other species of grouper were observed with some regularity including the blacktip grouper (*Epinephelus fasciatus*) which appeared to be more abundant at Howland Island and the lyretail grouper (*Variola louti*) which was abundant at both islands but generally not observed along transects.

Snappers (Lutjanidae):

Snappers were a prominent component of the fish communities at both Howland and Baker Islands. The species most frequently encountered were the smalltooth jobfish (*Aphareus furca),* the twinspot snapper *(Lutjanus bohar),* and the onespot snapper (*L. monostigma).* The humpback snapper (*L. gibbus),* blue-lined snapper (*L. kasmira),* blacktail snapper (*L. fulvus),* and the green jobfish (*Aprion virescens)* were also recorded. There were two species that were recorded at only one of the islands. The half-barred snapper (*L. semicinctus)* was common but not abundant at Howland Island, and a juvenile of the black snapper (*Macolor niger)* was observed in the deeper section of BAK-11P.

Emperors (Lethrinidae):

Overall, emperors were not commonly encountered during surveys. The bigeye emperor (*Monotaxis grandoculis*) was by far the most commonly recorded species from this family at both Howland and Baker Islands. The yellowspot (*Gnathodentex aurolineatus)* and the yellowlip emperor (*Lethrinus xanthocilus)* were present at a number of sites, but were not abundant. A longface (*L. olivaceus)* emperor was recorded during a stationary point count at Howland Island at a depth of approximately 16m.

Angelfish (Pomacanthidae):

The most commonly observed angelfishes at both Howland and Baker Islands were the flame angel (*Centropyge loricula*) and the lemonpeel angel (*C. flavissima*). Other fairly common species included the emperor angelfish (*Pomacanthus imperator)*, the gold-spotted angelfish (*Apolemichthys xanthopunctatus)*, and the regal angelfish (*Pygoplities diacanthus).* There were a number of species recorded at Baker Island that were not observed during surveys at Howland Island. Griffis' angelfish (*Apoemichthys griffisi)* was present at most sites on Baker Island, but not abundant. Two angelfish were observed specifically during deeper portions of surveys, the multibar angelfish (*C. multifasciata*) and the bicolor angelfish (*C. bicolor). C. bicolor* was observed by both the REA fish team and the tow-board team along the western portion of the island.

Triggerfish (Balistidae):

The most prevalent species from this family was the orange-striped triggerfish (*Balistapus undulatus)*. The pinktail trigger (*Melichthys vidua),* the blacktail triggerfish (*M. niger),* and the scythe trigger (*Sufflamen bursa)* were also fairly abundant. The titan triggerfish (*Balistoides viridescens)* were regularly encountered in shallower portions of the REA sites at both Howland and Baker Islands. There are three species from this family that were only observed at Baker Island. Adults of the yellowmargin triggerfish (*Pseudobalistes flavimarginatus)* were usually encountered in shallower portions of survey areas. The redtooth trigger (*Odonus niger)* was abundant, but was rarely recorded on transects as it was most often seen schooling around a depth of 16 m. A single wedge picassofish (*Rhinecanthus rectangulus)* was recorded during a roving diver survey at BAK-06. Additionally, the blue-lined trigger fish (*Xanthichthys caeruleolineatus),* which is a deepwater species (usually 75 m or greater) was observed by members of the tow-board and REA teams on the reef slope around Howland Island.

Goatfish (Mullidae):

Observations from this family were dominated by the doublebar goatfish (*Parupeneus insularis).* The mulit-barred goatfish (*P. mulitfasciatus)* and the yellowfin goatfish (*Mulloidichthys vanicolensis)* were present at both Howland and Baker Islands, but were not major contributors to overall fish biomass. The mimic goatfish (*P. mimicus)* was seen at BAK-11P, schooling with *M. vanicolensis* and the blue-lined snapper (*Lutjanus kasmira)* that it mimics.

Butterflyfish (Chaetodontidae):

Eleven species of butterflyfish were recorded at Howland and Baker Islands; seven of these species were present at both islands. While no one species clearly dominated, the forcepsfish (*Forcipiger flavissimus*) was commonly observed at most sites. Moderately common were the raccoon butterflyfish (*Chaetodon lunula*), the ornate butterflyfish (*C. ornatissimus),* and Meyer's butterflyfish (*C. meyeri*). The chevron butterflyfish (*C. trifascialis)* was occasionally seen, more often at Baker Island than Howland Island. The threadfin butterflyfish (*C. auriga)* and the reticulated butterflyfish (*C. reticulatus)* were rarely seen at both islands. The fourspot butterflyfish (*C. quadimaculatus*) was rarely seen, and only at Howland Island, as was the humphead bannerfish (*Heniochus varius*). A single longfin bannerfish (*H. acuminatus*) was seen at only one site at Baker Island at a depth below 100 fsw, and a pair of doublebarred butterflyfish (*C. ulitensis*) was observed once at a southern site at Baker Island.

Parrotfish (Scaridae):

Six species of parrotfish were recorded. Most commonly seen were the redlip parrotfish (*Scarus. rubroviolaceus*), which also comprised the largest individuals from this family, with sizes up to 50 cm TL recorded. The bridled parrotfish (*S. frenatus*) was moderately common at both Baker and Howland Islands. Less commonly seen were the stareyed parrotfish (*Calatomus carolinus*) and the tricolored parrotfish (*S. tricolor*); both of these species were observed only at Baker Island. A solitary individual steephead parrot (*C. microrhinos*) was observed off transect at an eastern Baker Island site.

Squirrelfish and Soldierfish (Holocentridae):

Of this family, the soldierfish (subfamily Myripristinae) was the most common and most abundant. The bigscale soldierfish (*Myripristis berndti*) was the dominant species, although it should be noted that Earle's soldierfish (*M. earlei*), a very similar soldierfish, may have been present and misidentified as the bigscale soldierfish; thus their numbers may be overstated. The Tahitian squirrelfish (*Sargocentron tiere*) was recorded relatively often; the tailspot squirrelfish (*Sargocentron caudimaculatum*) was occasionally recorded. Rarely seen was the whitespot soldierfish (*M. woodsi*).

Cirrhitidae (Hawkfish):

Members of this family were common and relatively abundant. The arc-eyed hawkfish (*Paracirrhites arcatus*) were the dominant species and were found at every site at Howland and Baker Islands. Moderately common were the pixie hawkfish (*Cirrhitichthys oxycephalus*) and the blackside hawkfish (*P. forsteri*). Of interest was the less commonly seen dark brown shading to yellow color phase of the blackside hawkfish which occurred at a western site of Baker Island. The halfspotted hawkfish (*P. hemistictus*) was occasionally recorded at both islands. A single individual yellow hawkfish (*P. xanthus*) was seen at a southern Baker Island site.

Fusiliers (Caesionidae):

Although the four species of fusiliers seen were most frequently in large schools, because they were off transect and usually smaller than 20cm TL, they were not quantified as to actual numbers. Most commonly recorded were the blue-and-yellow fusilier (*Caesio teres*) and the neon fusilier (*Pterocasio tile*). Rarely seen were the wideband fusilier (*P. lativittata*) and Marr's fusilier (*P. marri*).

C.4.2 Towed-diver Fish Surveys

The tow team conducted seven towed-diver habitat and fish surveys at Howland Island and 10 at Baker Island, surveying approximately 12 km and 19.12 km, respectively (311,200 m^2 total). A total of 871 fishes over 50 cm TL were observed.

Fish Observations

At the family level, snappers (Lutjanids) made up the majority of observations with 224 sightings, the majority of which (217) were the twin-spot snapper (*Lutjanus bohar*). Sharks (*Carcharhinids*) were the next most numerous family with 166 observations primarily of the grey-reef shark (*Carcharhinus amblyrhynchos*) (158), 147 of which were from Howland Island. Barracudas were seen in high numbers particularly at Howland Island (138). Carangids accounted for 116 observations, 55 of which were the black trevalley (*Caranx lugubris*), 24 of which were the giant trevalley (*Caranx ignobilis*) and 21 of which were the bluefin trevalley (*Caranx melampygus*).

The twin-spot snapper (*Lutjanus bohar*) was the most common species seen (217 observations) followed by the grey-reef shark (*Carcharhinus amblyrhynchos*) (158). The two islands, however, showed significant differences in fish assemblage. Overall, we observed 602 fishes at Howland Island while observing 269 at Baker Island. *L. bohar* were seen in similar numbers (108, 109) at both islands while *C. amblyrhynchos* were far more numerous at Howland Island (147) than at Baker Island (11). Other notable observations included sightings of schools of scalloped hammerhead sharks (*Shyrna lewini*), the Napoleon wrasse (*Cheilinus undulatus*) and a large aggregation of green turtles (*Chelonia mydas*) located on the south side of Baker Island.

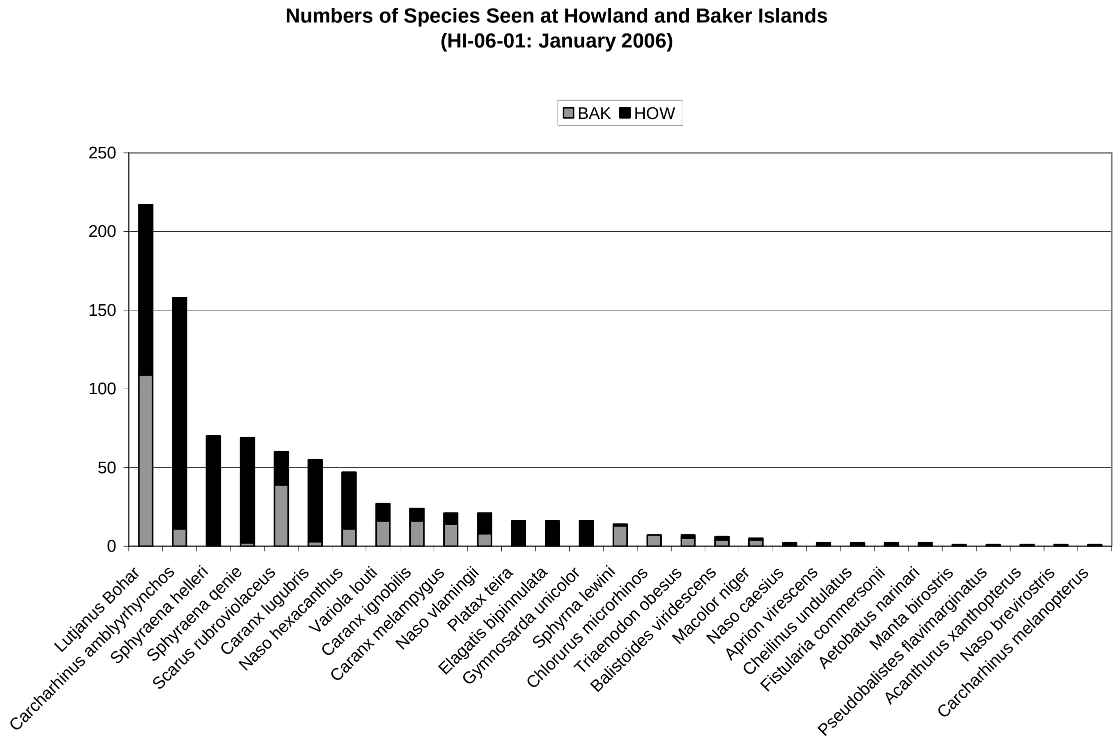


Figure C.4.2-1 Numbers of Species Seen at Howland and Baker Islands

C.5. Terrestrial Surveys

Chris Eggleston of the Terrestrial Team conducted pelagic bird and marine mammal transects 6 hours per day during the transit from Johnston Island National Wildlife Refuge (NWR) to Howland Island NWR and transit from Baker Island NWR to American Samoa. He recorded all birds and mammals sighted as well as an index of flying fish occurrence along the cruise track. No marine mammals were observed. Bird density and diversity was generally low during the transit, peaking after leaving Baker Island NWR.

The Terrestrial Team of Lee Ann Woodward and Chris Eggleston disembarked the *Hi'ialakai* for Howland Island the morning of January 28, 2006. Signs of trespass were documented and destroyed. Camp was made on the west shore. For the 2 days ashore, January 28-29, they conducted Mean Incubation Counts of masked boobies, red-footed boobies, brown boobies, great and lesser frigatebirds, red-tailed tropicbirds, brown noddies, and white terns. The team found large numbers of lesser frigate fledglings dead and dying of apparent starvation. Many carcasses of sooty tern fledglings were also found; conditions must be bad for the sea-foraging adults. Shorebird counts found ruddy turnstones, Pacific golden plover, and bristle-thighed curlew. Plants were identified, photographed, and cataloged according to location. Collection of Global Positioning System (GPS) data for features identified from satellite imagery and landing sites was conducted along with the collecting of base station data for two identifiable locations. The Terrestrial Team was embarked on the *Hi'ialakai* on the afternoon of January 29, 2006 after two shifts of visitors from the ship visited the Earhart Light (total four people).

C.6 Maps

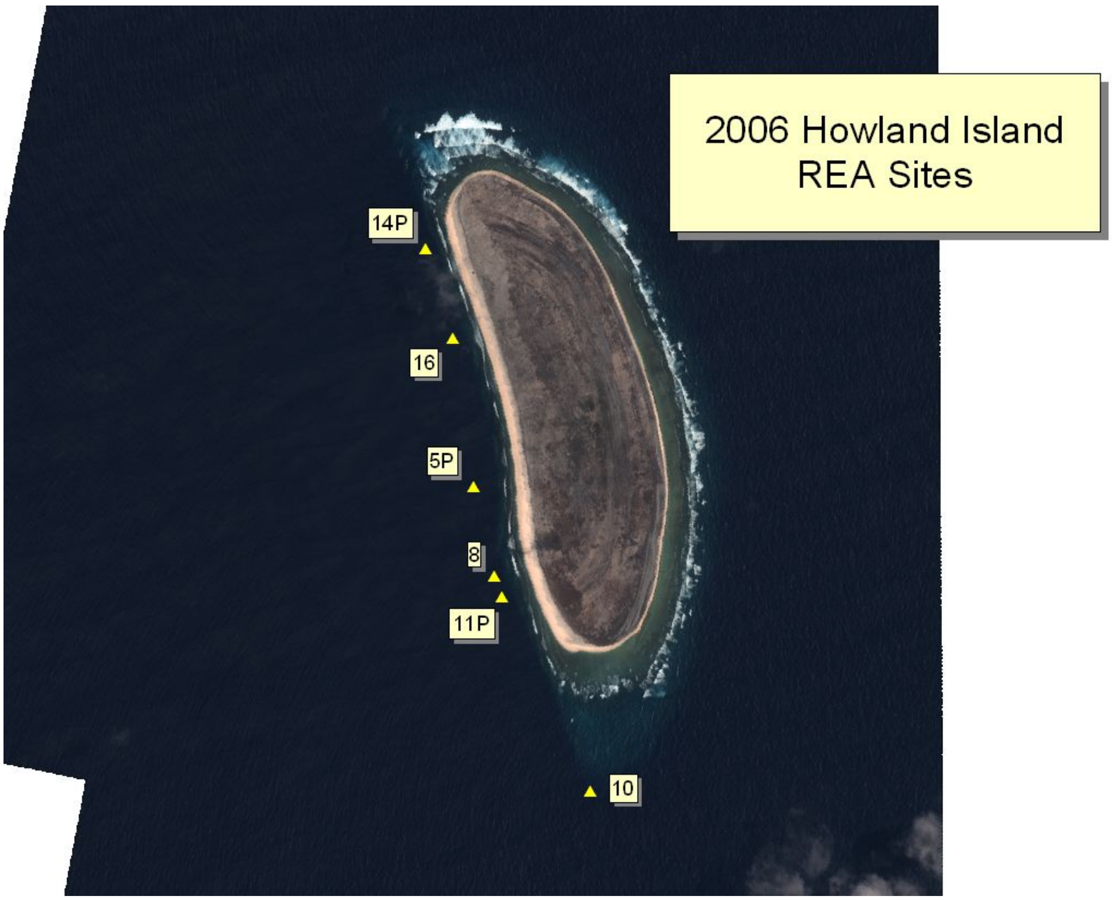


Figure C.6.1. Map showing location of established Rapid Ecological Monitoring (REA) sites at Howland Island.

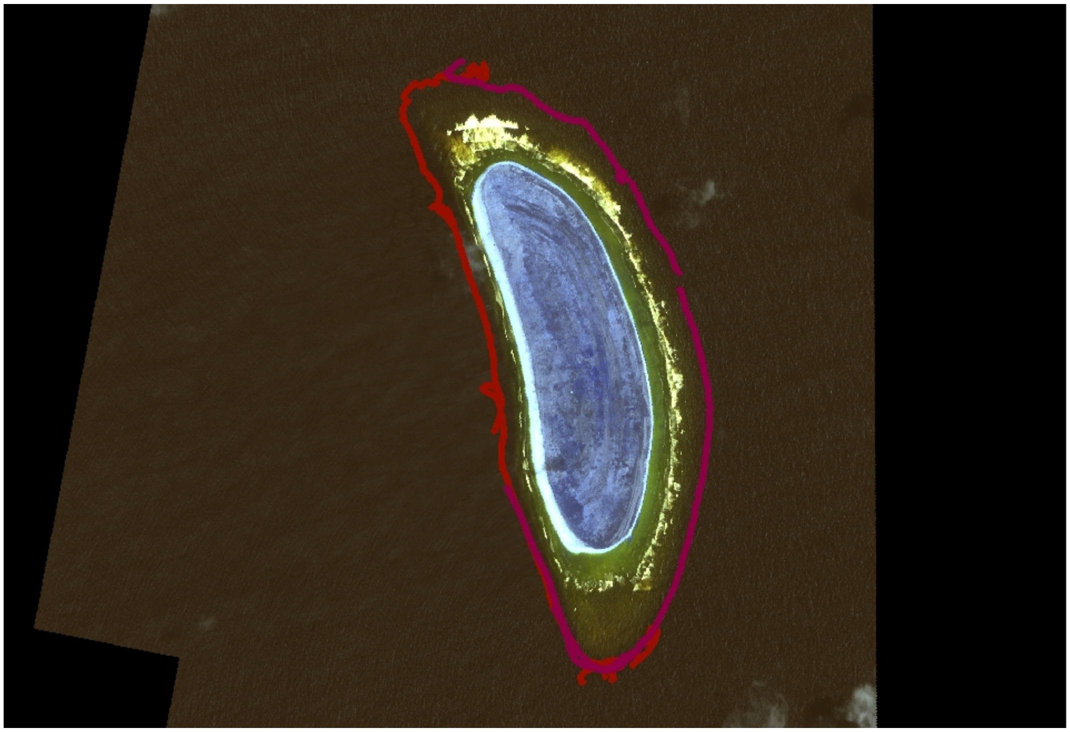


Figure C.6.2. Map showing location of towboard tracks at Howland Island.

Appendix D: Baker Island

D.1. Benthic Habitat Mapping

Shipboard mapping surveys were done at Baker Island during the day on January 31, 2006 and during night operations on January 31 and February 1, 2006. Acoustic Habitat Investigator *AHI* mapping was completed in 1 day on January 31, 2006 in 8-300+ m water depths. Ship surveys were done in 100-4500-m water depths and the data were combined with existing gridded multibeam data from the Seamount Catalogue. These bathymetric data may be helpful in explaining significant, observed biological differences between Howland and Baker Islands, which are only ~ 38 nmi apart (Fig. D.1-1). At Howland Island steep, almost vertical walls were found on all sides of the island with no intervening shallow shelf areas; at Baker Island (Fig. D.1-2) there are steep near-shore walls only on the south and west sides and 0-20-m shelf areas that are 0.25-1 nmi wide on the north and east sides of the islands; these shelf areas show evidence of high complexity (roughness), possibly indicating the location of coral formations. In addition, the slope on the north and east sides of Baker Island are not as steep as those on the south and west sides or on all sides of Howland Island. The area surveyed at Baker Island is 256 sq. km.

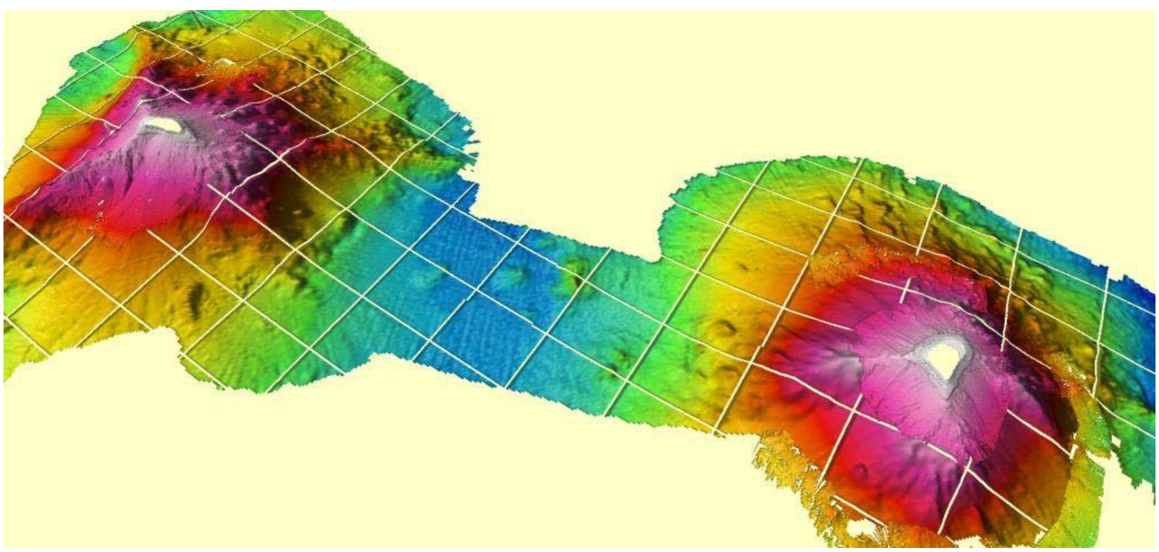


Figure D.1-1: Howland Island (left) lies 38 nmi north of Baker Island (right).

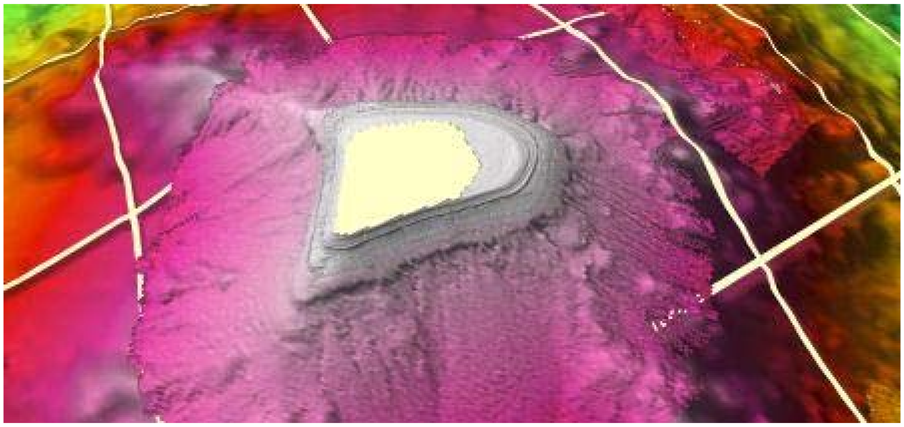


Figure D.1-2: Baker Island is steep on the south and west sides with a 0-20-m deep shelf area and less steep slopes on the north and east sides.

D.2. Oceanography and Water Quality

A ~ 80 kilometer acoustic Doppler current profiler (ADCP) transect was performed from 11.3 km north of Howland Island to 11.3 km south of Baker Island.

One Oceanographic Data Platform (ODP) was replaced at the established site on the southeast shelf of the island (Fig. D.2-1). A new sea surface temperature (SST) was installed with the mooring anchor placed 25 m to the south of the ODP. This site was chosen for two reasons: to provide a more secure mooring site than previous locations at Howland Island and to complement data collected from the ODP. Four subsurface temperature recorders (STRs) were replaced at their previously established sites.

Figure D.2-1: Oceanographic instrumentation at Baker Island.

Twenty-six shallow water conductivity-temperature-depth (CTD) casts were conducted around the periphery of the island in greater than 30 m of water. Water sample profiles were conducted at five of these sites for a total of 20 chlorophyll, 20 nutrient, and 2 microbiota samples collected. Four deepwater CTD/water sample profiles were conducted at the midpoints of an ADCP box transect around the island during night operations; 20 chlorophyll, 20 nutrient, and 2 microbiota samples were collected. Five deepwater CTD/ water sample profiles were conducted along an east-west ADCP line transect to the west of the island; 25 chlorophyll and 25 nutrient samples were collected. Two 7-mile ADCP transects were performed from west to east along the same latitude on either side of the island. In support of the mapping effort (for the primary purpose of surface velocity profiles), one deepwater CTD was conducted from the *Hi'ialakai* and one was conducted from the *AHI* to 200 m.

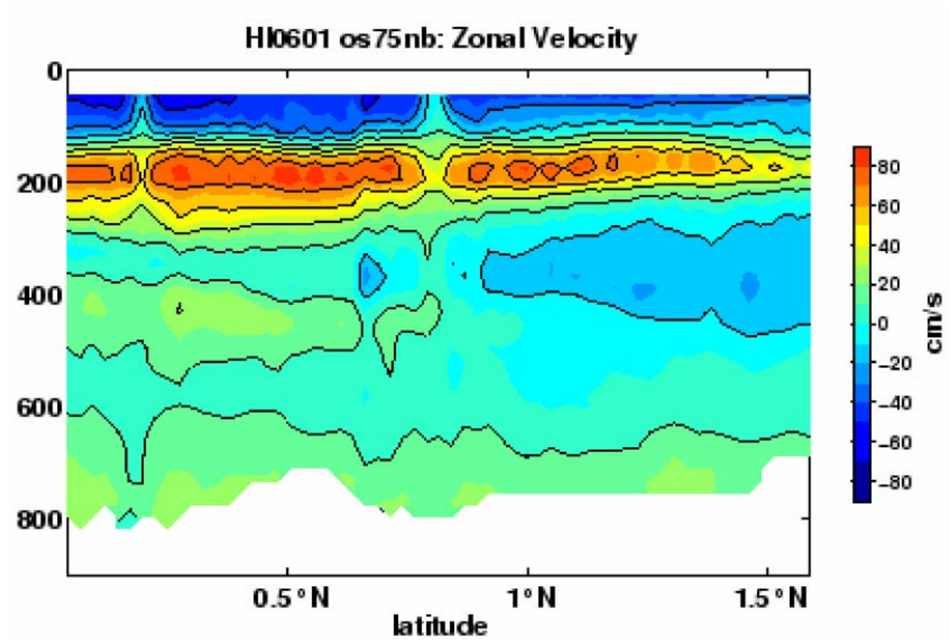


Figure D.2-2: Latitudinal cross section along 176°W of zonal currents (east/west flow) measured by the shipboard ADCP. Eastward flow is positive while westward flow is negative; strength is indicated by the colorbar to the right of the plot.

The equatorial Pacific is dominated by two distinct and opposite flowing currents; the South Equatorial Current (SEC), a westward-flowing surface current, and the Equatorial Undercurrent (EUC), an eastward-flowing subsurface counter-current. The SEC is typically a warm, nutrient depauperate, and relatively weak current (~ 30 cm/s) while the EUC is a cold, nutrient rich, and fast flowing current (~ 80 - 100 cm/s). Howland Island's (0° 48.0'N, 176° 35.0'W) and Baker Islands's (0° 12.0'N, 176° 28.0'W) proximity to the equator and isolation from neighboring islands results in both islands to be in the mean flow path of the SEC and the EUC, creating a dynamic and variable oceanographic setting. In surveys past, variable upwelling has been observed on the western side because of the EUC's interaction with these islands.

During Coral Reef Ecosystem Division's (CREDs) Reef Assessment and Monitoring Program (RAMP) survey of Howland and Baker Islands, zonal currents, as measured by the shipboard ADCP, are relatively strong in the upper 250 m from 1.5° N to the equator (Fig. D.2-2). The surface westward flowing SEC is nearly twice its mean strength with a maximum flow of ~60 cm/s while the eastward flowing EUC, residing at ~180 m, is slightly weaker than mean flow (~70 cm/s). This observed current structure is likely not conducive for EUC-driven upwelling; however, additional data (CTD, STR) must be analyzed to properly assess oceanographic conditions during the RAMP surveys of Howland and Baker Islands.

Summary analysis of the shallow water CTD data at Howland Island shows cooler temperatures and increased salinity and density values to the western side of the island (Fig. D.2-3). Northern and eastern sides of the island show, in general, little variability at 10 m, while an anomalously cool and dense water mass is observed in the southern most

CTD cast compared to immediately surrounding areas. CTD data from Baker Island shows similar spatial variance as that observed at Howland Island, with increased salinity and density values and decreased temperatures to the west and south of the island (Fig. 7). This water mass separation is most evident in salinity and density values as a clear and abrupt decrease occurs in both measurements to the northwest and to the southeast of the island.

It can be surmised that these cooler denser areas along Baker and Howland Island's west and south sides indicant upwelling as a result of current shear or some other current-island interaction. Also of note, overall water temperatures at Baker Island were 0.3–0.5 C° cooler than at Howland Island. This may be due in part to mixing from more vigorous SEC flow during operations there, as indicated by Figure D.2-2, as well as a somewhat shallower thermocline. Validation of this hypothesis, as well as attributing upwelling to EUC- and/or SEC-island interaction at either Baker or Howland Islands requires much further data analysis.

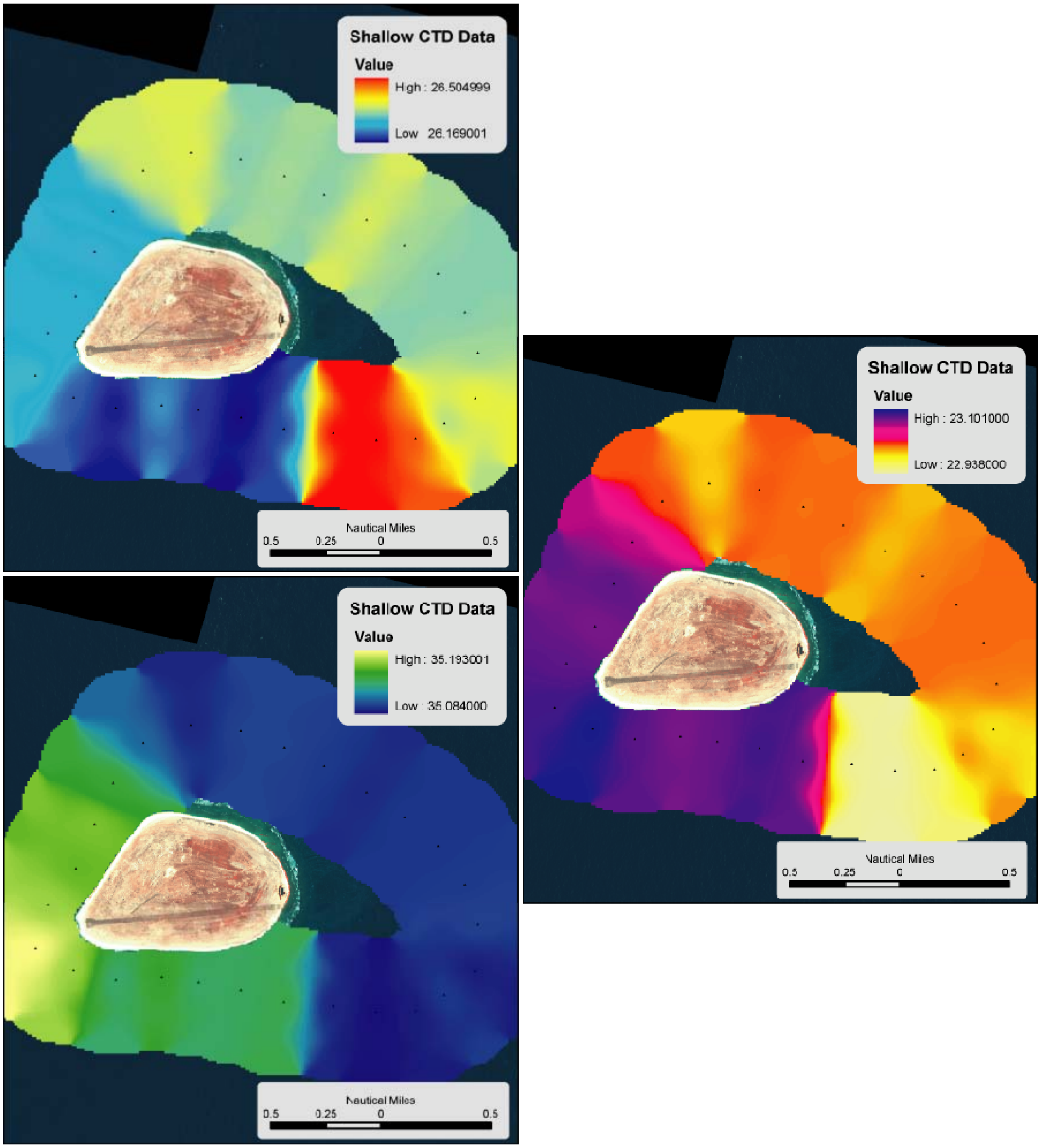


Figure D.2-3 - Interpolation of Shallow CTD casts at Baker Island. Upper left panel: water temperature (C°), 10-m depth bin; lower left panel: salinity (psu), 10-m depth bin; right panel, σ-t values (density), 10-m depth bin.

Table D.1-1: Instrumentation Summary

Site	CREWS	SST	ODP	WTR	STR	RPA	Comments
Johnston Atoll		1		1	5*		* One STR is a new deployment on an SST anchor.
Howland Island					5*		* Two STRs are deployments from OES0401 not recovered during HI0601 due to conditions.
Baker Island		1	1		4	1	

Table D.2-2: Shallow-water Oceanographic Sampling Summary

Site	CTD casts (SBE19+)	Water sample profiles	Chlorophyll samples collected	Nutrient samples collected	Microbiota samples collected	Comments
Johnston Atoll	39	9	26	26	6	
Howland Island	29	7	28	28	4	
Baker Island	26	5	20	20	2	

Table D.2-3: Deepwater Oceanographic Sampling Summary

Site	CTD casts (SBE19_AHI)	CTD casts (SBE911_ mapping/stand alone)	CTD casts (SBE911_ ADCP and water samples)	Chlorophyll samples collected	Nutrient samples collected	Microbiota samples collected	Comments
Johnston Atoll	6	5	4	20	20		
Howland Island	3		12	12	60	3	
Baker Island	1	1	9	9	45		

D.3. Benthic environment

D.3.1. Algae

- Pavements of pink crustose coralline algae dominate many sites at both islands.
- Macroalgal cover was very low, with most fleshy macroalgae restricted to protected areas between coral fingers.
- The algal floras appear distinct between Howland and Baker Islands, which is interesting because they are separated by only 56 kilometers. After four expeditions to these islands, *Wrangelia* sp. has only been found in abundance on Howland Island, while *Halimeda heteromorpha* has only been found on Baker Island. This may be because of limited sampling or some oceanographic regime that serves as a barrier to algal dispersal between the two islands.
- *Udotea*, *Hynea* and *Galaxura* were also only found at Baker Island.

D.3.1.1. Algal Rapid Ecological Assessment (REA) Site Descriptions

BAK-16P 1/30/2006

This was a shelf on the east side of Baker Island with a depth of 10.7 meters. This site was dominated by a monotypic thicket of *Acropora nobilis* with occasional sand patches. A moderate to strong current prevented quantitative photoquadrat data from being collected, so only a qualitative survey was conducted. Crustose coralline red algae and turf algae grew on the lower branches of coral. *Halimeda fragilis*, *Amphiroa* sp., *Peyssonnelia* sp. and *Dictyosphaeria versluysii*, *D. cavernosa*, and a cyanophyte were also collected.

BAK-09 1/30/2006

This site was located on the southeast corner of the island with survey depths ranging from 9.1 to 15.2 meters. As reported in 2004, “occasional *Acropora nobilis* patches were separated by more diverse stretches of reef slope.” In the photoquadrats turf algae, crustose coralline red algae, *Peyssonnelia* sp., *Halimeda fragilis*, *Laurencia* sp., *Lobophora variegata*, *Dicyosphaeria versluysii*, a dichotomously branched red (possibly in the order Rhodymeniales?), a fine iridescent filamentous red alga, and a cyanophyte were present. *Halimeda heteromorpha* and *Caulerpa webbiana* were collected on the random swim.

BAK-02 1/30/2006

This site was located on the south side of the island. Survey depths ranged from 7.6 to 15.2 meters. This site was characterized by dense patches of *Acropora nobilis* interspersed with more diverse coral patches. In the photoquadrats, *Halimeda heteromorpha*, *H. fragilis*, *Laurencia* sp., *Peyssonnelia* sp., *Dictyota* sp., *Lobophora variegata*, *Dictyosphaeria versluysii*, *Galaxaura filamentosa*, turf algae, crustose coralline red algae, and a cyanophyta were seen. The same dichotomously branched red alga seen at BAK-09 was found during the random swim, as was *Avrainvillea lacerata* and *Dictyosphaeria cavernosa*.

BAK-07 1/31/2006

This site was located on the southwest side of Baker Island with depths ranging from 9.5 to 12.2 meters. We sampled on a slope of *Acropora nobilis* that ended at about 18.3 meters and became a sand flat. There was a large amount of dead and broken *A. nobilis* pieces. Among the fingers of *A. nobilis*, turf algae, *Halimeda fragilis*, *Lobophora variegata*, *Udotea palmetta*, *Dictyota* sp., crustose coralline red algae, *Hypnea pannosa*, and a cyanophyte were found. During the random swim, *Bryopsis pennata*, *Halimeda heteromorpha,* and *Galaxura filamentosa* were collected.

BAK-05P, BAK-11P 1/31/2006

These sites were located on the west side of Baker Island working depths ranging from 4.6 to 15.2 meters with the slope continuing deeper. *Acropora nobilis* patches alternated with more diverse areas being common. In the photoquads, crustose coralline red algae, turf algae, *Lobophora variegata*, *Hypnea pannosa*, *Dictyota* sp., *Chlorodesmis* sp., *Bryopsis pennata*, *Dictyosphaeria cavernosa*, *Halimeda fragilis*, *Galaxura filmentosa* were found. At site 5P, *Halimeda heteromorpha* was seen during the random swim.

BAK-05P deep 2/1/2006

We dropped to 29.0 meters in order to collect sediment samples from under chain and anchors for the U.S. Fish and Wildlife Service (USFWS). *Udotea palmetta*, *Hypnea pannosa*, and *Halimeda heteromorpha* were collected.

BAK-03, BAK-06 2/1/2006

These sites were located on the south side of Baker Island with survey depths of around 9.1 to 12.2 meters. As with site BAK-02 (which was also located in this general area), the sites were characterized by dense patches of *Acropora nobilis* interspersed with more diverse coral patches. At both sites, turf algae and crustose coralline red algae were dominant, and *Halimeda heteromorpha*, *H. fragilis*, *Hypnea pannosa*, *Dictyota* sp., *Lobophora variegata*, *Dictyosphaeria versluysii*, and a cyanophyta were recorded in the photoquadrats. At site BAK-06, a species of *Laurencia* and *Peyssonnelia* were also commonly seen in photoquadrats, sometimes in great abundance. *Udotea palmetta, Dictyosphaeria cavernosa, Bryopsis pennata, and Valonia fastigiata* were collected during the random swim at BAK-03. *Microdictyon umbillicatum*, *Avrainvillea lacerata*, and *Valonia fastigiata* were collected during the random swim at BAK-06.

	BAK-09	BAK-02	BAK-07	BAK-05P	BAK-11P	BAK-03	BAK-06	Island Average
GREEN ALGAE								
Avrainvillea		*					*	
Bryopsis			*	**8.3** 2.0		*		NA
Caulerpa	*		*					
Chlorodesmis				**8.3** 3.0				NA
Dictyosphaeria	**16.7** 4.0	**16.7** 6.0			*	**8.3** 7.0	**16.7** 3.0	**7.2 (8.3)** 5.8 (1.3)
Halimeda	**91.7** 3.0	**58.3** 2.7	**50.0** 3.7	*	**16.7** 4.0	**75.0** 4.2	**91.7** 3.5	**25.0 (36.5)** 3.1 (0.5)
Microdictyon							**8.3** 5.0	NA
Udotea			**8.3** 4.0		*	*		NA
Valonia						*	*	
RED ALGAE								
Galaxaura		**8.3** 4.0			*			NA
Hypnea			**8.3** 5.0	**25.0** 2.7	*	**41.7** 4.2		**25.0 (16.7)** 4.0 (1.2)
Laurencia	*	**50.0** 4.2					**41.7** 4.4	**11.5 (21.3)** 4.3 (0.2)
Peyssonnelia	**75.0** 2.9	**25.0** 2.0					**41.7** 3.0	**17.7 (28.0)** 2.6 (0.5)
Wrangelia			*					
BROWN ALGAE								
Dictyota		**8.3** 5.0	**91.7** 3.1	**16.7** 2.5	**91.7** 3.0	**83.3** 3.3		**36.5 (43.9)** 3.4 (1.0)
Encrusting brown	**25.0** 3.3	**33.3** 3.0	**16.7** 3.5				**41.7** 2.8	**16.7 (17.3)** 3.2 (1.0)
Lobophora			**25.0** 4.0	**41.7** 3.8	**33.3** 3.8	**50.0** 5.5		**18.8 (21.2)** 4.3 (0.8)
TURF	**41.7** 2.2	**83.3** 1.9	**100** 1.1	**66.7** 2.0	**100** 2.0	**100** 2.1	**100** 1.6	**83.3 (35.6)** 1.8 (0.4)
Crustose Coralline algae	**100** 1.0	**100** 1.6	**100** 2.2	**100** 1.0	**100** 1.0	**100** 1.0	**83.3** 2.3	**76.0 (36.6)** 1.5 (0.6)
Cyanophytes	**16.7** 4.0	**16.7** 4.5	**8.3** 4.0			**16.7** 5.0	**8.3** 6.0	**8.3 (7.7)** 4.7 (0.8)

Table D.3.1-1: Algae of Baker Island. Bold numbers indicate the number of photoquadrats in which an alga occurred, below which is the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviations of the island averages are given in parentheses. Asterisks indicate algae found during the random swim that were not present in the sample.

D.3.2. Corals

D.3.2.1 Coral populations

Nine sites at Baker Island were surveyed in 2006 between January 30 and February 1, including eight REA sites. The three permanent transects at Baker Island are among these, and a ninth deeper dive at site BAK-05P did not include population counts. A total of 91 species and 37 genera of corals and anemones have now been reported from Baker Island since surveys and collections began in 1998. These include 32 genera and 82 species of stony corals. Among these are two new species and generic records for Baker Island: *Rhizopsammia verrilli* and *Cladopsammia eguchii.* Both are cryptic, shade dwellers, often difficult to see but widely distributed in the Pacific. Generic diversity on all but one transect ranged from 8 to 11 in 2004 compared to 8-12 at the same sites in 2006, and ranging from 5 to 13 at all 2006 sites. One site (16P) off the eastern reef terrace demonstrated a low generic diversity level of five, despite its high coral cover of about 80% because the dominant staghorn *Acropora* corals monopolizes all substrates. Photoquadrat data collected at site 16P in 2004 has not yet been analyzed to offer comparisons to population data there collected in 2006. However, the general impression is that staghorn corals in 2006 remain healthy, abundant, and comparable to those in 2004, and among the highest of all sites in terms of coral cover.

Patterns at sites BAK-09, -02, and -07 that were surveyed both in 2004 and 2006:

Coral population data at Baker Island in 2006 reveal characteristics similar to those reported for Howland Island in 2006 at the same three sites. Coral frequencies in 2006 were substantially higher (8.9, 3.2, 6.7 per m^2) compared to 2004 frequencies (1.8, 2.3, and 1.8 per m^2) respectively at the same three sites (BAK-02, -07, and -09). Somewhat contrary to trends observed at Howland Island, the largest corals at the same three Baker Island sites were comparable to 2004 levels when corrected for the same sampling areas. However, there was nearly an order of magnitude increase in the numbers of corals for the four smallest size classes and total numbers of corals. The mean percent coral cover for three sites combined were similar for 2004 levels (49.8%) compared to 2006 levels (52.9%). However, coral cover in 2006 doubled at BAK-09, remained the same at BAK-02, and declined to half the 2004 levels at BAK-07. Hence, there was no consistent trend among the three sites.

In 2006 at site BAK-09, *Acropora* was more abundant, but at site BAK-07, it was more abundant in 2004. The mushroom coral (*Fungia*) was considerably more abundant at all sites in 2006. *Cyphastrea* was absent at the REA sites in 2004 but reported at four sites in 2006. *Montipora* declined slightly in size in 2006 compared in 2004, and only one larger colony was seen at all 2006 sites combined. *Pocillopora* showed across-the-board increases at all size classes and sites in 2006 except for the lack of the largest size class observed in 2004. *Porites* showed a dramatic increase in abundance at site BAK-02 in 2006, but otherwise is not a common coral at Baker.

Leptoseris was substantially more abundant in 2006 at two of the three same sites (BAK-02 and -09).

Patterns applying to all eight 2006 REA sites in 2006:

Overall, there were no consistent patterns in coral cover: at BAK-02, -11P, and -05P, percent coral cover was low averaging about 25% and was double that coverage at BAK-02, -03, -06, and -07. The highest percent coral estimates were reported at sites BAK-09 and -16P, averaging about 80% cover. *Acropora* was common at all sites except BAK 5P. *Fungia* was common at all sites except -05P and -16P, the former perhaps as a result of habitat degradation and the latter because of the dominance of staghorn *Acropora.* The red invasive corallimorph, *Rhodactis howsii* showed dramatic increases at BAK-05P and is now present at BAK-11P; both of these sites serve as landings and corroding iron from anchors and chains may be stimulating the growth of this species as observed elsewhere at Palmyra adjacent to a shipwreck in 2005 and at the Howland Island landing site in 2006. In 2006, the bubble-tip anemone, *Entacmaea quadricolor* was observed for the first time on one of the REA transects, and the stone snake coral *Herpolitha* at three REA sites for the first time. The brain coral *Favia* appeared common at several sites including a dramatic increase at BAK-09, but a close relative *Favites* was not common at any site. *Leptoseris* was reported at proportionately more sites at 2006, and *Pavona* was seen at all sites, but with not very large colonies.

BAK-05P appeared to be degraded, both at transect depths of 10 m and at depths to 30 m. It is the only site at either Howland or Baker Island that appeared “sick.” Wave action appeared to have fractured some corals, and *Rhodactis* is asserting its dominance, especially at depth. Non-coral substrates are dark and covered by cyanobacteria, also likely stimulated by dissolved iron from the numerous anchors and chains observed at all depths. Sediment samples were collected at the site for toxicological analyses to be accomplished by the USFWS under the direction of ecotoxicologist Lee Ann Woodward. Coral photoquadrat data have been collected at this same site five times since 2000, and trends over the 6-year period will be analyzed after 2006 photoquadrat data have been analyzed.

D.3.2.2. Coral Disease

Full REA surveys were conducted at eight sites between January 30, 2006 and February 1, 2006 (BAK-16P, -09, -02, -07, -05P, -11P, -03, and -06). Three of these sites were permanent monitoring sites (BAK-05P, -16P, and -11P) previously established by Dr. Jim Maragos during 2000-2002. REA dive depths ranged between 9.1 and 13.7 m. Coral species inventories, colony counts, and size class distribution were conducted at all sites by Dr. Jim Maragos (USFWS). One dive depth (29.3 m) was conducted at site BAK-05P to collect sediment samples analyses by the USFWS. In addition, coral transect point counts, bleaching, predation, and disease assessments were conducted by Dr. Bernardo Vargas Angel, CRED. REA surveys indicted that staghorn acroprid corals were dominant at all sites visited on Baker Island. Other salient coral taxa included: Faviid corals, *Pocillopora*, *Porites*, *Pavona, and Montipora*.

General observations on coral bleaching and disease:

At Baker Island, mean percent coral cover for all sites combined was 30.8%. Percent live coral cover was high (35–70%) at site BAK-16P, where extensive *Acropora nobilis* thickets occurred. At other sites, percent live coral cover was lower, and ranged between 10 and 35%. At many sites, old dead staghorn coral rubble overgrown by coralline and green algae was an important component of the benthic ensemble. This contrasted with the reefs at Howland Island, where the percent of old dead coral was lower and crustose coralline was more abundant. The elevated amount of old dead coral at Baker Island suggests that in the past some of these communities may have extensive stands of staghorn *Acropora*. Coral health and disease assessments were conducted along the 25-m transect line, as well as 3 m on each side of the transect line. In 2006, 16 transects were visited for a total survey area of area of approximately 4800 m^2. Within this area, 65 cases of 'disease' were detected (0.02 cases/m^2), including 61 instances of *Acropora* cf *nobilis* tissue loss, 1 case of *A. hyacinthus* tissue loss, 2 cases of paling (*Acropora* cf *nobilis* and Favites, respectively), and 1 instance of *Acropora* cf *nobilis* skeletal growth anomaly. In addition, 24 cases of predation were observed, mainly on staghorn Acropora, Faviids, and *Gardineroseris*. Grossly, staghorn *Acropora* tissue loss lesions consisted of a clean, sharp, white band completely devoid of tissue (similar to the Caribbean White Band Disease). This band was generally 1 to 5, but up to 10 cm in length. A community of filamentous algae trailed the band of exposed skeleton. Most lesions were located toward the base of individual branches and seemed to progress upward toward the tip of the branch tip. Generally, there was only one lesion per branch and one diseased branch per colony. Only in few cases, disease patterns differing from the aforementioned were observed; these included mid-branch and branch-tip lesions, as well as lesions affecting only one side (right or left) of the branch. Also, a few cases of contact between diseased branches were observed, indicating the possibility of transmission between disease and healthy branches. Our findings for 2006 contrast somewhat with a prior health assessment conducted by Dr. Greta Aeby for 2004, whereby moderate bleaching, but no signs of disease were found at Baker Island.

B.3.2.3. Coral REA Site Descriptions

January 23, 2004
BAK-16P

Windward east ocean forereef terrace; depth range was 9.8-10.7 m. Percent live coral cover ranged between 35 and 72% for transects 1 and 2, respectively. Prolific staghorn coral development. Disease assessment: No evidence of bleaching. Within the two , 50 m^2 surveyed there were multiple cases of what looked as predation on the staghorn coral, particularly on bases of branches. Also, there were four cases of tissue loss. Grossly, morphology resembled the Caribbean *Acropora* white band disease. However, extent of damage was limited to 1–5 cm along the base of branch mainly (four samples collected, see photos).

Finally, there was one case of skeletal growth anomaly; this was detected outside the 50 m^2 belt (sample collected)

BAK-09

Southeast ocean fringing reef slope; depth range was 9.8-10.7 m. Disease assessment: one case of A. cf. nobilis tissue loss and one case of A. nobilis paling were observed. Coral densities averaged 6.7 colonies per m^2, and the dominant corals in descending order were *Acropora* and *Pocillopora*.

BAK-02

South ocean fringing reef slope; depth range 11.0-12.8 m. Mean live coral cover was 30%. Disease assessment: Paling was observed on summits of several colonies of *Favia stelligera* and *Favites* cf. *pentagona*, and one colony of *Acropora* nobilis. No specific afflictions or diseases were observed within the two 25 m^2 belt transect. However, within a 3-4-m corridor on each side of the transect line, one case of tissue loss in *Acropora hyacinthus* was detected, as well as three cases of tissue loss (white-band-like) in *Acropora* cf *nobilis*

January 31, 2006

BAK-07

Southwest ocean fringing reef; depth range 11.3-13.7 m. Mean percent live coral cover was 28%. Lots of staghorn coral rubble overgrown with crustose algae and green algae. Disease assessment: There were five cases of tissue loss detected on branches of *A. nobilis*.

BAK-05P

West ocean fringing reef slope; depth range 7.6-11.6 m. Mean live coral cover was 19%. Like site BAK07, the salient characteristic of this site was the elevated amount of staghorn coral rubble overgrown with crustose algae and green algae. Disease assessment: Within the tow 50 m^2 belt transects, only one case of tissue loss was detected in *Acropora nobilis.* No other afflictions were detected outside the belt transects.

BAK-11P

Northwest ocean fringing reef slope; depth 10.1-11.9 m. Percent live coral cover averaged 10%. The dominant coral at this site was staghorn *Acropora*; however, other scleractinians such as favids were present at this sites. In contrast to the 2004 surveys, no bleaching of branching acroporids was detected. Disease assessment: A total of nine cases of tissue loss were detected within the two 50 m^2 belt transects.

BAK-05P

West ocean fringing reef slope. Deep dive (29.3 m) to collect sediment samples for Jim Maragos.

BAK-03

Southwest ocean fringing reef slope; depth range 9.1-10.4 m. Mean percent coral cover was 35%; mostly branching *A.* cf. *nobilis*. At this site, old dead staghorn coral rubble overgrown with crustose algae and green algae accounted for nearly 54% of the bottom benthic cover. Disease assessment: 14 cases of acroporid tissue loss were detected within the two 150 m^2 area adjacent to each of the survey transects lines.

BAK-06

Southwest, ocean fringing reef slope; depth range 9.1-10.4 m. Mean percent live coral cover was 35%, mostly *A.* cf. *nobilis*. Other important components of the benthic community included the following scleractinian species in descending order: *Fungia*, *Acropora hyacinthus*, *Pocillopora*, and *Montipora foveolata*. Crustose coralline algae and the calcifying alga, *Halimeda* were also important benthic components at this site. Disease assessment: 12 cases of acroporid tissue loss were detected within the two 150 m^2 area adjacent to each of the survey transect lines.

D.3.3 Macroinvertebrates

D.3.3.1. Macroinvertebrate REA site descriptions

BAK-02, Forereef, Max Depth: 18.3 m, Location: South of Island
GPS: 00 11.278, 176 28.759

This forereef slope along the south side of the island was composed of variable corals and dominated by coralline algae. There were few non-cryptic macroinvertebrates. The Asteroid, *Linckia multifora,* was abundant. The black sea cucumber, *Holothuria atra*, and the giant clam, *Tridacna maxima*, were rare. The empty shells of *Turbo argyrostoma* were in the hundreds, if not thousands throughout the site. The empty shells of *T. argyrostoma* filled areas with a width of 1.2 meters and a length of 4.6 m. The majority of the shells contained a hole in the turbin area. At the top of this landslide of dead empty shells were piles of operculums and purple colored *Heterocentrotus* spines. There were three of these long graveyards and several other piles spread out randomly within the transects. Several empty shells of *Trachycardium orbita* were within the piles of *Turbos.*

BAK-03, Forereef, Max Depth: 14.9 m, Location: Southwest
GPS: 00 11.292, 176 28.964

Acropora nobilis and crustose coralline algae dominated site. Low abundance of invertebrates with the exception of the star fish, *Linkia multifora*. The lone-spined urchin, *Diamdema sauvigny,* was common. A skeleton of the tufted spiny lobster, *Panulirus pencillatus*, was found. The bubble anemone, *Entacmaea quadricolor,* was seen throughout the site. Several species of Dendrophyllias, *Tubastraea coccinea, Cladopsammis eguchi, and Rhizopssammia verrilli* were noted. Coral hermit crabs, *Paguritta sp.,* were present within *Porites sp*. Empty shells from the gastropod, *Turbo* *argyrostoma,* were abundant throughout the site. Zoanthids from the genera *Palythoa* and *Ophiuroideans* were present.

BAK-05P, Forereef, Max Depth: 13.1 m, Location: West Side
GPS: 00 11.821, 176 29.173
This forereef slope was dominated by crustose coralline and turf algae among staghorn coral rubble. Low abundance of macroinvertebrates with the exception of the starfish, *Linckia multifora*. The urchins, *Diadema sauvignyi, Echniothrix calamaris,* and *Echinostrephus aciculatus*, were rare. *Dardanus* hermit crabs, Ophiuroideans, and the corallimorpharian, *Rhodactis howseii*, were common. The bubble anemone, *Entadmaea quadricolor*, was present. Empty shells from the gastropod, *Turbo argyrostoma,* were common throughout the site. The Dendrophyllia, *Tubastraea coccinea*, was noted. The nudibranch, *Chromodoris annae*, was rare.

BAK-06, Forereef, Max Depth: 14.0 m, Location: Southeast corner
GPS: 00 11.258, 176 28.484
Acropora nobilis and crustose coralline algae dominated site. The starfish, *Linckia multifora,* and the long-spined urchin, *Diadema sauvignyi*, were common. Several Trapezids and hermit crabs were within *Pocillopora* heads. Empty shells from the gastropod, *Turbo argyrostoma,* were abundant throughout the site. Purple spines from the urchin, *Heterocentrotus mammilatus*, were in piles. One area in particular had thousands of spines, a cemetery of *Hetercentrotus*.

BAK-07, Forereef, Max Depth: 21.6 m, Location: Southwest corner
GPS: 00 11.437, 176 29.343
This forereef slope was predominantly covered in crustose coralline algae and staghorn coral rubble. Low abundance of macroinvertebrates with the exception of the star fish *Linkia multifora. Diadema sauvignyi, Echniothrix calamaris,* and *Spondylus sps.* were rare. Zoanthids from the genera *Palythoa* were present. An unknown species of white sponge was common throughout the site.

BAK-09, Forereef, Max Depth: 18.6 m, Location: Southeast of Island
GPS: 00 11.197, 176 28.216
This reef slope was dominated by *Acropora*, both branching and table. There were few non-coral invertebrates. The Asteroid, *Linckia multifora,* was common and the echinoid, *Diadema sauvigny,* was present but not common. The bubble anemone, *Entacmaea quadricolor,* was noted in shallower depth (25). An unknown Bryozoan and a green tunicate were common. A skeleton of the tufted spiny lobster, *Panulirus pencillatus*, was found. The gastropod, *Turbo argyrostoma,* was rare but empty shells were abundant throughout the site. The unknown and very abundant anemone noted from surveys in 2004 which had characteristics of the family *Aiptasidae*, was not present.

BAK-11P, Forereef, Max Depth: 16.2 m, Location: West Side
GPS: 00 11.932, 176 29.097

This forereef slope habitat dominated by crustose coralline algae and staghorn *Acropora* had a low abundance of macroinvertebrates. The starfish, *Linckia multfora*, and the corallimorpharian, *Rhodactis howseii*, were common. The hermit crabs, *Calcinus sp.*, and coral boring hermit crabs, *Paguritta sp.*, were common. Dendrophylliads were noted and the nudibranchs, *Chromodoria lochi* and *Phylidiella pustulosa*, were rare. Several empty Spondylus shells and *Ophiuroideans* were present.

BAK-16P, Forereef, Max Depth: 12.8 m, Location: East of Island
GPS: 00 11.683, 176 27.765

An *Acropora nobilis/formosa* covered reef along the eastern terrace. There were few non-coral invertebrates with the exception of the echinoid, *Diadema sauvigny* and the asteroid, *Linkia multifora* which were abundant.

D.3.4 Towed-diver Benthic Surveys

We observed the dominant habitat around Baker Island to be continuous reef. For the 10 towed-diver habitat surveys conducted we observed an overall 20.2% of the reef habitat to be live coral, 20.3% to be covered in coralline algae, and less than 1% to be soft coral which was only observed on the northern edge. We observed the eastern terrace habitat to be 20.6% live coral cover and the southern shore to be 20.9% live coral cover. On the western shore we observed an abundance of anchors and chains, along with ~10% cover of Coralliomorpharians, *Discosoma sp.* A total of 30 giant clams were recorded, with 40% of the giant clams observed along the eastern shore along with 39% of the sea urchins. No crown-of-thorns starfish were observed.

D.4. Fish

D.4.1. REA Fish Surveys

From January 28 to February 1, 2006, the fish REA team (Craig Musburger, Paula Ayotte, and Sarah McTee) surveyed 15 sites around Howland and Baker Islands. Most sites were located on the protected west and south facing exposures, but one site on the far eastern flat of Baker Island was surveyed. All of the sites were monitoring sites previously visited by CRED teams. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys (for species presence) were conducted at each site, using the same methodology as in previous years. Site 5P on the western side of Baker Island was visited twice. The first visit to this site included the usual quantitative monitoring activities, but the second visit was a deep dive performed by all REA team members where safe scuba diving limits prohibited the laying of transects or the completion of SPCs. During this dive, fish REA team members conducted roving diver surveys down to depths of 30.5 meters and were able to observe several deep dwelling species that would have otherwise gone unnoticed. The benthic team (corals, algae, invertebrates) followed the fish team at all survey sites.

FISH FAMILY SUMMARIES

A total of 210 species of coral reef fishes were documented at Howland and Baker Islands by the fish REA team. Following is a brief synopsis of selected families.

Damselfishes (Pomacentridae):

A total of 16 species of damselfish were observed at Howland and Baker Islands. At both islands, the fusilier damsel (*Lepidozygous tapeinosoma*) was one of the most abundant fish species observed. Large schools of this species along with two anthiine serranid species (see below) were observed at all sites. These three species were more abundant at Howland Island than at Baker Island, but made up a large percentage of all fish observed at both islands. Baker Island hosted several species of damselfish that were not observed at Howland Island including the goldfin dascyllus (*Dascyllus auripinnis*), the orange-fin anemonefish (*Amphiprion chrysopterus*), and the variable chromis (*Chromis xanthura*). Damselfish species abundant at both islands included the dwarf chromis (*Chromis acares),* vanderbilt's chromis (*C. vanderbilti*) the blue-eye damsel (*Plectroglyphidodon johnstonianus),* and dick's damsel (*P. dickii*). Damselfish recruits of several species were abundant at both islands including bicolor chromis *(Chromis margaritifer*) and *C. vanderbilti*.

Surgeonfish/Unicornfish (Acanthuridae):

Surgeonfish were common and abundant at all sites at Howland and Baker Islands. Among surgeonfish, the dominant species observed along transects included the bluespotted bristletooth (*Ctenochaetus marginatus*) the goldrim surgeonfish (*Acanthurus nigricans*) and the bluelip bristletooth (*Ctenochaetus cyanocheilus*). Convict tang (*A. triostegus*) were often observed in large schools, but these aggregations were usually observed shallower than the transect depth so their overall abundance may be underrepresented by the quantitative survey methods used. One surgeonfish species previously reported from Howland and Baker Islands, the striped bristletooth (*Ctenochaetus striatus*) was not observed by the REA fish team, and it is believed this previous report was a misidentification. Among unicornfish, the orange-spine unicornfish (*Naso lituratus)* was most abundant and was the only species observed very frequently, but occasional observations were made of bluespine unicornfish (*N. unicornis),* paletail unicornfish (*N. brevirostris),* the difficult to distinguish grey unicornfish (*N. caesius)* and sleek unicornfish (*N. hexacanthus),* and the whitemargin unicornfish (*N. annulatus*).

Wrasses (Labridae):

The wrasses were the most speciose family at Howland and Baker Islands, with 32 species observed. Numerically, the most abundant wrasse was the bluntheaded wrasse (*Thalassoma amblycephalum*). Many sites hosted large numbers of new recruits of this species estimated to be 2 cm and less in length. Adult individuals were rare at the depths of our surveys, but were more common in shallower water. No other wrasse species dominated across the survey sites, but many species were recorded with high frequency including three species of cleaner wrasses (*Labroides dimidiatus*, *L. bicolor,* and *L. rubrolabiatus*), the bird wrasse (*Gomphosus varius*), the sixstripe wrasse (*Pseudocheilinus hexataenia*), and the eightstripe wrasse (*P. octotaenia*). Napoleon wrasse (*Cheilinus undulatus)* were observed by the fish REA team at both Howland and Baker Islands, but were only observed within quantitative survey boundaries during one SPC at Baker Island.

Sharks & Rays (Carcharhinidae, Myliobatidae, Dasyatidae):

Four species of shark and three rays were observed by the fish REA team at Howland and Baker Islands. The grey-reef shark (*Carcharhinus amblyrhynchos)* and the whitetip reef shark (*Triaenodon obesus*) were most abundant and were recorded on BLT and SPCF surveys at both islands. Blacktip reef sharks (*C. melanopterus*) were seen at two sites and a single large great hammerhead shark (*Sphyrna mokarran*) was seen deep along the west side of Baker Island. Although quantitative comparisons have not yet been made, sharks seemed to be less abundant than reported in previous years. Manta rays (*Manta birostris*) were observed along the south shore of Baker Island, and spotted eagle rays (*Aetobatis narinari*) were seen at both islands. Two sightings of the blackblotched stingray (*Taeniurus meyeni*) were made along the west side of Baker Island.

Groupers and Anthias (Serranidae):

Two anthiine serranids (along with the fusilier damsel detailed above) made up the bulk of all fish observed at Howland and Baker Islands. Bartlett's anthias (*Pseudanthias bartlettorum*) and Whitley's splitfin (*Luzonichthys whitleyi*) were observed in dense schools at nearly every site. Both species appeared to be slightly more abundant at Howland Island, but even at Baker Island schools of thousands of individuals were encountered regularly. On rare occasions the peach anthias (*Pseudanthias dispar*) was also mixed with these schooling planktivores. Among groupers, the peacock hind (*Cephalopholis argus*), the coral hind (*C. miniata*), and the darkfin hind (*C. urodeta*) were most abundant. Peacock groupers were often quite large with individuals up to 50 cm TL being recorded. The slenderspine grouper (*Gracila albomarginata*) was also common and often observed hovering in midwater along steep dropoffs. Several other species of grouper were observed with some regularity including the blacktip grouper (*Epinephelus fasciatus*) which appeared to be more abundant at Howland Island and the lyretail grouper (*Variola louti*) which was abundant at both islands but generally not observed along transects.

Snappers (Lutjanidae):

Snappers were a prominent component of the fish communities at both Howland and Baker Islands. The species most frequently encountered were the smalltooth jobfish (*Aphareus furca),* the twinspot snapper *(Lutjanus bohar),* and the onespot snapper (*L. monostigma).* The humpback snapper (*L. gibbus),* blue-lined snapper (*L. kasmira),* blacktail snapper (*L. fulvus),* and the green jobfish (*Aprion virescens)* were also recorded. There were two species that were recorded at only one of the islands; the half-barred snapper (*L. semicinctus)* was common but not abundant at Howland

Island, and a juvenile of the black snapper (*Macolor niger)* was observed in the deeper section of BAK-11.

Emperors (Lethrinidae):

Overall, emperors were not commonly encountered during surveys. The bigeye emperor (*Monotaxis grandoculis*) was by far the most commonly recorded species from this family at both Howland and Baker Islands. The yellowspot (*Gnathodentex aurolineatus)* and the yellowlip emperor (*Lethrinus xanthocilus)* were present at a number of sites, but were not abundant. A longface (*L. olivaceus)* emperor was recorded during a stationary point count at Howland Island at a depth of approximately
16 m.

Angelfish (Pomacanthidae):

The most commonly observed angelfishes at both Howland and Baker Islands were the flame angel (*Centropyge loricula*) and the lemonpeel angel (*C. flavissima*). Other fairly common species included the emperor angelfish (*Pomacanthus imperator)*, the gold-spotted angelfish (*Apolemichthys xanthopunctatus)*, and the regal angelfish (*Pygoplities diacanthus).* There were a number of species recorded at Baker Island that were not observed during surveys at Howland Island. Griffis' angelfish (*Apoemichthys griffisi)* was present at most sites on Baker Island, but not abundant. Two angelfish were observed specifically during deeper portions of surveys, the multibar angelfish (*C. multifasciata*) and the bicolor angelfish (*C. bicolor). C. bicolor* was observed by both the REA fish team and the tow-board team along the western portion of the island.

Triggerfish (Balistidae):

The most prevalent species from this family was the orange-striped triggerfish (*Balistapus undulatus)*. The pinktail trigger (*Melichthys vidua),* the blacktail triggerfish (*M. niger),* and the scythe trigger (*Sufflamen bursa)* were also fairly abundant. The titan triggerfish (*Balistoides viridescens)* were regularly encountered in shallower portions of the REA sites at both Howland and Baker Islands. There are three species from this family that were only observed at Baker Island. Adults of the yellowmargin triggerfish (*Pseudobalistes flavimarginatus)* were usually encountered in shallower portions of survey areas. The redtooth trigger (*Odonus niger)* was abundant, but was rarely recorded on transects as it was most often seen schooling around a depth of 16 m. A single wedge picassofish (*Rhinecanthus rectangulus)* was recorded during a roving diver survey at BAK-06. Additionally, the blue-lined trigger fish (*Xanthichthys caeruleolineatus),* which is a deepwater species (usually 75 m or greater) was observed by members of the tow-board and REA teams on the reef slope around Howland Island.

Goatfish (Mullidae):

Observations from this family were dominated by the doublebar goatfish (*Parupeneus insularis).* The mulit-barred goatfish (*P. mulitfasciatus)* and the yellowfin goatfish (*Mulloidichthys vanicolensis)* were present at both Howland and

Baker Islands, but were not major contributors to overall fish biomass. The mimic goatfish (*P. mimicus)* was seen at BAK-11, schooling with *M. vanicolensis* and the blue-lined snapper (*Lutjanus kasmira)* that it mimics.

Butterflyfish (Chaetodontidae):

Eleven species of butterflyfish were recorded at Howland and Baker Islands; seven of these species were present at both islands. While no one species clearly dominated, the forcepsfish (*Forcipiger flavissimus*) was commonly observed at most sites. Moderately common were the raccoon butterflyfish (*Chaetodon lunula*), the ornate butterflyfish (*C. ornatissimus),* and Meyer's butterflyfish (*C. meyeri*). The chevron butterflyfish (*C. trifascialis)* was occasionally seen, more often at Baker Island than Howland Island. The threadfin butterflyfish (*C. auriga)* and the reticulated butterflyfish (*C. reticulatus)* were rarely seen at both islands. The fourspot butterflyfish (*C. quadimaculatus*) was rarely seen, and only at Howland Island, as was the humphead bannerfish (*Heniochus varius*). A single longfin bannerfish (*H. acuminatus*) was seen at only one site at Baker Island at a depth below 100 fsw, and a pair of doublebarred butterflyfish (*C. ulitensis*) was observed once at a southern site at Baker Island.

Parrotfish (Scaridae):

Six species of parrotfish were recorded. Most commonly seen were the redlip parrotfish (*Scarus. rubroviolaceus*), which also comprised the largest individuals from this family, with sizes up to 50 cm TL recorded. The bridled parrotfish (*S. frenatus*) was moderately common at both Baker and Howland Islands. Less commonly seen were the stareyed parrotfish (*Calatomus carolinus*) and the tricolored parrotfish (*S. tricolor*); both of these species were observed only at Baker Island. A solitary individual steephead parrot (*C. microrhinos*) was observed off transect at an eastern Baker Island site.

Squirrelfish and Soldierfish (Holocentridae):

Of this family, the soldierfish (subfamily Myripristinae) was the most common and most abundant. The bigscale soldierfish (*Myripristis berndti*) was the dominant species, although it should be noted that Earle's soldierfish (*M. earlei*), a very similar soldierfish, may have been present and misidentified as the bigscale soldierfish; thus their numbers may be overstated. The Tahitian squirrelfish (*Sargocentron tiere*) was recorded relatively often; the tailspot squirrelfish (*Sargocentron caudimaculatum*) was occasionally recorded. Rarely seen was the whitespot soldierfish (*M. woodsi*).

Cirrhitidae (Hawkfish):

Members of this family were common and relatively abundant. The arc-eyed hawkfish (*Paracirrhites arcatus*) were the dominant species and were found at every site at Howland and Baker Islands. Moderately common were the pixie hawkfish (*Cirrhitichthys oxycephalus*) and the blackside hawkfish (*P. forsteri*). Of interest was the less commonly seen dark brown shading to yellow color phase of the blackside hawkfish which occurred at a western site of Baker Island. The halfspotted hawkfish (*P. hemistictus*) was occasionally recorded at both islands. A single individual yellow hawkfish (*P. xanthus*) was seen at a southern Baker Island site.

Fusiliers (Caesionidae):

Although the four species of fusiliers seen were most frequently in large schools, because they were off transect and usually smaller than 20cm TL, they were not quantified as to actual numbers. Most commonly recorded were the blue-and-yellow fusilier (*Caesio teres*) and the neon fusilier (*Pterocasio tile*). Rarely seen were the wideband fusilier (*P. lativittata*) and Marr's fusilier (*P. marri*).

D.4.2 Towed-diver Fish Surveys

The tow team conducted 7 towed-diver habitat and fish surveys at Howland Island and 10 at Baker Island, surveying approximately 12 km and 19.12 km, respectively (311,200 m^2 total). A total of 871 fishes over 50 cm TL were observed.

Fish Observations

At the family level, snappers (Lutjanids) made up the majority of observations with 224 sightings, the majority of which (217) were the twin-spot snapper (*Lutjanus bohar*). Sharks (*Carcharhinids*) were the next most numerous family with 166 observations primarily of the grey-reef shark (*Carcharhinus amblyrhynchos*) (158), 147 of which were from Howland Island. Barracudas were seen in high numbers particularly at Howland Island (138). Carangids accounted for 116 observations, 55 of which were the black trevalley (*Caranx lugubris*), 24 of which were the giant trevalley (*Caranx ignobilis*) and 21 of which were the bluefin trevalley (*Caranx melampygus*).

The twin-spot snapper (*Lutjanus bohar*) was the most common species seen (217) observations followed by the grey-reef shark (*Carcharhinus amblyrhynchos*) (158). The two islands, however, showed significant differences in fish assemblage. Overall, we observed 602 fishes at Howland Island while observing 269 at Baker Island. *L. bohar* were seen in similar numbers (108, 109) at both islands while *C. amblyrhynchos* were far more numerous at Howland Island (147) than at Baker Island (11). Other notable observations included sightings of schools of scalloped hammerhead sharks (*Shyrna lewini*), the Napoleon wrasse (*Cheilinus undulatus*) and a large aggregation of green turtles (*Chelonia mydas*) located on the south side of Baker Island.

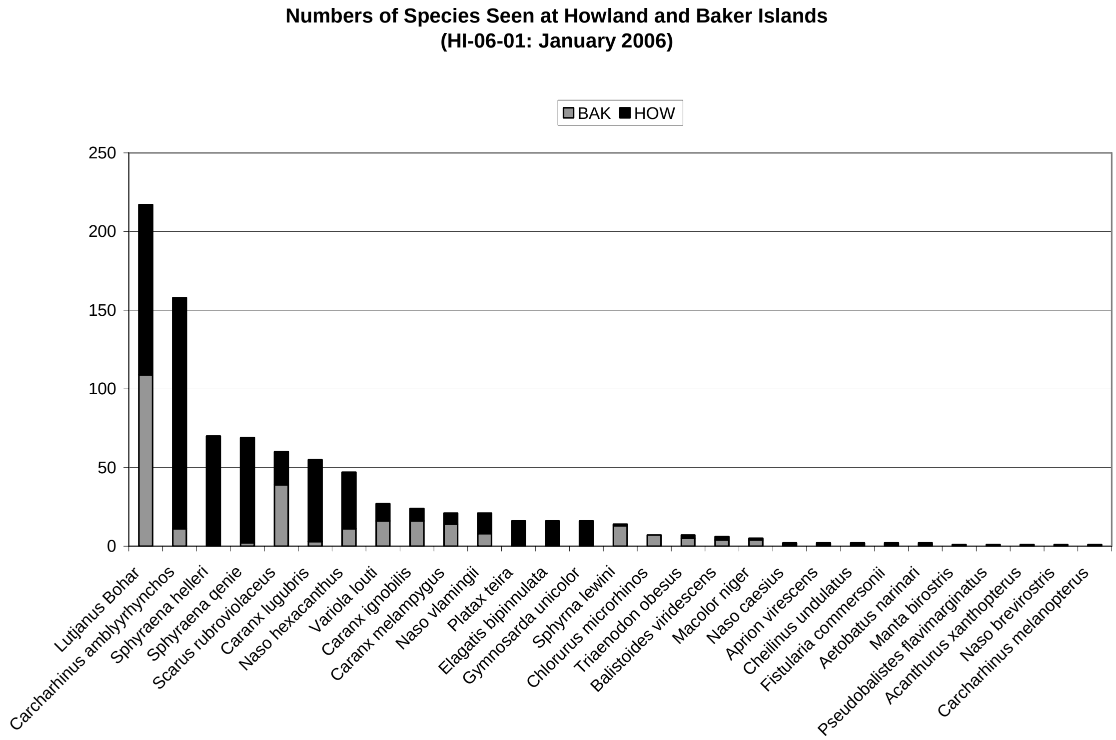


Figure D.4.2-1. Numbers of Species Seen at Howland and Baker Islands.

D.5. Terrestrial Surveys

The Terrestrial Team of Lee Ann Woodward and Chris Eggleston disembarked the *Hi'ialakai* for Baker Island the morning of January 30, 2006. Camp was made on the south shore at the alternate landing site. For the three days ashore, January 30-February 1, they conducted Mean Incubation Counts of masked boobies, red-footed boobies, brown boobies, great and lesser frigatebirds, and greyback terns. Tens of thousands of sooty terns were swarming, but were not found on any nests. As was found at Howland Island National Wildlife Refuge (NWR), the team found large numbers of lesser frigate fledglings dead and dying of apparent starvation. Many carcasses of sooty tern fledglings were also found; conditions must be bad for the sea-foraging adults. Shorebird counts found ruddy turnstones, Pacific golden plover, and bristle-thighed curlew. Plants were identified, photographed, and cataloged according to location. The Baker Island NWR sign was painted and repaired. Collection of Global Positioning System data for features identified from satellite imagery and landing sites was conducted along with the collecting of base station data for three identifiable locations. Soil samples were collected from several suspect sites for contaminants testing. On the final day, the team collected several eels and fish from the nearshore region for contaminants testing. The Terrestrial Team was embarked on the *Hi'ialakai* on the afternoon of February 1, 2006 after a very short shore visit by the *Hi'ialakai* CO.

D.6 Maps

Figure D.6.1. Map showing location of established Rapid Ecological Monitoring (REA) sites at Baker Island.

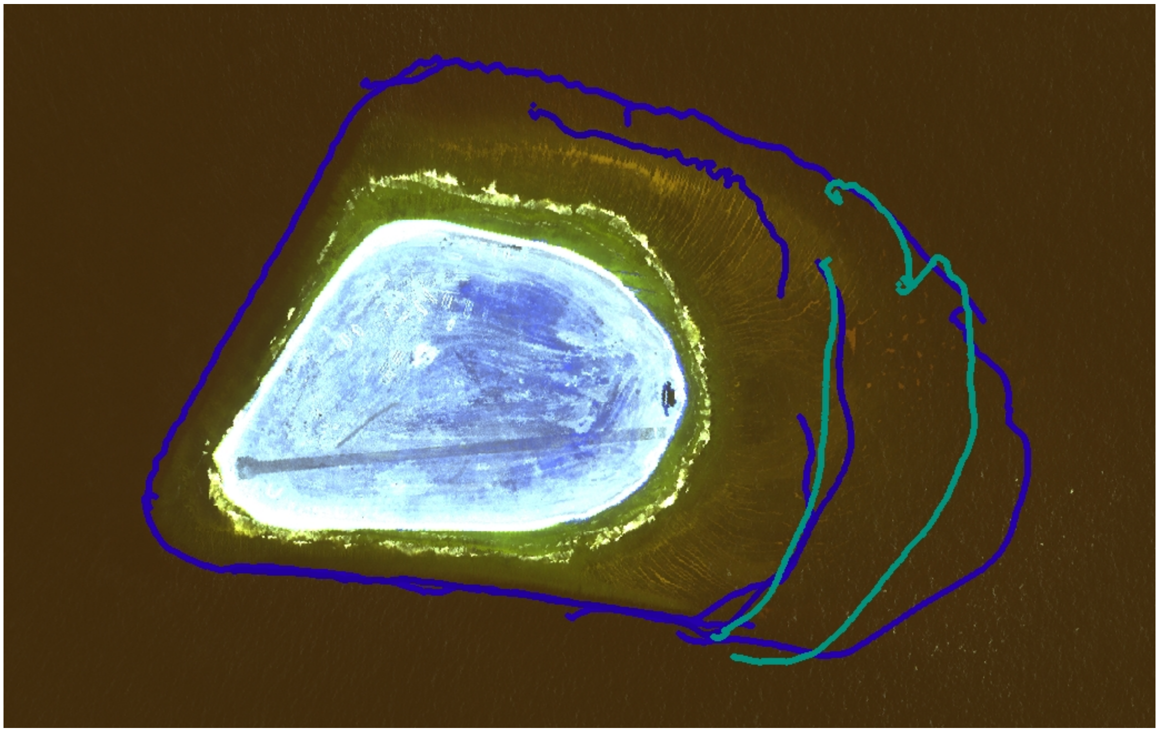


Figure D.6.2. Map showing location of towboard tracks at Baker Island.