U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

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CRUISE REPORT[1]

VESSEL: *Oscar Elton Sette*, Cruise 05-13 (OES-35) (Fig. 1)

CRUISE PERIOD: 12 October–30 October 2005

AREA OF OPERATION: Wake Atoll

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

ITINERARY:

10-12 Oct Start of cruise. Embarked Jamie Grover (fish), Joe Laughlin (fish), Stephani Holzwarth (fish/towboard), Aline Tribollet (algae), and Victor Bonito (invertebrates). Molly Timmers (towboard/fish), Jake Asher (towboard/habitat), Craig Musburger (fish), Elizabeth Keenan (towboard/habitat), Jamie Gove (oceanography), Ronald Hoeke (oceanography), Danniel Merritt (oceanography), Kyle Hogrefe (night ops), Kim Page (algae), Jean Kenyon (corals), and Bill Gordon (Chamber Operator) remained onboard from the previous leg. Departed the Guam Naval Harbor 12 October at 0800 en route to Wake Atoll. Conducted shipboard orientation meeting for all scientists. Conducted ship's fire and abandon ship drills.

13-17 Oct Transited to Wake Atoll. Conducted dive safety management meeting; new scientists experienced decompression chamber. Scientists set up computer work stations and network and prepared field survey gear and equipment. Fish and benthic rapid ecological assessment (REA) teams met to discuss site selections, and tow and mooring teams met to discuss operations. Arrived at Wake ~ 1800. Commenced night operations with six EK60 bioacoustic

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transects, one EK60 trawl, one Isaac Kidd Midwater Trawl (IKMT) and one acoustic Doppler current profiler (ADCP) transect.

18 Oct Diving operations began. Fish and benthic REA teams surveyed three stations along the southern forereef of the atoll. Towed-diver survey completed six tows along the southern forereef. Oceanography team collected 14 shallow conductivity (salinity), temperature, and depth (CTD) casts and 4 water sample profiles (22 samples total). Conducted one Bottom Camera Bait Station (BotCAM) survey. Conducted two daytime EK60 bioacoustic transects. During the night conducted one ADCP transect, two EK60 transects, and four deepwater CTD casts.

19 Oct Captain Trinh of USAF, Commander of Wake Island; Don Davis, Chugash Project Manager of Chugach Support Services (CSSI); Alan Woffard, Sheriff CSSI; and Thomas Tilley, Environmental Manager CSSI, embarked on the *Oscar Elton Sette* at 0800 for a Wake Atoll briefing and disembarked at 1000. Fish and benthic REA teams surveyed three stations along the southern forereef. Towed-diver survey team conducted three replicate southern tows and two shallow depth tows. Oceanography team collected seven shallow CTD casts and deployed a subsurface temperature recorder (STR). Conducted one BotCam station. During the evening conducted one ADCP transect, two EK60 transects, and four deepwater CTD casts.

20 Oct Fish and benthic REA teams surveyed two stations along the west forereef and one along the southeast forereef. Towed-diver survey team conducted tows along the west and northwest side of the atoll. Mooring team collected 12 shallow CTD casts, 2 CTD "tows," and 2 water samples (4 samples total). Deployed one sea surface temperature (SST) buoy and one STR in the lagoon. Conducted one BotCam station survey. Towed-diver survey team assisted in the retrieval of the BotCam. During the evening, conducted one ADCP transect and four deepwater CTD casts.

21 Oct Fish and benthic REA teams surveyed two sites inside the lagoon. Towed-diver survey team completed the northeast and east side of the atoll. Oceanography team conducted 11 shallow CTD casts and collected 2 water samples (12 samples total). Deployed an STR. All teams were back onboard ship by 1530. Chief scientist presented overview of CRED's Pacific Reef Assessment and Monitoring Program.

22 Oct Fish and benthic REA teams surveyed three stations along the north and east forereefs. Oceanography team deployed four STRs. Tow team conducted invertebrate collection dives with the Captain of Wake Island. Departed Wake Island at 1800 en route to Honolulu

23-29 Oct Transited back to Honolulu.

30 Oct Arrived in Honolulu 2300. Disembarked Jamie Grover (fish), Joe Laughlin (fish), Stephani Holzwarth (fish/towboard), Aline Tribollet (algae), Victor Bonito (invertebrates), Molly Timmers (towboard/fish), Jake Asher (towboard/habitat), Craig Musburger (fish), Elizabeth Keenan (towboard/habitat), Jamie Gove (oceanography), Ronald Hoeke (oceanography), Danniel Merritt (oceanography), Kyle Hogrefe (night ops),

Kim Page (algae), Jean Kenyon (corals), and Bill Gordon (Chamber Operator). End of cruise.

Table 1: Cruise statistics for Wake Atoll. (Fig. 2)

Towed-diver habitat/fish surveys	19
Fish REA surveys	14
Benthic REA surveys	14
SST buoys deployed	1
STRs deployed	5
Deepwater CTD casts	12
Shallow water CTD casts	44
Water samples collected	38
EK60 bioacoustic transects	14
Isaac Kidd Midwater Trawl (IKMT)	1
Trawl during EK60 Transect	1
ADCP transects around Wake Atoll	228 km
ADCP transects while transiting	6060 km
SCUBA dives	169

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 Wake Atoll.

B. Deploy an array of surface and subsurface oceanographic instruments to allow remote long-term monitoring of oceanographic and environmental conditions affecting the hydrographic environment that influences the coral reef ecosystem at Wake Atoll.

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

D. 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 this atoll ecosystem.

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

F. 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 Appendix B and Figure 2.

SCIENTIFIC PERSONNEL:

Molly Timmers, Chief Scientist, Towed-diver Survey Team−Fish, University of Hawaii (UH)-Joint Institute for Marine and Atmospheric Research (JIMAR), Pacific Islands Fisheries Science Center (PIFSC)-Coral Reef Ecosystems Division (CRED)
Stephani Holzwarth, Towed-diver Survey Team–Fish, UH-JIMAR, PIFSC-CRED
Jacob Asher, Towed-diver Survey Team–Habitat, UH-JIMAR, PIFSC-CRED
Elizabeth Keenan, Towed-diver Survey Team–Habitat, UH-JIMAR, PIFSC-CRED
Jamison Gove, Mooring Team, UH-JIMAR, PIFSC-CRED
Ronald Hoeke, Mooring Team, UH-JIMAR, PIFSC-CRED
Daniel Merritt, Mooring Team/BotCam, UH-JIMAR, PIFSC-CRED
Kyle Hogrefe, Mooring Team/Night Ops, UH-JIMAR, PIFSC-CRED
Kimberly Page, Benthic Team–Algae, UH-JIMAR, PIFSC-CRED
Aline Tribollet, Ph.D., Benthic Team–Algae, UH-JIMAR, PIFSC-CRED
Jean Kenyon, Ph.D., Benthic Team–Corals, UH-JIMAR, PIFSC-CRED
Victor Bonito, Benthic Team–Invertebrates, Florida Museum of Natural History
Joseph Laughlin, Fish Team, UH-JIMAR, PIFSC-CRED
Craig Musburger, Fish Team, UH-JIMAR, PIFSC-CRED
Jamie Grover, Fish Team, Univ. California Santa Cruz
Bill Gordon, Chamber Operator, NOAA dive center
Phil White, Senior Survey Tech, NOAA ship *Oscar Elton Sette*

DATA COLLECTED:

Fish REA numerical and biomass densities by species
Fish specimens for genetic analysis
Digital images of fish-habitat associations
Target REA macroinvertebrate counts
Macroinvertebrate voucher specimens
Algal voucher specimens
Coral voucher specimens
Invertebrate voucher specimens
Algal REA field notes of species diversity and relative abundance
Digital images from algal photoquadrats
Quantitative towboard surveys of large fish species (>50 cm TL)
Digital video surveys of habitat from towboard transects
Benthic composition estimations from towboard surveys
Macroinvertebrate counts from towboard surveys
Digital images of the benthic habitat from towboard surveys
Habitat lineation from towboard surveys
Shallow-deep conductivity, temperature and depth (CTD) profiles
Nutrient Sampling
Dissolved inorganic carbon from deepwater CTDs
Bioacoustic (echosounder) transects of sound scattering layer
Trawls within the bioacoustic mid-water pelagic boundary layer

(/s/Scott Ferguson) for
Submitted by: _____
Molly A. Timmers
Chief Scientist

(/s/Samuel G. Pooley)
Approved by: _____
Samuel G. Pooley, Ph.D.
Science Director
Pacific Islands Fisheries Science Center

Attachments

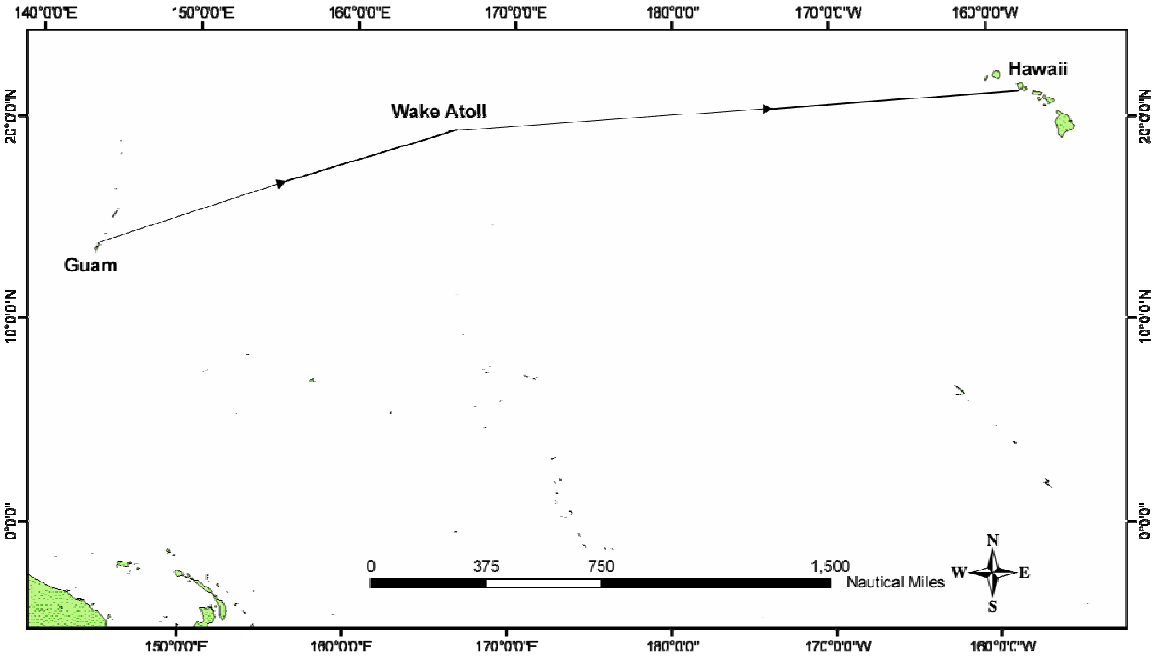

Figure 1. NOAA ship *Oscar Elton Sette* cruise track to Wake Atoll, 12–30 October 2005.

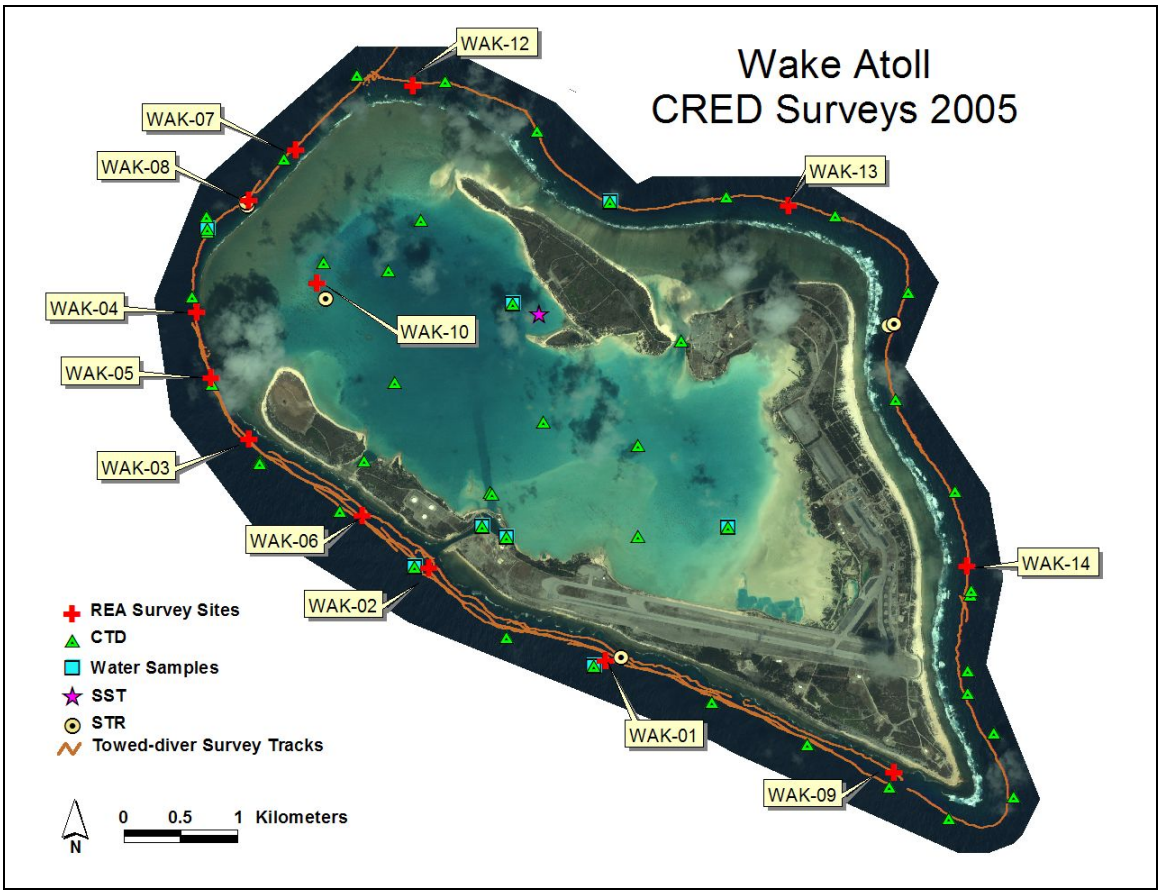

Figure 2. Surveys conducted on the *Oscar Elton Sette* Cruise 05-13 by the Coral Reef Ecosystem Division at Wake Atoll in 2005.

Appendix A: Methods

A.1 Oceanography & Water Quality Methods
(*Kyle Hogrefe, Ronald Hoeke, Jamison Gove, Daniel Merritt, and Phil White*)

Knowledge of oceanographic conditions and water quality at Wake Atoll is fundamental to understanding the structure and function of coral reef ecosystem dynamics such as reef morphology, larvae distribution, productivity, species richness and diversity, growth rates, and overall ecosystem health. Variability in the local hydrographic conditions directly affects water properties such as temperature, salinity, water clarity, and nutrient availability, all of which heavily influence local biological conditions on a reef ecosystem. A combination of in-situ and long-term monitoring data collection was conducted to help assess the oceanographic link to coral reef ecosystem dynamics.

The following in-situ oceanographic assessments were accomplished:

1. Shallow water (~30 m water depth) conductivity (salinity), temperature, and depth (CTD) profiles, including transmissometry (water clarity) measurements were conducted at regular intervals around Wake Atoll which provides information on small scale distributions of water masses, circulation, and local seawater chemistry changes.
2. Shallow water chlorophyll and nutrient samples were collected at 1-m, 10-m, 20-m, and 30-m water depths at regular intervals around Wake Atoll. This links water quality with water masses and provides insight into localized nutrient enrichment and/or eutrophication.
3. Shipboard (> 500 m water depth) CTDs and acoustic Doppler current profiler (ADCP) transects around Wake Atoll. This provides information on overall oceanographic structure, including dissolved oxygen and chlorophyll and circulation patterns surrounding the island.
4. Shipboard chlorophyll, nutrient, and dissolved inorganic carbon (DIC) samples taken at 3 m, 80 m, 100 m, 125 m, and 150 m at shipboard CTD locations around Wake Atoll. This provides ground truth information for the CTD profiles as well as insight into local nutrient levels and local carbon cycles.
5. Continuous recording of surface and subsurface water temperatures as a function of depth 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 information.

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

1. Sea Surface Temperature (SST) Buoys: Surface buoys measuring high-resolution water temperature. These buoys telemeter their data in near real time.
2. Subsurface Temperature Recorders (STRs) measure high-resolution subsurface temperatures.

Moorings, shallow water CTDs, and water samples were collected from a small boat during daylight hours. Shipboard CTDs, ADCP transects, and shipboard water samples were collected during nighttime hours and are generally termed “Night Ops,” along with bioacoustics data collection that is addressed in another section.

A.2 Rapid Ecological Assessment Methods

(Fish: Craig Musburger,Joe Laughlin, and Jamie Grover; Corals: Jean Kenyon and Victor Bonito; Algae: Kim Page and Aline Tribollet; Invertebrates: Victor Bonito)

The survey methodology used during OES-05-13 is the same as previous rapid ecological assessment (REA) surveys conducted by Coral Reef Ecosystem Division (CRED) cruises. 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 40–45 ft (~13–15 m) depth, except for a few shallow locations (12–35 ft;
~4–11 m). REA methods for each specific discipline are as follows.

A.2.1 Fish

Fish transect stations consisted of three consecutive 25-m lines set along a single depth contour at 13–15 m. As each line was set, quantitative belt transects (BLT) were conducted as the observers swam about 5 m apart along each side of the line, counting and recording size classes for all fishes >20 cm total length (TL) within an area 4 m wide and 4 m high. At the end of each 25-m line, the divers turned around and, while remaining on either side of the line, began counting and recording size classes of all fishes within 2 m of their side of the line and 4 m off the bottom. Four stationary point counts (SPC) were made at each transect station, generally ~15 m from the transect line. SPCs consist of the diver counting and recording the size classes for all fishes >25 cm total length observed in the water column within a cylindrical volume 10 m in radius during a 5-minute period. In addition, the divers recorded the species of fishes seen outside the transect area and outside the SPC counts on an opportunistic basis. During REA surveys, the divers record all species observed during the dive. These observations of diversity are combined with fish observed by other divers (benthic team, tow team, or mooring team) to develop an island-wide listing of all fishes observed. In addition, the fish team conducted supplementary collection activities on several dives following the completion of the quantitative surveys when potential new records or unidentifiable fish were observed.

A.2.2 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.2.3 Corals

Data pertaining to the coral fauna at Wake Atoll were collected by Dr. Jean Kenyon and Victor Bonito. At most sites, Kenyon videotaped along two 25-m transect lines deployed by the fish team and used the documentation as a permanent record of the condition of the benthos and for later use in independently calculating percent coral cover. Bonito followed behind Kenyon and used the line-intercept method at 50-cm intervals along both lines (51 points/transect) to

enable calculation of substrate composition. Then Kenyon swam in the reverse direction along the transect line(s) and tallied corals by genus, number of colonies, and maximum diameter. All corals whose colony center fell within 1 meter on either side of the transect line were enumerated and assigned to one of six size classes: <5 cm, 5-10 cm, 10-20 cm, 20-40 cm, 40-80 cm, or 80-160 cm. These transect tallies were used to determine coral abundance by genus and coral community size class distributions. Following this quantitative survey, Kenyon examined a larger area around the transect lines for the presence of additional coral taxa that did not occur within the belt transect. Digital still photos showing general overviews of the site were additionally taken by Kenyon as part of the data record.

Following implementation of the line-intercept method, Bonito conducted invertebrate surveys in the vicinity of the transect lines, including records of coral taxa. Bonito collected a number of coral specimens which were tagged and numbered upon returning to the ship and which will be deposited in the collections of the Florida Museum of Natural History. Kenyon collected six samples of *Acropora valida*, which will be sent to Dr. Steve Palumbi and Dr. Steve Vollmer as part of a pan-Pacific genetic assessment of this widespread species. Both Kenyon and Bonito took numerous digital still photos of corals in order to document their occurrence and as an aid to verifying their identification. Kenyon did not participate on surveys at sites WAK-6, 7, 8, or 9 because of illness. The data records at these sites are accordingly attenuated to what could be accomplished by Bonito.

En route to Honolulu onboard the *Oscar Elton Sette*, Kenyon and Bonito spent a full day reviewing a composite list of coral species by site, examining bleached specimens with a dissecting microscope, and reviewing digital photos. With the aide of Veron[1] and Randall and Myers[2], Kenyon and Bonito discussed several discrepancies in their respective taxonomic designations and rectified these discrepancies by agreeing upon a common terminology for each taxon.

A.2.4 Macroinvertebrates

The invertebrate fauna of Wake Atoll is poorly known and the only published species records is a baseline marine biological survey technical report based on surveys conducted in 1998 at six sites on the southern coastline. Taking this into consideration along with the fact that the coral REA team was lacking an assistant, the survey methods employed by the invertebrate surveyor were altered slightly from the protocol used on other expeditions in order to document the state of the reef and fauna with the personnel and resources available. The goals of the invertebrate REA surveyor were to: (1) collect quantitative data on the benthic composition of reef areas (usually done by the coral assistant), (2) collect quantitative data on macroinvertebrate abundance, and (3) document the invertebrate fauna (including corals) of Wake Atoll through observations, collections, and photographic records.

Goal (1) was achieved by employing a line-intercept sampling method along the first two of the three 25-m transects that were laid by the fish REA team at each site. For more details on this methodology and the results, see the Coral REA sections.

Goal (2) was achieved by conducting invertebrate belt transects along the same two transects as the line-intercept was employed on. Belt transects were 1 m wide on either side of the transect lines, thus two 50 m^2 belts were sampled at each site. Species searched for along the belt

transects include non-cryptic taxa of: zoanthids, anemones, echinoids, holothurians, ophiuroids, crinoids, asteroids, bivalves (*Tridacna*, ark shells, spondylid and pearl oysters), gastropods (i.e., *Lambis*, *Conus*, *Cypraea*, *Coralliophila* spp), cephalopods, and large crustaceans (lobsters, crabs, and shrimp).

Goal (3) was achieved during the remaining time on each dive (usually the last 15-25 minutes). Reef areas around the transects were searched and species lists, collections, and photographic records were made from each site. Additional reef flat snorkels were conducted at sites 3 (3-1 in table) and 11 to assess the invertebrate species composition of theses habitats. Results of the scleractinian, zoanthid, alcyoniin, milleporian, and gorgonian records are given in the coral REA section. Collections or photographic records of encrusting, boring, or delicate sponges, ascideans, and bryozoans were not made, thus documentation of this fauna is minimal. Sand collections were made from several of the sites for documentation of microfauna in the lab.

A.3. Towed-diver Survey Team Methods
(Molly Timmers, Elizabeth Keenan, Stephani Holzwarth, Jacob Asher, Jamison Gove, Ron Hoeke)

Shallow water habitats were surveyed using pairs of towed divers on towboards equipped with a downward high resolution digital still camera with dual strobes (benthic towboard) and forward-looking digital video camera (fish towboard) to quantify habitat composition and complexity and abundance and distribution of ecologically and economically important fish and macroinvertebrate taxa. The downward-looking camera was maintained 1-2 m off the bottom and was programmed to photograph benthic substrate every 15 seconds. The diver on the benthic towboard observed and recorded habitat composition (hard coral, stressed hard, soft coral, macroalgae, coralline algae, sand and rubble) and tallied conspicuous macroinvertebrates (crown-of-thorns starfish (COTS), urchins, sea cucumbers, and giant clams) along a 10-m swath. The diver on the fish towboard recorded fish greater than 50 cm total length along a 10-m swath for
4 minutes followed by a 1-minute all around search in the same 5-minute ensembles. Both towboards were instrumented with precision temperature and depth recorders (Seabird SBE39). GPS positions, temperature, and depth were recorded every 5 s along each transect. The data were downloaded and presented in ArcView GIS and overlaid on high resolution IKONOS imagery. Each towed-diver survey was approximately
50 minutes long and covered approximately 2 km of habitat.

A.4. Bottom Camera Bait Station
(Danny Merritt, Ron Hoeke, Jamison Gove, Jake Asher, Bill Gordon)

The BotCam system contains two stereo-video cameras housed within an aluminum frame. Attached to the frame is a removable bait arm. This positively buoyant frame is made negatively buoyant with sacrificial concrete anchors which are attached with an acoustic release. The cameras are arranged on the frame to float between 1.5 to 3 meters off the bottom, allowing the system to operate in high rugosity and steep terrain. The stereo-video configuration allows for the sizing and ranging of both fish and benthic features. The BotCam system includes programmable control functions which allow for the activation of imaging systems, bait release, image scaling indicators, and acoustic recovery.

The BotCam is deployed between 150 and 350 meters on steep shelves or deep pinnacles. Drop sites are found by both bathymetric charts and depth finders. It can be deployed repetitively during a survey or it can sit dormant on the seafloor and be activated by a preset time. Prior to deployment, a bait container is filled with a mixture of ground squid and mackerel and then sealed. The unit is programmed to turn on and off at a predetermined time and then lowered to the desired location via a surface line. Once the system reaches the bottom, recording begins and a signal is sent to the bait container to release the bait thereby attracting fish into the field of view. Filming continues for
20 minutes to an hour. Once the recording is complete, an acoustic signal is sent from the ship, releasing the concrete blocks from the system and allowing the BotCam to float to the surface. The ship can then retrieve the surface line and reel in the BotCam for data download.

A.5. Bioacoustics
(Kyle Hogrefe and Phil White)

Sound-scattering layers (SSLs) are communities of organisms composed of various combinations of zooplankton, planktonic larvae, and micronekton. SSLs are found in many parts of the world's oceans and are characterized by a diel vertical migration from daytime subphotic habitats into surface waters at night. Since 2003, nightly migrations of nearshore SSLs into shallow water habitats have been documented at nearly all locations surveyed during Reef Assessment and Monitoring Program (RAMP) cruises. This suggests that an important trophic link exists between coral reefs and the biomass occurring at the boundary between the neritic and pelagic habitats, commonly referred to as the mesopelagic boundary community (MBC). The goals of the bioacoustics effort are to collect physical samples and video images of the organisms that comprise the MBC, to further document the diel migration of the MBC, and to collect oceanographic data to help gain a better understanding of the interaction between the coral reef habitat and the MBC as it occurs around Wake Atoll.

The four objectives of the bioacoustics effort are as follows (in order of priority):

1. Obtain biological samples of MBC organisms around island/atoll slopes and in the water column over coral reef banks using an Isaacs-Kidd midwater trawl (IKMT) net with an effort to sample from layers occurring at different depths in the water column. This is because some organisms, such as micronekton, may limit the extent of their vertical and horizontal migrations.

2. Document the diel migration of mid-water biota near the different islands and atolls of the Mariana Islands by utilizing an EK60 echosounder as on previous RAMP cruises across the Pacific. This is accomplished by sampling preset transect lines, both during the day and at the midpoint of the night, to establish the presence or absence of the MBC and document its vertical and horizontal migration.

3. Obtain data on the properties of the water column where MBCs are observed using deepwater CTD casts that include water sample profiles. One CTD cast is usually conducted along or near the transect line sampled acoustically. Acoustic Doppler current profiles may also serve to explain the distribution of the MBC around islands, atolls, and banks.

4. Obtain video recordings of the organisms of the MBC in shallow water conditions, where a trawl is not feasible, with a cabled video camera to depths of up to 75 meters.

Appendix B: Wake Atoll

B.1. Oceanography and Water Quality

Although most data collected by the oceanography team requires extensive post-cruise analysis, preliminary analyses of shallow and deep (shipboard) conductivity-temperature-depth (CTD) profiles have provided some initial insight into the oceanographic conditions at Wake Atoll. There are indications of weak upwelling along the north and east sides of the atoll; shallow water CTD temperatures are 0.1-0.2ºC cooler and salinities ~0.05 PSU greater than surrounding waters as well as shipboard CTD temperatures and salinities measured at the same depth range (Fig. B.1.1). This possible upwelling of subsurface waters, however, is extremely weak compared to reef assessment observations at other locations (e.g., Jarvis, Pearl and Hermes, and Palmyra). Overall, the surface layers (<50 m) in the forereef zone and offshore were well mixed, with little stratification or spatial variation during operations at Wake Atoll; hardly surprising given the large swell (~2–5 m) and strong winds (10–25 knots). Conversely, water types within the lagoon were extremely diverse. At most CTD locations within the lagoon, temperatures were 0.5–1.5ºC cooler and salinities 02.−0.7 PSU lower than the forereefs. In the small channel between Peale and Wake Island, however, temperatures were 1.5ºC greater than outside the lagoon and up to 3ºC greater than surrounding lagoon waters, although salinities were close to those outside the lagoon (Fig. B.1.2). These large differences within the lagoon are difficult to explain. One potential hypothesis is that rainfall and radiative cooling associated with the stormy conditions during the first few days of field operations cooled and diluted lagoon waters relative to oceanic conditions. The high north swell during the following warm sunny days drove relatively warmer, more saline water over the extensive reef flat bordering the north side of the atoll, where the water was warmed further before being adverted through the small pass and into the lagoon. It is, however, difficult to understand why the waters elsewhere in the lagoon were not heated to a similar temperature. An alternate hypothesis is that the observed differences in water type were attributed to anthropogenic outfalls associated with the extensive military facility on Wake Island. In general, lagoon waters were about 20−50% more turbid than outside the lagoon. The large disparity between the lagoon and the surrounding oceanic waters indicate relatively little exchange between these two areas. The only indication of lagoon waters exiting to the forereef zone is just south and west of Wilkes Island and just outside the small boat harbor, indicating a possible outflow at the latter location. The observations and hypotheses presented here only pertain to conditions during field operations; it is unlikely that they represent modal conditions considering the episodic swell heights during much of the field effort.

Table B.1.1 : Instrumentation Summary

Site	SST	STR	Comments
Wake Atoll	1	6	These are all new deployments as this is the first Reef Assessment cruise to Wake. The SST and an STR were deployed in the Lagoon; the remaining STRs were deployed in the forereef zone.

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

Acronyms:SST = Sea Surface Temperature (buoy), STR = Subsurface Temperature Recorder

Table B.1.2: Shallow Water Oceanographic Sampling Summary

Site	CTD sites	Water sample sites	Chlorophyll samples collected	Nutrient samples collected	Comments
Wake Atoll	46	9	24	14	Wake Lagoon is extremely shallow; only surface (1 m) water samples were collected. At other water sampling locations, only 1-m and 30-m nutrient samples were collected because of a shortage of sample bottles.

Note: all water sample sites are concurrent with CTD sites.

Table B.1.3: Shipboard Oceanographic Sampling Summary

Site	CTD sites	Water sample sites	Chlorophyll samples collected	Nutrient samples collected	DIC samples collected	Comments
Wake Atoll	12	12	60	16	16	CTD profiles and concurrent water samples were obtained on the corners of three acoustic Doppler current profiler (ADCP) box transects around the atoll. One large and one small transect had cardinal orientation with a second small transect rotated 45˚. Both small transects were nested within the large transect. Chlorophyll samples were collected at all sights while DIC and nutrient samples were collected only at 80 m and 3 m on the corners of the transects with cardinal orientation.

Note: all water sample sites are concurrent with CTD sites.

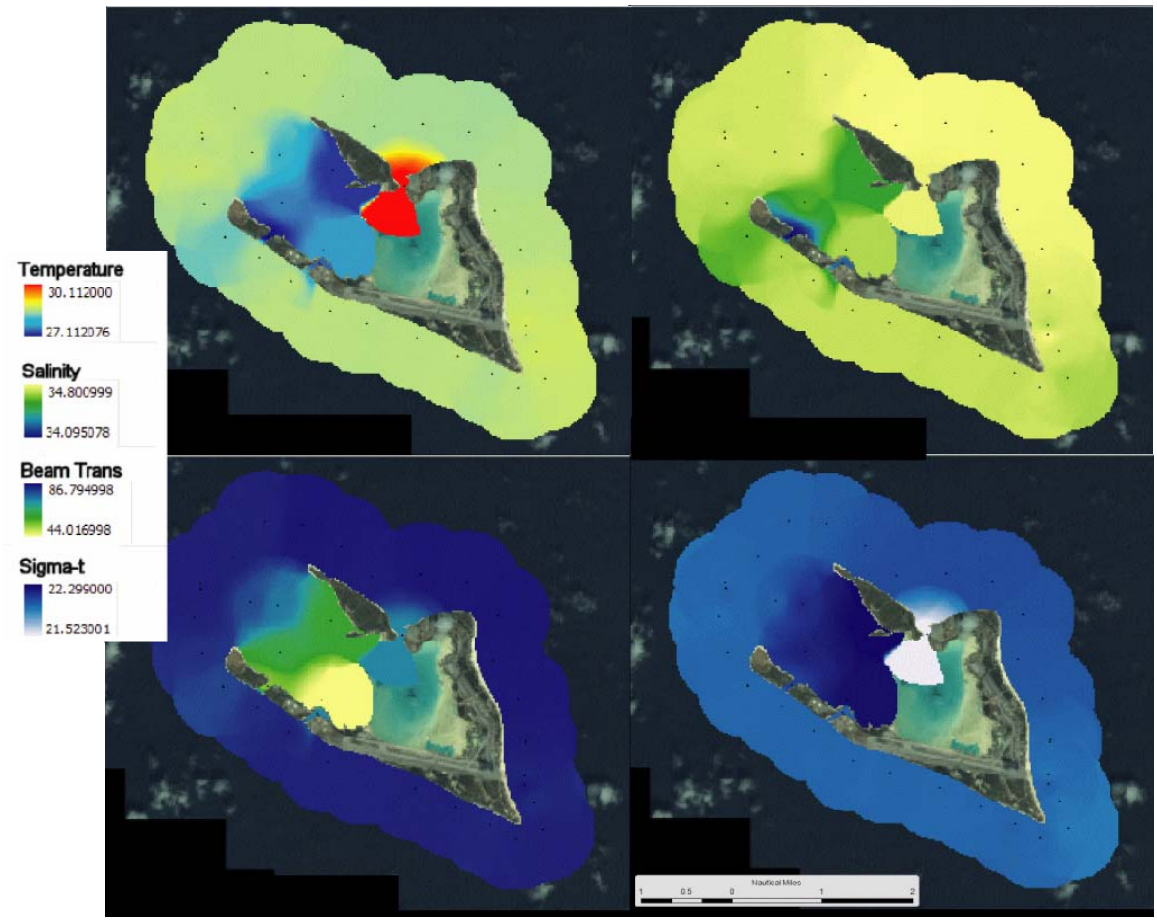

Figure B.1.1 – Water properties at 2-m depths from shallow CTD casts. Upper left, temperature (ºC); upper right, salinity (psu); lower left, beam transmission (turbidity) (%); lower right, σ_t (density) (kg/m^3).

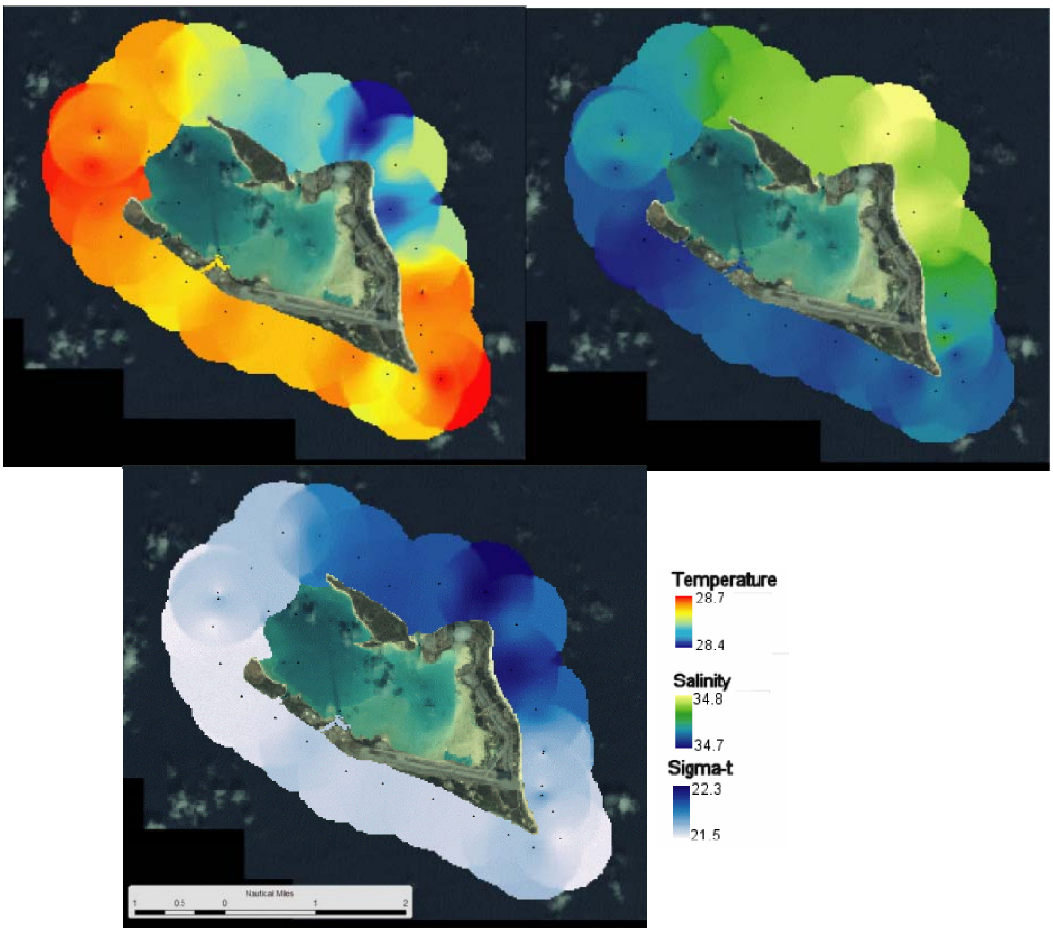

Figure B.1.2 – Water properties at 20m depths from shallow CTD casts. Upper left, temperature (°C); upper right, salinity (psu); below, σ_t (density) (kg/m^3).

B.2. Benthic environment

B.2.1. Algae

- *Halimeda* sp., *Dictyota* spp., *Lobophora variegata* and *Caulerpa* spp. were the most ubiquitous and abundant macroalgae found at Wake Atoll, each seen at greater than 25% of the photoquadrats.
- Turf algae and crustose corallines were seen at greater than 60% of the quadrats.
- Blue-green alga mats and *Caulerpa serrulata* were very common within the lagoon.

B.2.1.1. Algal Rapid Ecological Assessment (REA) Site Descriptions

WAK 1: This site was located on the southwest side of Wake Island on the forereef. It had the highest live coral cover of the three sites visited on this day. It comprised a number of reefs surrounded by white sand channels. On the shore side of the transect there was a vertical wall from ~14 m to ~3 m, and on the ocean side of the transect there was a drop-off at ~21 m. The transect was located on the plateau between these two walls. Turf algae, *Dictyota* sp., *Halimeda* sp., *Caulerpa* spp., crustose coralline algae, blue-green algae, *Jania* sp., and *Cladophora* sp.

were recorded within the photoquadrat area. *Ventricaria ventricosa* was additionally found during the random swim.

WAK 2: This site was located on the southwest side of Wake Island directly east of the small boat harbor entrance. This site was characterized by the presence of a large shipwreck. Both transects were laid over pieces of the shipwreck which serve as new habitat for reef organisms. Turf algae, *Dictyota* sp., *Halimeda* sp., *Caulerpa* spp., crustose coralline algae, blue-green algae, *Jania* sp., *Lobophora variegata*, and *Neomeris* sp. were recorded within the photoquadrat area. *Ventricaria ventricosa* was additionally found during the random swim.

WAK 3: This site was on the southwest tip of the island. This site had high relief with lots of pinnacles and less live coral than WAK 1. The visibility was low here because of the proximity of the lagoon entrance. Turf algae, *Dictyota* sp., *Halimeda* sp., *Caulerpa* spp., *Lobophora variegata*, *Neomeris* sp., *Cladophora* sp., and blue-green algae were seen within the quantitative survey area.

WAK 4: This site was located on the southwest corner of the atoll. It was characterized by a steep slope with a high abundance of fish and live coral. *Halimeda* sp. was also very abundant. In addition, turf algae, *Dictyota* sp., *Lobophora variegata*, *Peyssonnelia* sp., *Caulerpa* sp., crustose coralline algae, *Cladophora* sp., blue-green algae, and *Neomeris* were recorded from the photoquadrat area. An orange encrusting alga was additionally recorded outside of the survey area.

WAK 5: This site was located on the southwest corner between WAK 4 and 3. This site looked like a canyon with large pinnacles, and had lower visibility closer to the reef crest. *Dictyota* was the dominant macroalgae. In addition, turf algae, *Halimeda* sp., *Lobophora variegata*, crustose coralline algae, *Caulerpa serrulata*, *C. racemosa*, *Neomeris* sp., and *Cladophora* sp. were seen during the quantitative assessment.

WAK 6: This site was also located on the south, southwest side of the island between WAK 2 and 3. This site had a high abundance of soft coral around 6 m depth. There was a wall going down to the survey area at ~15 m with large pinnacles and sand channels. *Dictyota* sp., crustose coralline algae, *Halimeda* sp., turf algae, *Lobophora variegata*, *Caulerpa* sp., *Neomeris* sp., and blue-green algae were recorded during the photoquadrat survey. *Ventricaria ventricosa* was additionally found during the random swim.

WAK 7: This site was located on the west side of the island. It was a steep sloped forereef with high wave energy (large waves breaking on the reef crest). There was a high diversity of corals and fish. *Halimeda* sp., turf algae, *Lobophora variegata*, crustose coralline, *Caulerpa* sp., *Dictyosphaeria versluysii*, *Dictyota* sp., *Cladophora* sp., *Ventricaria ventricosa*, blue-green algae and *Neomeris* were recorded during the photoquadrat survey.

WAK 8: This site was located south of WAK 7 on the west side of the atoll. This site experienced similar wave energy as WAK 7 but had less coral cover and diversity. Turf algae, *Halimeda* sp., *Dictyota* sp., crustose coralline algae, *Lobophora variegata*, *Caulerpa* sp., *Jania* sp., blue-green algae, *Neomeris* sp., *Galaxaura filamentosa*, *Dictyosphaeria versluysii*, and *Ventricaria ventricosa* were recorded during the quantitative assessment.

WAK 9: This site was located on the southeast side of the island near the southeastern tip of the reef. It was characterized by pinnacles of biotic reef composed of soft corals and *Pocillopora* heads as well as large areas of dead carbonate substrate. Turf algae, *Dictyota* sp., *Halimeda* sp., crustose coralline algae, *Caulerpa* spp., and *Cladophora* sp.were recorded from the photoquadrat area. *Ventricaria ventricosa*, *Neomeris* sp., *Peyssonnelia* sp. and an orange crust were additionally seen during the random swim.

WAK 10: This site was located on the west side of the lagoon near the reef crest. There was a shallow patch reef surrounded by sandy areas with high amounts of *Caulerpa serrulata* and microbialites (blue-green mats). In addition, turf algae and *Lobophora variegata* were recorded from the quadrat area. Outside the quadrat area, *Avrainvillea* sp., *Caulerpa racemosa*, *Halimeda* sp., *Dictyota* sp., and *Dictyosphaeria* sp. were collected.

WAK 11: This site was located on the southwest side of the lagoon that was also near the reef crest. This site was too shallow to survey quantitatively. Only a qualitative collection was completed. From this site, turf algae, crustose coralline algae, *Halimeda* sp., *Dictyota* sp. and *Caulerpa* sp. were collected.

WAK 12: This site was located on the northwest side of Wake Atoll in front of the open side of the lagoon. This site had very high coral cover and high abundances of fish including eagle rays and algae. It was a steep sloping reef with very high visibility. Turf algae, Crustose coralline, blue-green algae, *Lobophora variegata*, *Dictyota* sp., *Halimeda* sp., *Caulerpa* spp., and *Ventricaria ventricosa* were recorded from within the quadrat area. A branched species of *Codium* was additionally found at this site.

WAK 13: This site was located on the north side of the atoll off from the "downtown" region on Wake Island. This was also a steep sloping reef with pinnacles causing there to be higher relief. There was also a higher surge and less coral cover and higher coralline algae cover at this site than at WAK 12. Turf algae, crustose coralline algae, *Halimeda* sp., *Cladophora* sp., branched coralline algae, *Lobophora variegata*, *Dictyota* sp., *Codium* sp., *Dictyosphaeria* sp., *Caulerpa* spp. (3 spp.), blue-green algae, and *Neomeris* sp. were observed within the photoquadrat area. *Avrainvillea* sp. was additionally collected.

WAK 14: This site was located on the east side of the atoll off from the runway. This site had a shelf-like morphology and was dominated by large *Porites* sp. coral heads. Turf algae, *Halimeda* sp., *Lobophora variegata*, *Caulerpa* sp., *Dictyota* sp., blue-green algae, *Cladophora* sp., *Neomeris* sp., and crustose coralline algae were quantitatively recorded. Additionally, *Codium* sp. was collected from this site.

Table B.2.1.1: Algae of Wake Atoll. Bold numbers indicate the number of photoquadrats in which an alga occurred; italicized numbers indicate the alga's relative abundance (rank) in relation to other algae occurring in the same photoquadrat. Standard deviations of island averages are given in parentheses. Asterisks indicate algae found during the random swim that did not occur in photoquadrats sampled.

	WAK 1	WAK 2	WAK 3	WAK 4	WAK 5	WAK 6	WAK 7	WAK 8	WAK 9	WAK 10	WAL 12	WAK 13	WAK 14	**Island Average**
Avrainvillea							**8.33** *8.00*			*		*		**0.64** **(2.31)** *8.00*
Caulerpa	**25.00** *4.00*	**25.00** *5.00*	**33.33** *2.75*	**41.67** *3.20*	**58.33** *3.00*	**25.00** *3.33*	**66.67** *4.00*	**66.67** *5.00*	**8.33** *5.00*	**75.00** *1.67*	**33.33** *4.50*	**8.33** *4.00*	**25.00** *3.67*	**37.82** **(22.21)** *3.78* *(0.99)*
Cladophora	**8.33** *5.00*		**8.33** *6.00*	**16.67** *5.50*	**8.33** *6.00*		**8.33** *4.00*		**8.33** *q3.00*			**41.67** *4.60*	**16.67** *4.00*	**8.97** **(11.52)** *4.76* *(1.07)*
Codium											*	**8.33** *4.00*	*	**0.64** **(2.31)** *4.00*
Dictyosphaeria							**66.67** *3.50*	**58.33** *4.29*		*		**33.33** *4.25*		**12.18** **(24.20)** *4.01* *(0.44)*
Halimeda	**75.00** *2.11*	**91.67** *3.09*	**83.33** *2.90*	**100.00** *1.33*	**75.00** *3.22*	**66.67** *2.75*	**100.00** *2.25*	**100.00** *2.67*	**75.00** *2.78*	*	**100.00** *2.67*	**100.00** *2.33*	**100.00** *2.00*	**82.05** **(27.61)** *2.51* *(0.53)*
Neomeris		**66.67** *5.88*	**33.33** *4.50*		**8.33** *5.00*	**8.33** *4.00*	**8.33** *7.00*	**25.00** *8.00*	*			**8.33** *6.00*	**16.67** *6.00*	**13.46** **(19.11)** *5.80* *(1.31)*
Ventricaria	*	*				*	**16.67** *6.50*	**8.33** *6.00*	*		**8.33** *6.00*			**2.56** **(5.25)** *6.17* *(0.29)*
Galaxaura								**16.67** *7.00*						**1.28** **(4.62)** *7.00*

	WAK 1	WAK 2	WAK 3	WAK 4	WAK 5	WAK 6	WAK 7	WAK 8	WAK 9	WAK 10	WAL 12	WAK 13	WAK 14	**Island Average**
Jania	**16.67** *5.50*	**8.33** *7.00*						**16.67** *6.50*						**3.21** **(6.40)** *6.33* *(0.76)*
Peyssonnelia	**16.67** *4.50*			**16.67** *3.50*					*					**2.56** **(6.26)** *4.00* *(0.71)*
branched upright coralline												**8.33** *4.00*		**0.64** **(2.31)** *4.00*
crustose coralline	**50.00** *4.50*	**75.00** *2.89*	**16.67** *3.50*	**58.33** *4.57*	**58.33** *4.43*	**50.00** *4.33*	**75.00** *4.89*	**83.33** *3.80*	**58.33** *3.71*		**100.00** *2.17*	**100.00** *1.92*	**66.67** *3.13*	**60.90** **(28.74)** *3.65* *(0.97)*
Dictyota	**83.33** *1.90*	**100.00** *3.33*	**100.00** *2.08*	**100.00** *3.50*	**100.00** *1.50*	**100.00** *1.92*	**58.33** *6.00*	**58.33** *5.57*	**83.33** *2.10*		**58.33** *5.43*	**25.00** *4.67*	**91.67** *3.18*	**73.72** **(32.25)** *3.43* *(1.62)*
Lobophora	**33.33** *4.25*	**66.67** *3.75*	**33.33** *3.50*	**58.33** *5.29*	**75.00** *4.56*	**50.00** *3.50*	**91.67** *3.73*	**91.67** *3.27*		**8.33** *4.00*	**100.00** *3.75*	**58.33** *4.71*	**25.00** *3.67*	**53.21** **(32.01)** *4.00* *(0.59)*
orange crust	**8.33** *4.00*			*					*					**0.64** **(2.31)** *4.00*
Blue-green	**16.67** *4.00*		**16.67** *6.50*	**25.00** *5.00*										**18.59** **(14.89)** *5.10* *(1.18)*

B.2.2. Corals

REA surveys were conducted at 13 sites (12 forereef, 1 lagoon), and a qualitative snorkel survey assessing occurrence of coral taxa was conducted at one backreef site (WAK-11). Bonito additionally snorkeled in shallow (<5 m) water along the coast near WAK-3. Site numbers, locations, and other site descriptive parameters are presented in Table B.2.2.1. Locations of REA sites around Wake are shown in Fig. B.2.2.1.

Table B.2.2.1. Sites surveyed by REA team, OES-05-13, October 2005. Depths and temperatures are from Kenyon dive gauges. NA = data not taken

Wake Site #	Date	Latitude (N)		Longitude (E)		Transect depth (m)	% Coral cover	Max depth (m)	Temp °C
1	10/18/05	19	16.809	166	37.652	15-18	24.5	18.3	28.3
2	10/18/05	19	17.259	166	36.782	12.5-13.4	24.5	15	28.3
3	10/18/05	19	17.864	166	35.890	15	26.5	16.4	28.3
4	10/19/05	19	18.170	166	35.692	13.5-14.5	27.4	16.4	28.3
5	10/19/05	19	18.469	166	35.627	13.5-14.5	27.5	16.7	28.3
6	10/19/05	19	17.503	166	35.446	NA	22.5	NA	NA
7	10/20/05	19	19.228	166	36.129	NA	56.9	NA	NA
8	10/20/05	19	18.992	166	35.894	NA	35.3	NA	NA
9	10/20/05	19	16.270	166	39.069	NA	24.9	NA	NA
10	10/21/05	19	18.608	166	36.230	0.5-2	14.7	2.7	28.8
11	10/21/05	19	18.299	166	36.009	Qualitative snorkel survey			28.8
12	10/22/05	19	19.524	166	36.712	13.5-15	76.6	15.8	28.3
13	10/22/05	19	18.946	166	38.573	15-16.7	81.4	19.5	28.3
14	10/22/05	19	17.237	166	39.441	15-16.7	64.7	17.7	28.3

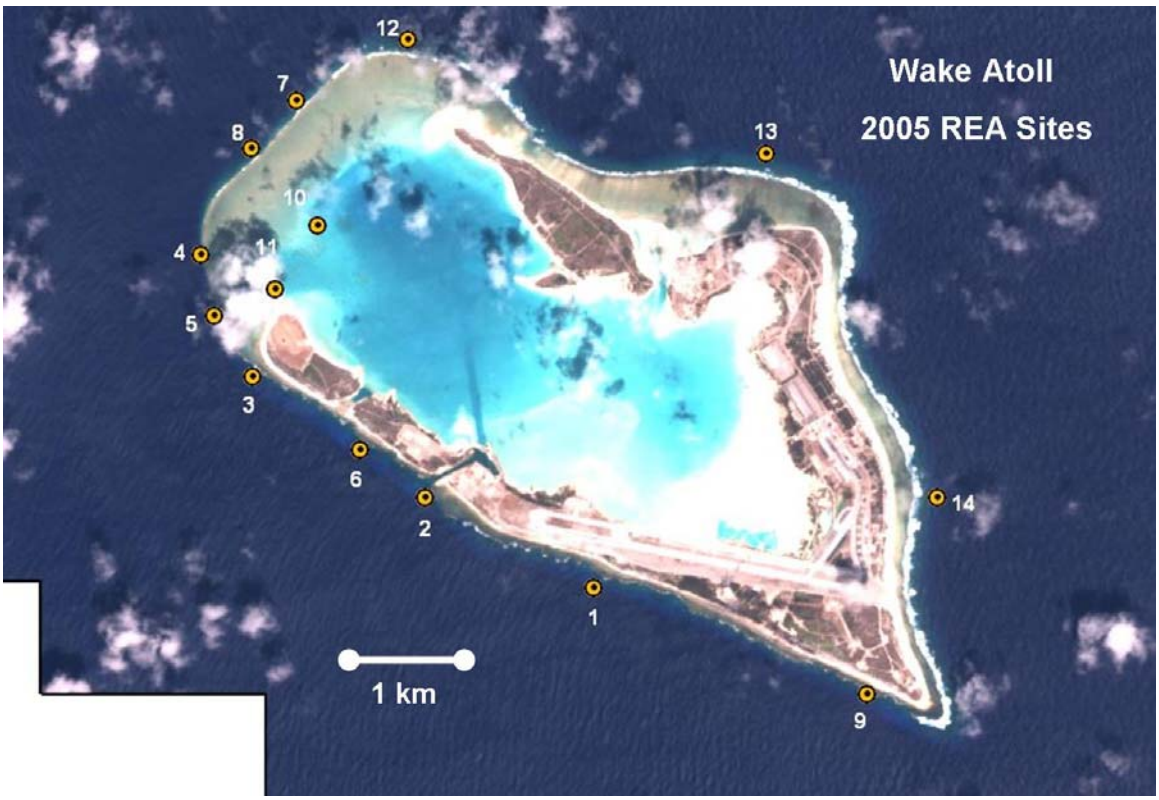

Figure B.2.2.1. Location of REA survey sites at Wake Atoll.

Coral Biodiversity

Before the present surveys, only two scientific surveys that included observations of corals had been undertaken at Wake Atoll. Dr. James Maragos[3] generated a list of 31 species representing 13 genera of cnidarians from surveys conducted at five sites in 1979 (two south forereef sites and three north backreef/lagoon sites), and Michael Molina[4] generated a list of 41 species representing 20 genera of cnidarians from surveys conducted at six sites along the south forereef in 1998. Molina's list also included octocorals, which were lumped as a single category. Together these studies included 50 scleractinian species representing 23 genera, two *Millepora* (Class Hydrozoa) species, and an unspecified suite of octocorals. Maragos and Molina's lists were a valuable background resource for the present survey.

Bonito and Kenyon recognized, photographed, and/or collected 81 putative scleractinian coral species and photographed an additional 4-5 *Montipora* species that appear to be distinct but whose identification could not be referenced with materials available onboard. In addition, one hydrozoan (*Millepora platyphylla*), a zoanthid (*Palythoa* sp.), and five octocoral genera (*Lobophytum*, *Sarcophyton*, *Sinularia*, *Stereonephthya*, and *Acabaria*) were documented with photographs and collections (Table B-2). Bonito/Kenyon did not observe 17 of the 52 cnidarian taxa reported by Maragos/ Molina. It is possible that some of the identifications made by Bonito/Kenyon may, upon further study of specimens and photographs at the Florida Museum of Natural History, overlap with designations made by Maragos/Molina (e.g., an unknown *Montipora* species recorded by Bonito/Kenyon

may be the same species as what Maragos termed *M. marshallensis*, which is not recognized by Veron[3]; also, Bonito/Kenyon wondered if Molina's "*Acropora aculeus*" was what they have termed "*Acropora microclados*", as they are not aware of the degree of photographic/specimen documentation that was associated with the Maragos/Molina studies). With these caveats in mind, the present study brings to 102 the number of scleractinian taxa now reported from Wake Atoll, in addition to 2 *Millepora* species, a zoanthid, and 5 octocoral genera. Of the 81 putative scleractinian species compiled by Bonito/Kenyon, at least 46 are new records, as are the zoanthid *Palythoa* and all 5 octocoral genera (Table B.2.2.2).

Table B.2.2.2. Coral fauna at Wake Atoll, October 2005, Coral Reef Ecosystem Division cruise OES-05-13; VB = Victor Bonito; JK = Jean Kenyon. ? = tentative identification requiring further study. Descriptive working names of unidentified spp. are given in quotations. N = No, Y = Yes

Taxon	New record?	Recorded by:	Collected (VB)	Photographed (VB and/or JK)
Scleractinian Corals				
Acroporidae				
Montipora foveolata	N	VB/JK	x	X
M. aff. Foveolata	Y	VB	x	X
M. hoffmeisteri	N	VB/JK		X
M. "spikey"	Y	VB/JK	x	X
M. lobulata	N	VB/JK	x	X
M. aff. Elschneri	Y	VB	x	X
M. ?monasteriata	N	VB		
M. grisea	Y	VB/JK	x	X
M. aff. Grisea	Y	VB	x	X
M. informis sensu Veron[1] = M. tuberculosa sensu Randall[2]	N	VB	x	X
M. aff. Planiuscula	Y	VB		X
M. sp. 2 sensu Randall[2]	Y	VB	x	X
M. ?incrassata	Y	VB/JK	x	X
Montipora sp. 2	?	VB	x	X
M. other spp.(~4-5)	?	VB/JK	x	X
Acropora abrotanoides	Y	VB	x	X
A. valida	N	VB/JK	x	X
A. aff. Valida	Y	VB		
A. humilus	Y	VB/JK	x	X
A. hyacinthus	Y		x	
A. surculosa	Y	VB/JK	x	X
Acropora sp. 1 sensu Randall[2]	Y	VB		X
A.?microclados	Y	VB/JK	x	X
A. "distorted"	Y	VB/JK	x	X
A. palmerae	Y	VB		
A. ocellata sensu Randall[2]	Y	VB		
A. aff. ocellata sensu Randall[2]	Y	VB	x	
A. "cerealis-type"	Y	VB		
A. "robusta-like"	Y	VB	x	X

Taxon	New record?	Recorded by:	Collected (VB)	Photographed (VB and/or JK)
A. "lip"	Y	VB/JK	x	X
A. ?striata	Y	JK	x	X
A. "fragile"	Y	VB	x	X
Astreopora myriophthalma	N	VB/JK	x	X
A. randalli	Y	JK		X
Pocilloporidae				
Pocillopora damicornis	N	VB/JK	x	X
P. eydouxi	N	VB/JK		X
P. meandrina	N	VB/JK		X
P. verrucosa	N	VB/JK	x	X
P setchelli	Y	VB		
P. elegans	Y	VB		X
Stylophora mordax	Y	VB/JK	x	X
Siderastreidae				
Psammocora sp.	?	VB/JK	x	X
Psammocora profundicella	Y	VB	x	X
Agariciidae				
Pavona varians	N	VB/JK	x	X
P. sp. 1 sensu Randall[2] (VB; JK: cf. venosa)	Y	VB	x	X
P. duerdeni	Y	VB/JK	x	X
P. maldivensis	Y	VB	x	X
Leptoseris mycetoseroides	N	VB	x	X
Fungiidae				
Fungia scutaria	N	VB/JK	x	X
Fungia sp. (juvenile F. scutaria?)	?	VB	x	X
Merulinidae				
Merulina ampliata	N	VB	x	X
Scapophyllia cylindrical	Y	VB	x	X
Hydnophora exesa	Y	VB	x	X
Mussidae				
Acanthastrea echinata	N	VB/JK		X
A. hillae	Y	VB	x	X
Symphyllia recta	N	VB/JK	x	X
Faviidae				
Favia matthaii	Y	VB/JK	x	X
F. stelligera	N	VB/JK	x	X
F. helianthoides	Y	VB	x	X
F. pallida	N	VB/JK	x	X
F. favus	N	VB/JK		X
Favia sp.	Y	VB		X
Favites ?complanata	Y	VB	x	X
Goniastrea edwardsi	Y	VB/JK	x	X
G. cf. favulus	N	VB	x	X
G. pectinata	N	VB/JK	x	X
Platygyra ?lamellina	N	VB	x	X

Taxon	New record?	Recorded by:	Collected (VB)	Photographed (VB and/or JK)
P. daedalea	N	VB/JK	x	X
Montastrea curta	N	VB	x	X
M. valenciennesi = Favites russelli sensu Randall[2]	N	VB/JK	x	X
Leptastrea purpurea	N	VB/JK	x	X
L. transversa	Y	VB	x	X
L. ?aequalis	Y	VB	x	X
Cyphastrea serailia	N	VB/JK		X
C. microphthalma	N	VB	x	X
C. chalcidicum	Y	VB/JK	x	X
Echinopora lamellosa	N	VB/JK	x	X
Poritidae				
Porites lobata	N	VB/JK	x	X
P. lutea	N	VB/JK		X
P. solida	N	VB/JK	x	X
P. rus	Y	VB/JK	x	X
P. lichen	Y	VB/JK	x	X
Dendrophylidae				
Tubastrea sp.	Y	VB	x	X
Hydrocorals				
Millepora platyphylla	N	VB/JK	x	X
Zoanthids	-	-		
Palythoa sp.	Y	VB/JK	x	X
Octocorals	-	-		
Lobophytum "large nodes"	?	VB/JK	x	X
Lobophytum " ridges"	?	VB/JK	x	X
Lobophytum "fingers"	?	VB	x	X
Sinularia "scrunchie"	?	VB/JK	x	X
Sinularia "long"	?	VB/JK	x	X
Sarcophyton sp.	?	VB/JK	x	X
Stereonephthya sp.	?	VB	x	X
Gorgonian (?Acabaria purple)	Y	VB	x	

Population Parameters

A total of 1,983 anthozoan colonies were enumerated within belt transects covering 500 m^2 at Wake Atoll. The number of colonies enumerated and percentage of coral colonies represented by each taxon are shown in Table B.2.2.3.

Table B.2.2.3. Number of anthozoans surveyed in belt transects at Wake Atoll during OES-05-13. Taxa contributing more than 10% of the total number of coral colonies are in bold.

Taxon	Forereef		Lagoon	
	# of colonies	Percent of total	# of colonies	Percent of total
Acanthastrea	168	8.9	0	0.0
Acropora	8	0.4	9	9.3
Astreopora	55	2.9	1	1.0
Cyphastrea	63	3.3	4	4.1
Echinopora	4	0.2	0	0.0
Favia	333	**17.7**	1	1.0
Fungia	1	0.1	0	0.0
Goniastrea	177	9.4	1	1.0
Leptastrea	4	0.2	0	0.0
Montastrea	69	3.7	6	6.2
Montipora	327	**17.3**	64	**66.0**
Pavona	15	0.8	0	0.0
Platygyra	10	0.5	0	0.0
Pocillopora	363	**19.2**	4	4.1
Porites	95	5.0	7	7.2
Symphyllia	1	0.1	0	0.0
Octocorals	193	10.2	0	0.0
Total # colonies	1886		97	
Area surveyed, m²	400		100	

Sixteen genera of scleractinian corals, as well as several taxa of octocorals (*Lobophytum*, *Sarcophyton*, *Sinularia*), were enumerated within belt transects encompassing 500 m^2. In terms of number of colonies represented within transect belts, *Favia*, *Montipora*, and *Pocillopora* codominated the coral fauna at forereef sites, while encrusting *Montipora* colonies dominated the single site surveyed in the lagoon. Eleven anthozoan genera (*Acabaria*, *Favites, Leptoseris, Hydnophora, Merulina, Palythoa, Psammocora, Scapophyllia, Stylophora*, *Stereonephthya*, *Tubastrea*) and the hydrozoan *Millepora* were not observed within belt transects but were recorded within the larger area examined in the vicinity of the transects (Table B.2.2.2).

Figure B.2.2.2 shows the percent live coral cover at forereef sites, calculated from the point-intercept method applied by Bonito. The sites are arranged in the figure by geographic sector (i.e., exposure to oceanographic wave and swell conditions). Coral cover at forereef sites ranged from 22.5% to 81.4%. The lowest coral cover (22.5%−27.5%) was consistently found along the southern and southwestern exposures. Higher coral cover (35.3%−63.7%) was found along the western and eastern exposures. The highest coral cover (76.6%–81.4%) was found

along northerly (northwestern and northern) exposures. Coral cover at the single site assessed in the lagoon (WAK-10) was 14.7%.

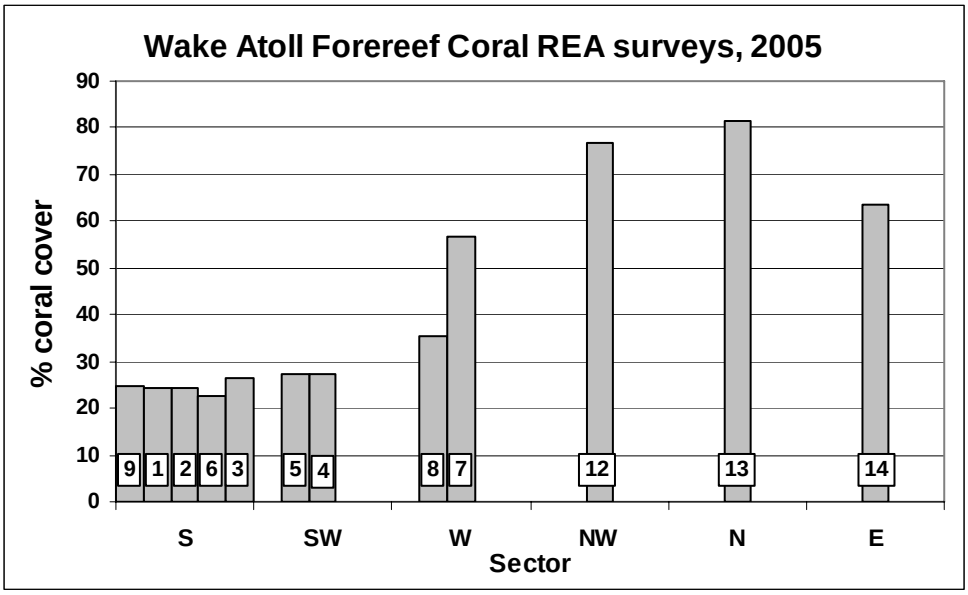

Figure B.2.2.2. Percent live coral cover at forereef sites determined with the line-intercept method (102 points/site), arranged by geographic sector. Site numbers are shown at the base of each column.

Cnidarian biodiversity patterns showed some geographic similarities to those of percent coral cover patterns: the lowest numbers of cnidarian taxa were generally found along the southern and southwestern exposures, with higher levels of biodiversity along the western, northwestern, and northern exposures (Fig. B.2.2.3). Cnidarian biodiversity at WAK-14, an eastern forereef site with high coral cover (63.7%, Fig. B-2) that was dominated by massive colonies of *Porites* and by large *Montipora* encrustations, was comparable to that at sites along the southern and southwestern exposures. Nineteen cnidarian taxa were reported from the single REA site in the lagoon (WAK-10) and 27 cnidarian taxa from the single backreef site where a nonquantitative survey was conducted (WAK-11).

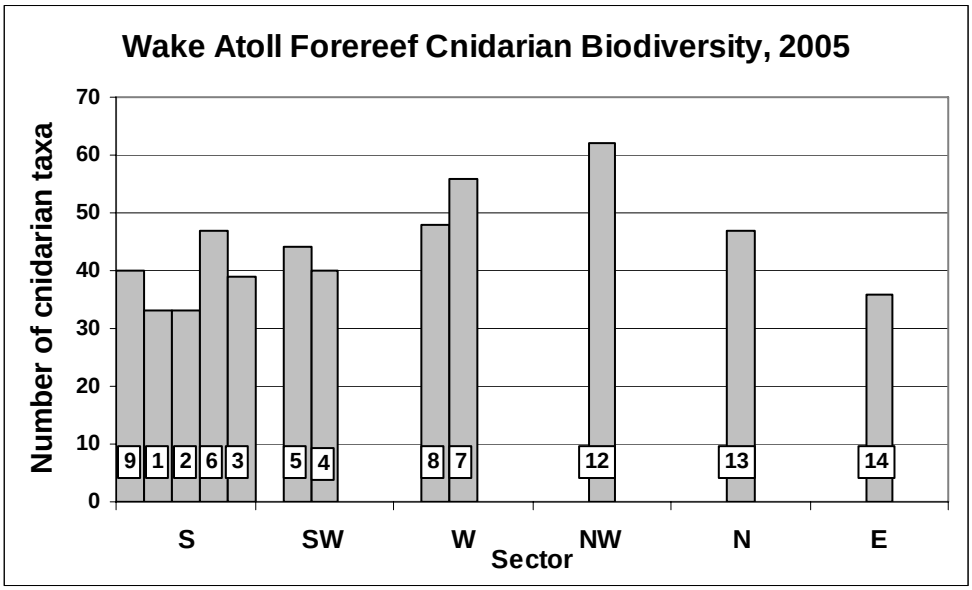

Figure B.2.2.3. Number of cnidarian taxa reported by Bonito and Kenyon at Wake Atoll REA forereef sites during October 2005 sites.

In addition to data on live coral cover, the line-intercept method also collects data on macroalgae, coralline algae, other macroinvertebrates, sand, rubble, pavement (i.e., consolidated carbonate which is typically epiphitized by a thin veneer of turf algae), and metallic debris. Coralline algae percent cover data derived from this method revealed a pattern in alignment with that of live coral cover: coralline algae was not found along the southern and southwestern exposures (the sectors of lowest coral cover) and was highest along those sectors where coral cover was highest (W, NW, N, and E). Moreover, only along the southwestern exposure (sites 4 and 5) was the contribution of macro plus coralline algae greater than the contribution of live coral to the benthic biota (Fig. B.2.2.4).

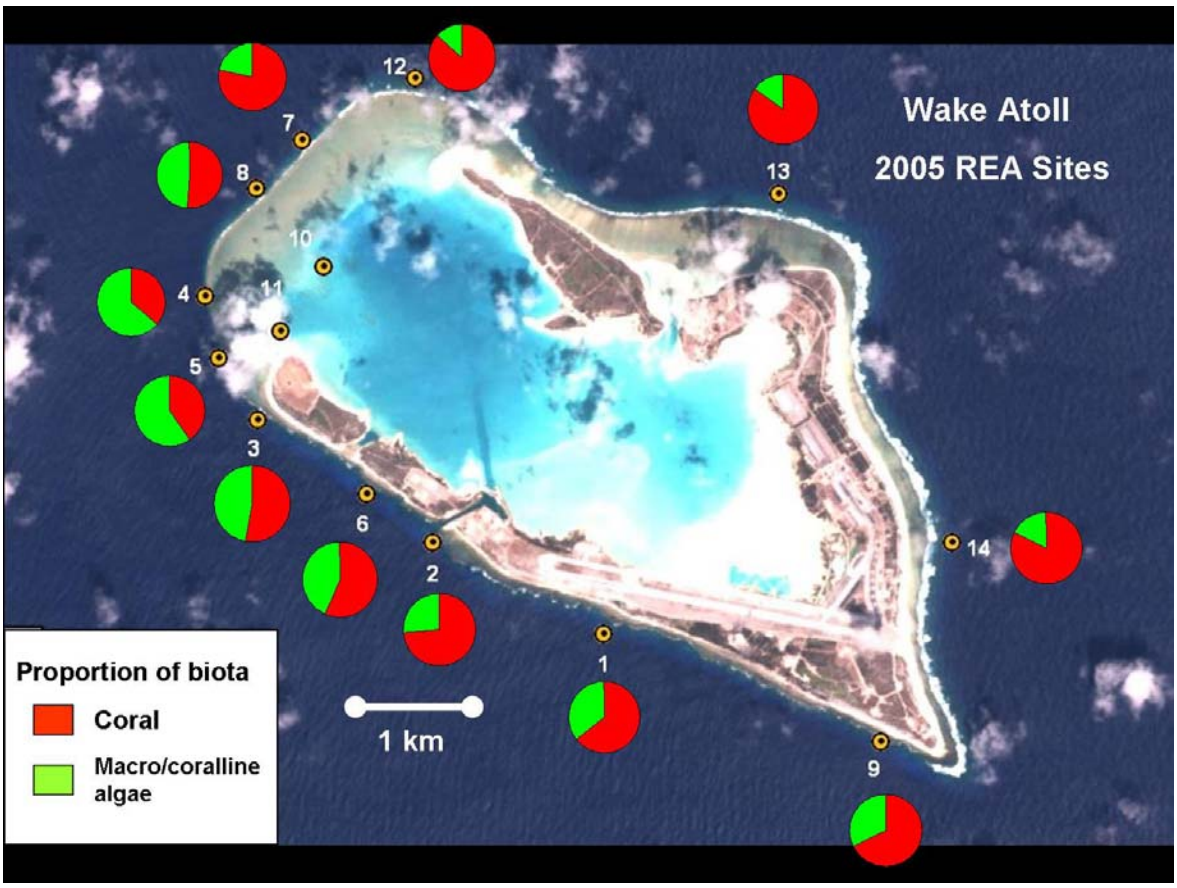

Figure B.2.2.4. Relative proportions of live coral percent cover and macro/coralline algae percent cover to the benthic biota at Wake Atoll forereef sites.

Size class distributions of all anthozoans enumerated within belt transects at Wake Atoll by Kenyon are shown in Figure B.2.2.5a-b. For purposes of comparison, size class distributions of corals enumerated within belt transects at nine sites at Guam during comparable REA surveys conducted in October 2005 are shown in Figure B.2.2.5c. Overall, the anthozoan communities at Wake Atoll are characterized by larger colonies than those at Guam: 39.8% (n = 1,886) and 77.3% (n = 97) of colonies measured >20 cm maximum diameter on the Wake forereef and lagoon, respectively, whereas only 16.6% (n = 5,017) of anthozoan colonies at Guam measured >20 cm maximum diameter.

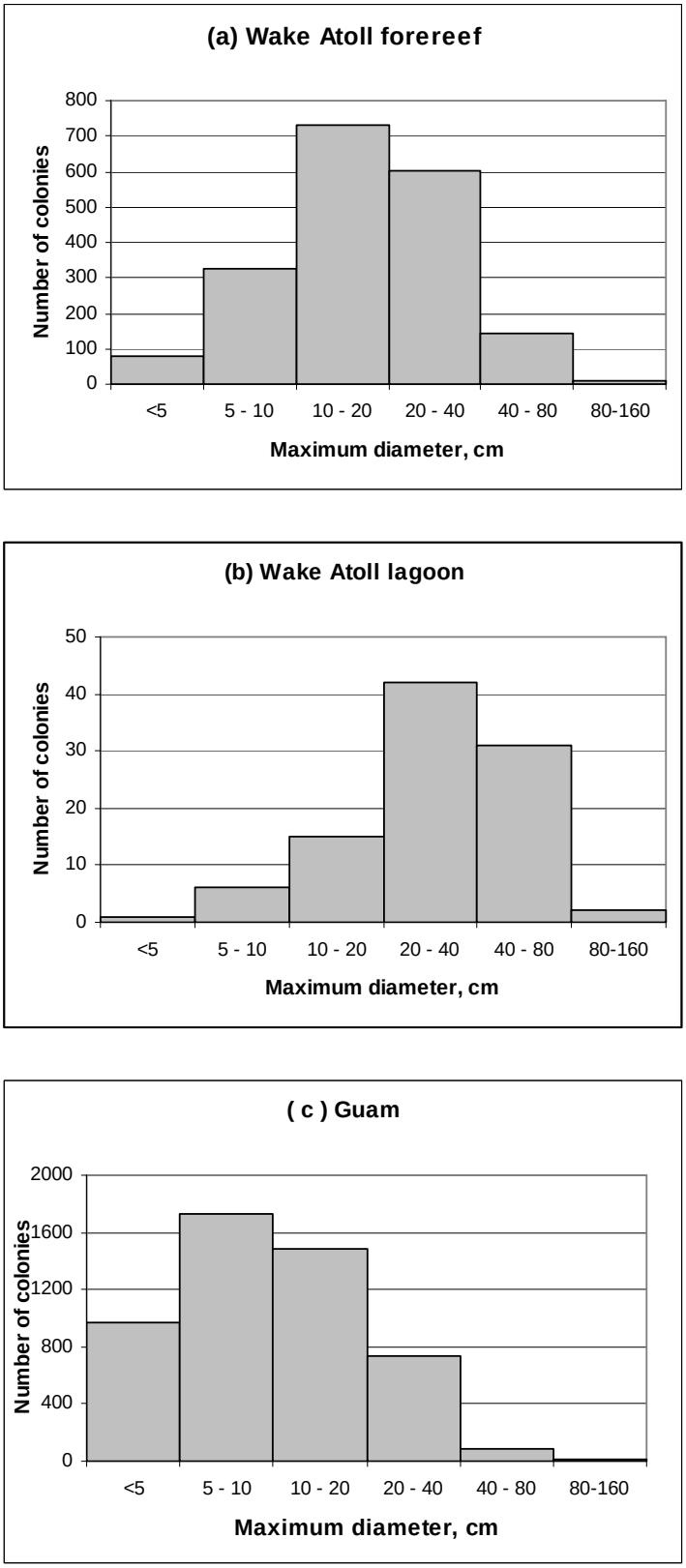

Figure B.2.2.5. Size class distributions of anthozoans within belt transects at (a) Wake forereef sites, (b) a single Wake lagoon site, and (c) Guam 2005 REA sites.

References

[1]Veron, J.E.N. (2000) Corals of the World. Australian Institute of Marine Science, Townsville. Australia.
[2]Randall, R. and Myers, R. (1983). Guide to the Coastal Resources of Guam: Vol. 2, The Corals. University of Guam Press, 128 pp.
[3]Unpublished data, Dr. James Maragos, U.S. Fish & Wildlife Service, Honolulu
[4] Baseline Marine Biological Survey, Peacock Point Outfall and other Point-source Discharges, Wake Atoll, Pacific Ocean. Report prepared by U.S. Dept. of the Interior, Fish and Wildlife Service, Pacific Islands Ecoregion, Honolulu, March 1999, 23 pp.
[1]Veron, J.E.N. (2000) Corals of the World. Australian Institute of Marine Science, Townsville. Australia.

B.2.3 Macroinvertebrates

Species inventories resulted in the recognition of at least 92 species from Wake Atoll. This list will expand upon additional identification of collected specimens not fully identifiable in the field by the surveyor and the processing of sand samples. Of the 92 species recorded, 5 were echinoids, 8 were holothurians, 4 were ophiuroids, 3 were asteroids, 32 were crustaceans, and 36 were mollusks; additional identification of collections will primarily expand the number of recorded crustaceans and mollusks. Reef areas surveyed were generally very steep and wave swept and had very little rubble, thus invertebrate records from most sites reflect only what was out on the reef. The greater species richness of fauna documented from sites 9 and 11 reflect the fact that there were large areas of rubble that could be turned and searched for invertebrates. Sampling of the rubble in these areas, however, was limited to < 20 minutes at site 9 and ~ 1 hour at site 11 and new species were continually found over those periods, thus records from these areas represent only a small sampling of the diversity present. While the rubble at site 9 was fairly well scoured, the undersides did host a fair diversity of ascideans and encrusting sponges that were not sampled. Rubble on the reef flat at site 11 was much more coated with a diverse assemblage of ascideans and sponges on the underside. Time and resources, however, did not permit for the sampling of this fauna.

A total of 10 species were recorded along the belt transects (2 echinoids, 1 holothurian, 1 asteroid, 4 mollusks, 1 crustacean, and 1 sponge). None of the species recorded along the transects were particularly abundant, except for : (1) *Holothuria edulis* in the sandy areas between bommies along some transects on the southern shore, and (2) *Tridacna maxima* on hard bottom areas along the lagoon transects. When present along the transects, densities of *H. edulis* ranged from .04 to 1.66/ m^2; however, these densities should not be taken as reliable population densities as belt transects followed the fish, benthic, and algal transects and went over hard-bottom as well as soft-bottom areas. Sampling conducted over only soft bottom areas would have yielded much higher densities. When present along the transects, densities of *T. maxima* ranged from .02 to .68/m^2. Transects in the lagoon by far yielded the highest densities of *T. maxima*. However, the lagoon

transects primarily went over soft bottom areas, thus the recording of the abundances of *T. maxima* are much lower than would be found if only hard bottom areas were sampled. The recorded densities of *Echinostrephus aciculatus* and *Echinometra mathae*i, the most commonly observed urchins, were particularly low at all sites. Observations off the transects suggest that recorded densities are good estimates of densities of those echinoids around transect depths; however, *E. mathaei* were observed to be more abundant at < 9.1-m depth.

Noteworthy was the abundance of *Tridacna* found in the shallower reef areas (< 9.1-m depth) and on the reef flat and coral bommies in the lagoon. Likewise was the high abundance of *Holothuria edulis* observed in all soft bottom areas surveyed outside the lagoon. Interestingly, holothurian abundance in the lagoon was very low, despite the fact that the lagoon is primarily shallow, soft-bottom habitat.

Of particular interest was the lack of certain components in the invert fauna. Conspicuously lacking at Wake Atoll were anemones, corallomorphs, zoanthids (only two small specimens of *Palythoa* found in rubble piles), large urchins (e.g., *Diadema*−one photographed, *Echinothrix*), hydroids, lobsters and large crustaceans (only a few pieces of *Etisus* carapaces found), crinoids, large asteroids, octopus, and ascideans and sponges (only several individuals of one species observed) on the reef. Conversations with members of the towed-diver survey team (who were towed around the entire atoll and had several passes along the south shore) confirm these observations. Towed-diver survey team members did spot, however, one *Acanthaster planci*. A technical report based on surveys conducted at six sites in 1998 (mentioned in the methods), however, reported *Panularis pencellatus* at four of the six sites and *Octopus cyanea* at one of the six sites they surveyed on the south shore. Several of those survey sites were revisited during REA surveys.

Table B.2.3.1 Invertebrates observed at each REA survey site and whether they were collected, previously reported, or photographically documented. A d indicates that the species was dead.

	WAKE Atoll REA Survey Sites																	
	1	2	3-1	3-2	4	5	6	7	8	9	10	11	12	13	14	Collected	Photo	Previously reported
Echinoids																		
Echinometra mathaei	x	x	x	x	x	x	x	x	x	x			x	x	x	X	X	x
Echinometra oblonga			x															
Echinostrephus aciculatus	x	x	x	x	x	x	x	x	x	x	x		x	x	x		X	x
Diadema sp.				x													X	
Heterocentrotus mammalatus			x							x							X	?
Holothurians																		
Holothuria atra			x								x	x				X	X	x
Holothuria edulis	x	x	x	x	x	x	x	x	x	x						X	X	x
Holothuria hillae																X	X	
Bohadshia argus							x				x	x				X	X	?
Stichopus chloronotus												x				X		?
Actinopyga mauritiana							x								x	X	X	
Chiridota hawaiensis																X	X	
Euapta godeffroyi																X	X	
Ophiuroids																		
Ophiocoma pica	x	x		x			x						x			X	X	
Ophiocoma erinaceus																X	X	
Ophiocoma doderleini										x						X	X	
Ophiuroid spp.										x						X	X	x
Asteroids																		
Linckia multiflora		x		x		x		x		x	x			x	x	X	X	x
Linckia laevigata	x											x				X		
Neoferdina cummingi								x								X		
Crustaceans																		
Paguritta spp.										x				x				
Calcinus morgani	x	x		x	x	x	x	x	x	x	x	x	x	x	x	X		
Calcinus isabella						x		x	x	x	x		x		x	X		

	WAKE Atoll REA Survey Sites																	
	1	2	3-1	3-2	4	5	6	7	8	9	10	11	12	13	14	Collected	Photo	Previously reported
Calcinus spp.																X		
Dardanus lagopodes					x	x		x		x		x			x	X		
Aniculus aniculus												x				X	X	
Liomera sp.	x			x								x				X		
Trapezia rubropunctata	x	x		x	x	x	x	x	x	x	x	x	x	x	x	X		
Trapezia ? lutea												x				x		
Tetralia vanninii	x			x	x	x	x	x	x	x	x	x	x	x	x	x		
Etisus sp.												d				d		
Charybdis obtusifrons	d															x		
xanthid sp. 1										x						x	X	
xanthid sp. 2												x				x	X	
xanthid sp. 3												x				x	X	
xanthid sp. 4												x				x	X	
xanthid sp. 5												x				x	X	
xanthid sp. 6												x				x	X	
xanthid sp. 7												x				x	X	
xanthid sp. 8												x				x	X	
xanthid sp. 9												x				x	X	
xanthid sp. 10												x				x	X	
xanthid sp. 11												x				x	X	
Lissocarcinus orbicularis												x				x	X	
portunid sp. 1												x				x	X	
portunid sp. 2												x				x	X	
Petrolisthes sp. 1												x				x	X	
Percnon sp. 1																x	X	
Alpheid	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		
Stomatopod								x								x		
Balanus sp.												x				x		
Chthamalus sp.												x				x		
Molluscs																		
Tridacna maxima	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		X	x
Tridacna ?dersa											x	x				x	X	
Tridacna squamosa	x							x		x	x	x					X	
Limaria fragilis																x	X	
Barbatia sp.				d	d		d		d	d	d	d	d		d	x		

	WAKE Atoll REA Survey Sites															Collected	Photo	Previously reported
	1	2	3-1	3-2	4	5	6	7	8	9	10	11	12	13	14			
Fragum fragum											x					x	X	
pectin										x								
Phyllidiella pustulosa	x	x			x	x		x								x	X	
Chromodoris aspersa										x						x		
Dendrodoris albobrunnea														x		x		
Lambis truncata	x		x			x	x			x	x			x	x			x
Turbo sp.			x			d	d	x	x	x						x		
Cypraea caputserpentis			x					d		x						x		
Cypraea mauritiana			x													x		
Cypraea moneta											x					x		
Cypraea helvola									d							x		
Cypraea ?nucleus													d			x		
Conus imperialis												x				x		x
Conus ebraeus												x				x		
Conus sanguinolentus																x		
Conus ~textile group														d		x		
Conus eburneus											x	x				x		
Strombus gibberulus											x					x		
Strombus sp. 1											x					x		
Strombus sp. 2											d					x		
Tonna ?perdex	d			d												x		
?Rhinoclavus sp. 1											x					x	X	
?Rhinoclavus sp. 2											x					x		
Drupa morum	x		x	x			x		x		x	x	x	d	x	x		
Drupa ricideus			x	x				d	x	d	x	x	x			x		
Coralliophila violacea	x		x			x		x		x			x	x	x	x		
Distortio anus											x					x		
Haliotis sp.									x							x		
Limpet												x				x		
Dendropoma ?maxima	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Other gastropods																x		
Polychaetes																		
Spirobranchus giganteus	x	x		x	x	x	x	x	x	x	x		x	x	x		X	x
Porifera																		
black sponge				x												x		

	WAKE Atoll REA Survey Sites															Collected	Photo	Previously reported
	1	2	3-1	3-2	4	5	6	7	8	9	10	11	12	13	14			
Acideans																		
Small green on Halimeda	x	x				x			x									
Others										x		x						

B.2.4 Towed-diver Benthic Surveys

During 4 days of field work, a total of 19 towed-diver surveys were conducted on the reef slopes and flats surrounding Wake Atoll. Logistical access to the lagoon was limited, and tows were not attempted in that habitat during this cruise.

Benthic Observations: (Elizabeth Keenan, Jake Asher, Jamie Gove, and Ronald Hoeke)

Towed-diver surveys were conducted along the southern forereef for the first 2 consecutive days because of poor sea conditions along the northern, eastern, and western shores. The western, northern, and eastern reef surveys were completed in the subsequent 2-day period.

The southern forereef consisted of hard coral cover ranging from 20% to 75%, with the exception of the area around the channel leading to the small boat harbor (1-5% coral cover, with the rest being sand). A noted observation was the presence of coral bleaching/stressed corals, especially in deeper depths. Stress levels ranged from 5% to 40%, with a noted increase in marked stressed corals in an area west of the small boat channel along the northwestern edge of Wilkes Island. This was coupled with a dramatic decrease in visibility and warm-water temperature fluctuations recorded during the survey.

The hard coral cover along the western and northwestern shores remained high with values ranging from 20% to 75% overall bottom cover. Overall coral stress levels remained from 1% to 10%. As towed-diver surveys progressed along the northern and eastern forereefs, hard coral cover continued to range between 10% and 75% of the overall bottom habitat. Coral stress ranged between 1% to 40%, with one survey recording 40% stress for 8/9 time segments.

Soft coral cover was recorded at 0%-20% along the southern reefs, with a dramatic increase in soft coral cover as surveys continued up the western and northern coastlines. One 35-minute tow survey recorded between 50% and 75% soft coral cover along the bottom. As towboard surveys continued along the northeastern and eastern coastlines, soft coral cover remained high, ranging from 10% to 62.5%.

Surprisingly, only a single crown-of-thorns starfish was recorded during surveys around Wake Atoll. Giant clams were uncommon during deep tows around Wake (ranging from 0 to 7) but increased in frequency during shallower tows along the southern coast. In particular, one truncated 25-minute tow recorded 58 giant clams in the shallow waters approximately 1.8 km away from the southeastern corner of Wake Island. Less than 25 urchins were recorded by towed divers around the entire atoll.

The most abundant macroinvertebrate observed were sea cucumbers. Approximately 10,000 were recorded along the southern coastline. Only seven were recorded during all subsequent tows around the rest of the atoll.

B.3. Fish

B.3.1. REA Fish Surveys

The fish team surveyed 13 sites around the atoll. All sites were located on the exposed outer reef except for site WAK10 which was inside the lagoon. Stationary point counts (SPCs) were not conducted at site WAK11 because of limited visibility (<3m). Because of varying levels of taxonomic expertise among the fish team members, scientists Musburger and Laughlin conducted all belt transects (BLTs) while scientist Grover conducted all SPCs. Our general impression (pending statistical confirmation) was that fish assemblages at Wake were healthy. Large fish were common and easily approached. Bumphead parrotfish (*Bolbometopon muricatum)* and Napoleon wrasse (*Cheilinus undulatus)* were observed on nearly every dive, occasionally in schools of up to 30 individuals for Bumphead and 7 individuals for Napoleon wrasse. Grey reef sharks (*Carcharhinus amblyrhynchos)* were occasionally seen, as was one tiger shark (*Galeocerdo cuvier).* Parrotfish populations seemed especially abundant with schools upwards of 100 individuals being encountered. Many individual parrotfish appeared to be quite large (both in length and girth) compared to conspecifics observed at other locations in the Pacific. According to weather conditions, the survey effort was most concentrated along the protected southern and western exposures of the atoll, but two sites were surveyed along the north shore and one site was surveyed along the east shore.

Fish Family Summaries

A total of 190 species of coral reef fishes were documented at Wake Atoll by the REA team. Below is a brief synopsis of some of the more abundant families.

Sharks (Carcharinidae):
Shark density was highest and individuals were largest along the northwest side of the atoll. Grey reef sharks (*Carcharinus amblyrhynchos*) were the only species observed. In total only 11 grey reef sharks were observed during the belt surveys. One tiger shark (*Galeocerdo cuvier*) was observed off the transect on the northwest reef. No whitetip, blacktip, hammerhead, or nurse sharks were observed during any of the REA fish surveys.

Rays (Mobulidae):
Eagle rays (*Aetobatis narinari*) were observed around Wake. Most individuals had wingspans between 0.9 m and 1.5 m. They were observed singly and in small groups of 2−5 individuals. No manta rays (*Manta birostris*) were observed on any surveys.

Soldier/Squirrelfish (Holocentridae):
Bigscale soldierfish (*Myripristis berndti*) was the only soldierfish encountered on surveys. Also observed off survey were the shadowfin soldierfish (*Myrpristis adusta*) and the lattice soldierfish (*Myripristis violacea*). The most often recorded squirrelfish was the Tahitian squirrelfish (*Sargocentron tiere*); also seen were the

saber squirrelfish (*Sargocentron spiniferum*) and the spotfin squirrelfish (*Neoniphon samara*).

Groupers/Anthias (Serranidae):
Groupers were observed at all sites surveyed. At least seven differerent species were recorded. The most common were the peacock grouper (*Cephalopholis argus*) followed by the greasy grouper (*Epinephelus tauvina*). The purple queen (*Pseudanthias pascalus)* was the only anthias observed on surveys with 710 enumerated during the survey period. Groups of over 100 individuals were sited hovering above the reef.

Jacks (Carangidae):
The most common species was the bluefin trevally (*Caranx melampygus*). Also observed was the black jack (*Caranx Lugubris*), the doublespotted queenfish (*Scomberoides lysan*), the smallspotted pompano (*Trachinotus baillonii*), the greater amberjack (*Seriola dumerili*), the bigeye trevally (*Caranx sexfasciatus*) and a new record for Wake Atoll, the bigeye scad (*Selar crumenophthalmus*). No giant trevally (*Caranx ignobilis*) were observed by any survey team.

Snappers (Lutjanidae) and Emperors (Lethrinidae):
The most commonly encountered snapper was the blacktail snapper (*Lutjanus fulvus*) followed by the one spot snapper (*Lutjanus monostigma*). Also observed was the smalltooth jobfish (*Aphareus furca*) and the green jobfish (*Aprion virescens*). The bigeye emperor (*Monotaxis grandoculis*) was the most commonly recorder emperor. The orangestipe emperor (*Lethrinus obsoletus*) and the spotcheek emperor (*Lethrinus rubreoperculatus*) were also recorded.

Butterflyfish (Chaetodontidae):
With 14 species observed, butterflyfishes were relatively uncommon at our survey sites. The most common was the spot-banded butterflyfish (*Chaetodon punctatofasciatus*) followed by the raccoon butterflyfish (*Chaetodon lunula*) Sightings were usually limited to one or two individuals of each species, and sightings were infrequent.

Angelfish (Pomacanthidae):
The most commonly observed angelfish was the flame angel (*Centropyge loricula*) with the lemonpeel angel (*C. flavissima*) also observed. From the survey the only other species of angel encountered was the multibar angelfish (Centropyge multifasciata) which was observed in a small cave.

Damselfish (Pomacentridae):
Damselfish included the three most abundant species recorded on this survey. In order of abundance, these damsels were the midget chromis (*Chromis acares*) with nearly 5,000 recorded individuals, the agile chromis (*Chromis agilis*) and Vanderbilt's chromis (*Chromis vanderbilti*). All 3 of these species were observed in high concentrations, sometimes in groups of over 200 individuals along all transects outside of the lagoon. The only slight distribution patterns observed were Vanderbilt's chromis, which seemed to be most common on the southeast corner of the atoll while it was replaced in other areas by the midget chromis. It should be

noted that these two species were observed in mixed schools on several occasions. Two species of Plectroglyphidodon (*P. dicki* and *P. johnstonianus*), and the golden gregory (*Stegastes fasciolatus)* made up the bulk of the remaining damselfish biomass. In all, 12 species were observed.

Wrasses (Labridae):
The most notable wrasse observation was the presence of large (over 75 cm) napoleon wrasses (*Cheilinus undulatus*) at nearly every site surveyed. Although only seven were enumerated in the belt transects, they were constantly surrounding the survey sites. The only other large wrasses (over 30 cm) that were observed was the clown coris (Coris aygula) reaching up to 40 cm. The most commonly encountered wrasse was the sunset wrasse (*Thalassoma lutescens*), followed by the ornate wrasse (*Halichoeres ornatissimus*). In all, 22 species of wrasses were observed making wrasses the most species rich family at Wake.

Parrotfish (Scaridae):
Many sightings of the bumphead parrotfish (*Bolbometopon muricatum*) were the most unique parrotfish observations made over the surveys at Wake. Like the Napoleon wrasses, bumphead parrotfish were not encountered often on the transects (only 3 sightings total), but they were sighted off transit frequently in schools of up to 35 individuals. Inside the lagoon many bumpheads were observed in water as shallow as 0.6 m deep. A total of 11 species of parrotfish were recorded at Wake with the reefcrest parrotfish (*Chlorurus frontalis*) by far being the most common. *C. frontalis* was observed in schools of over 50 individuals primarily on the northwest reef. The second most abundant parrotfish was the whitespot parrotfish (Scarus forsteni) followed by the bullethead parrotfish (*Chlorurus sordidus*). At dive site WAK03, a relatively high diversity of parrotfish was observed with eight different species present.

Surgeonfish (Acanthuridae):
By far, the most dominant surgeonfish observed was the bluelip bristletooth (*Ctenochaetus cyanocheilus*) with 254 total observations. The next most abundant surgeons in order of abundance were the convict surgeonfish (*Acanthurus triostegus*), the bluelined surgeonfish (*Acanthurus nigroris*), and the brown surgeonfish (*Acanthurus nigrofuscus*). In total, 17 species of surgeonfish were recorded.

Rare or Absent Families:
Several families of reef fishes commonly observed in similar types of habitats were not encountered by the fish REA team at Wake Atoll. These include the lizardfishes (Synodontidae), fusiliers (Caesionidae), sweetlips (Haemuliade), and the sandperches (Pinguipedidae). The towed-diver survey team did report one sighting of the yellowback fusilier (*Caesio teres*). Only one species of scorpionfish (Scorpaenidae), the spotted croucher (*Caracanthus maculatus*) was observed by the REA team.

Stationary Point Count Summary

A total of 48 stationary point counts (SPCs) were conducted at sites 1-9 and 12-14 around Wake Atoll. In all, 19 families and some 60 species were recorded using this method. No SPCs were conducted in the lagoon as indicated above, because of visibility limitations. More than 2,300 individual fish were counted among all Wake sites, or nearly 50 individuals per count. Overall, there appeared to be a high degree of consistency among sites with a few taxa dominating the counts. Parrotfish constituted more than 31 percent of all fish counted and was the majority at most sites. Though seven species were counted, two, *Chlorurus frontalis* and *Scarus forsteni* dominated heavily. The next most prevalent family were the jacks (Carangidae, six species) representing about 20% percent of all fish in the SPCs, primarily because of two large schools of *Caranx sexfasciatus* and a consistent presence of *Caranx melampygus* across sites. Finally, two species, *Kyphosus bigibbus* (the grey rudderfish), and *Naso lituratus* (the orangespine unicornfish) were nearly ubiquitous, constituting more than 17 and 6 percent of total individuals, respectively. No other family comprised more than 5 percent of individuals. Notable fish counted also included 9 bumphead parrotfish (*Bolbometopom muricatum*), at 3 sites and 30 Napoleon wrasse (*Cheilinus undulatus*) (average size > 70 cm), at 8 sites. Grey reef sharks (*Carcharhinus amblyrhynchos*) were counted at more than half the sites visited.

Notes on new species and range extensions

Previous fish survey work at Wake Atoll has been quite limited. The only studies available to the REA team at the time of our work were publications by Lobel & Lobel (2004) and the U.S. Fish and Wildlife Service (1999). Lobel and Lobel conducted extensive surveys of Wake's fish fauna and compiled a species checklist which is the most recent and complete list for the area. Our survey efforts yielded a total of 10 new records and possibly one new species which are detailed below.

Arothron nigropunctatus, Black-Spotted Puffer – One individual was observed by Laughlin. This species was previously known to be distributed throughout Micronesia and the South Pacific.

Calotomus carolinus, Stareye Parrotfish – Several individuals were observed on multiple occasions by Musburger and Laughlin including observations along transects at a depth of 13.5 m. Stareye Parrotfish are widespread in distribution including Japan, Micronesia, and Hawaii.

Centropyge multifasciata, Multi-Barred Angelfish – One individual was observed by Musburger at a depth of 16.8 m. It fled into a hole deep in the reef when approached. Efforts to wait nearby until it reappeared to take video of it proved unfruitful as it never reemerged. This species is also widespread in its distribution and was previously known to exist throughout Micronesia.

Galeocerdo cuvier, Tiger Shark – One individual of approximately 3 m TL was observed by Musburger and Laughlin while they were conducting belt transects. The shark was in 22.9 m of water cruising along the reef drop-off and was out of

range to be counted on the transect. While rarely encountered by divers, tiger sharks are circumglobal in distribution.

Halichoeres melasmopomus, Blackear Wrasse – Many individuals were observed and recorded with video by Musburger, and one individual was collected by Laughlin. This species was quite abundant along deep reef slopes at depths from 24.4 to 35.6 m which makes it puzzling why it was not included on the Lobel list. It was previously known from throughout Micronesia.

Labropsis xanthonota, Wedege-Tailed Wrasse – Several individuals were observed by Musburger and Laughlin and Musburger filmed a pair at a depth of 30.5 m on the northern side of the island. The Micronesia distribution of this species was previously known to include only the Mariana Islands and the Marshall Islands which are likely source locations for species to reach Wake.

Naso annulatus, Whitemargin Unicornfish – Several individuals were observed by Musburger in 18.3 m of water. This species has a widespread distribution including all of Micronesia, the Marianas, and Hawaii so it is not surprising that it is found at Wake as well.

Odonus niger, Redtooth Triggerfish – A single large school (~75 individuals) was observed by Musburger at site WAK06 at a depth of 13.5 m feeding on plankton above the drop-off. Again, this species has a widespread distribution including all of Micronesia.

Scarus frenatus, Bridled Parrotfish – Several initial phase individuals with their distinctive red initial phase coloration were observed by Musburger at site WAK01 along the transect at a depth of 15.2 m.

Selar crumenophthalmus, Bigeye Scad – A large school (~125 individuals) was observed by Musburger and Laughlin along the transect at site WAK02 in a depth of 13.5 m.

Pseudojuloides sp. B, Possible new species of wrasse – Individuals were observed on nearly every dive by Musburger and Laughlin in depths ranging from 9.1 to 21.3 m. Laughlin collected several individuals of initial, intermediate, and terminal phase coloration. He also previously collected a similar species in the Northern Marianas Islands that has been verified by Dr. John Randall of the Bishop Museum as being a new species. The specimens collected at Wake are believed to be slightly different from the specimens collected in the Marianas and may represent another new species in this complex. This species most closely resembles *Pseudojuloides atavai*, (Polynesian Wrasse) and was likely misidentified as such by Lobel.

Fish collection at Wake

Eight fish specimens were collected.

Species	Observed	Collected
Pseudojuloides sp.	Present	7
Halichoeres melasmapomus	Present	1

B.3.2 Towed-diver Fish Surveys

Of the 19 towed-diver surveys conducted at Wake, the most notable observation was the abundance of bumphead parrotfish (*Bolbometapon muricatum*), with a total of 68 sightings. Bumphead parrots are extremely rare and/or shy at almost all of the other U.S. Pacific reefs surveyed by CRED; a single sighting at any other reef would be an extraordinary event. While unusual, the abundance of bumphead parrots was not entirely unexpected. Both R.F. Myer in his book "Micronesian Reef Fishes" and P. Lobel in his 2004 Pacific Science publication entitled, "Annotated Checklist of the Fishes of Wake Atoll", noted its population at Wake. The Napoleon Wrasse, (*Chelinus undulatus*), was also numerous with 90 total sightings by towed divers. Another notable observation was the abundance of spotted eagle rays (*Aetobatis narinari*), with a total of 27 sightings. No other rays (*Myliobatidiformes*) were sighted. The most numerically abundant fish, however, were bigeye jacks (*Caranx sexfasciatus*) observed in schools of up to 1,200 individuals, with an estimated 800-900 over 50 cm total length (TL). A large school of milkfish (*Chanos chanos*) was also seen, with an estimated 200-250 fish. Grey reef sharks (*Carcharhinus amblyrhynchos*) were also in the top three most abundant species, occurring both singly and in aggregations. Parrotfishes of several species, as well as planktivorous unicornfish were abundant (particularly *Naso brevirostris*), though only a small percentage was large enough to be recorded by towed-diver surveys. Very few turtles were seen by towed divers, with only three recorded.

B.4. Bottom Camera Bait Station

The BotCam was deployed three times on the south shore of Wake Atoll. Of these three drops, only two produced video. The third drop was programmed to turn on incorrectly. Further, the surface line on the third drop became entangled on the reef and the surface line had to be cut at both the BotCam side and the surface signature side. The remainder of the line was recovered via SCUBA divers and was found tangled around coral heads at approximately 19.8 m and 33.5 m. Depth ranges for the three drops were from 224 m to 347 m with temperatures between 18.4˚C and 12.4˚C. The first drop to 347 m was the only drop with a significant number of fish which included ehu, gindai, and onaga. This also represented the deepest drop to date with quality images of target fish species. Tables 1 and 2 below summarize the BotCam drops for Wake Atoll RAMP 2005.

TABLE 1. BOTCAM FIELD LOG - WARAMP 2005 OES0513

					Time, Date and Location - On Bottom						Record Time				
Date (UTC)	Location Name	Drop #	Acoustic Release Serial Number (S/N)	RF 700C1 Frequency	Latitude	Longitude	Date (UTC)	Time (UTC)	Depth Sounding (fa)	# Surface Line Sections Used	Start Date (UTC)	Start Time (UTC)	Stop Date (UTC)	Stop Time (UTC)	Comment
10/18/2005	Wake	WAK01	198	154.585	N 19 17.595	E 166 35.940	10/18/2005	0040	292m	12	10/18/2005	0130	10/18/2005	0205	
10/19/2005	Wake	WAK02	198	154.585	N 19 16.680	E 166 37.737	10/19/2005	0022	197m	12	10/19/2005	0115	10/19/2005	0150	
10/20/2005	Wake	WAK03	198	154.585	N 19 16.820	E 166 37.123	10/19/2005	2120	340m	12	10/19/2005	2145	10/19/2005	2230	Line tangled. Appeared to be related to the line weight. Line had to be cut at both ends. Line was recovered with SCUBA divers.

TABLE 2. PRELIMINARY BOTCAM DATA ANALYSIS - WARAMP 2005 OES0513

								Species Identified											
#	Date	Drop Location	Drop #	Seabird Pressure (dbar)	Seabird Temp. (deg. C)	Bottom Description	Slope (degrees)	Onaga	Opakapaka	Ehu	Gindai	Kalekale	Lehi	Grouper	Butaguchi	Kahala	Hogo	Other	Deployment Notes
43	10/18/2005	Wake	WAK01	347	12.5	Hard Bottom, Dominated By Large Features w/ Some Small Features, Very Steep Slope in background, Large Crevace	Mixed	x		x	x								Unit settled at 300 m for approximately 20 minutes before finally settling at 347 m
44	10/19/2005	Wake	WAK02	224	18.4	Hard Bottom, Light Sediment Cover with Small Features	45 to 55			x	x							Black Jack	
45	10/20/2005	Wake	WAK03	265	15.9														Timer set incorrectly, never turned on.

B.5. Bioacoustics

Site Summary:

Note: Great effort is being made to collect physical specimens, bioacoustics data and oceanographic data that may affect the MBC, but the collection of ADCP/ CTD/water sampling data in accordance with established CRED protocols has been prioritized over the bioacoustics effort during night operations. However, these oceanographic data are collected in close proximity to MBC sampling activity and should support the effort to understand MBC interactions with reef communities. All daytime survey activity and BotCam operations take precedence over any night operations.

Bioacoustics Sampling Summary

Site	EK60 day transects	EK60 night transects	EK60 trawl transects	IKMT trawl samples	CTD/ADCP/ water samples	Comments
Wake Atoll	3	10	1	1	Nearby	Most good MBC sign was below trawlable depths given prevailing weather conditions.