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PROJECT REPORT

VESSEL: NOAA Ship *Oscar Elton Sette*, Project SE-16-02, Legs I & II

PROJECT PERIOD: 13 April– 31 May, 2016

AREA OF OPERATION: American Samoa, Rose Atoll, and Jarvis Island

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystems Program (CREP) of the NOAA Pacific Islands Fisheries Science Center, the NOAA Pacific Islands Regional Office, the American Samoa Department of Marine and Wildlife Resources, the National Marine Sanctuary of American Samoa, the Bigelow Laboratory for Marine Sciences, Woods Hole Oceanographic Institution, and the University of Hawaii conducted stationary-point-count surveys of nearshore fish assemblages and associated benthic habitat in the waters surrounding American Samoa and Rose Atoll to supplement the reef fish component of the Pacific Reef Assessment and Monitoring Program (RAMP) using closed circuit rebreathers (CCR) and open circuit scuba (OCS). Small boat and diving field operations occurred on April 15–21 and April 26-May 5, 2016. In addition, collaborative coral bleaching research was also performed at Jarvis Island, Pacific Remote Islands Marine National Monument on May 16–25, 2016. All activities described in this report were covered by the following permits: Environmental Assessment (PIFSC-20100901); Endangered Species Act, Section 7 consultation (PIR-2015-9580); U.S. Army Corps of Engineers Permit: USACE POH-2009-00083 (effective date: March 18, 2014; expiration date March 18, 2017); U.S. Fish and Wildlife Pacific Reefs National Wildlife Refuge Complex Research and Monitoring Permit: 12521-14001; American Samoa Department of Marine and Wildlife Resources Scientific Permit: 2014/010; the Office of National Marine Sanctuaries Permit: FBNMS-2014-003; and the National Park of American Samoa Scientific Research and Collection Permit: NPSA-2015-SCI-0003.

ITINERARY:

Daily field operations included Rapid Ecological Assessment (REA) fish surveys. Additional REA benthic surveys; water sample collection for dissolved inorganic carbon (DIC), particulate organic carbon (POC), total alkalinity (TA), and microbial analyses, and the deployment and recovery of oceanographic instrumentation are otherwise specified in the following daily summaries.

9–12 April	Embarked scientists Kevin Lino, Andrew Gray, and Paula Ayotte during in port at Apia Harbor, Samoa. Reconfigured deck and lab spaces for SE-16-02.
13 April	Transited en route to Pago Pago Harbor, American Samoa, from Apia Harbor, Samoa.
14 April	Arrived at Pago Pago Harbor, American Samoa. Begin Leg I. Embarked: Ray Boland, Adel Heenan, Alice Lawrence, Motusaga Vaeoso, Tate Wester, Kelvin Gorospe, Michael Akridge, Julia Rose, Kaylyn McCoy, and Marc Nadon. Conducted boat familiarization; station walk-throughs and dive neurological examinations for incoming scientists.
15-16 April	Conducted fish REA surveys at Tutuila Island.
17–19 April	Conducted fish REA surveys at Tau Island.
20 April	Conducted fish REA surveys at Tutuila Island.
21–24 April	Disembarked Andrew Gray and Kaylyn McCoy via small boat at Pago Pago Harbor, American Samoa. Operations halted due to Hurricane Amos.
25 April	Transferred personnel via small boat at Pago Pago Harbor, American Samoa. Disembarked: Marc Nadon, Brittney Honisc and Julia Rose. Embarked: Frances Lichowski, Hatsue Bailey, Ivor Williams, Kosta Stamoulis, Mareike Sudek, and Zach Caldwell. Conducted boat familiarization, station walk-throughs, and dive neurological examinations for incoming scientists.
26–27 April	Conducted fish REA surveys and plankton tows at Tutuila Island.
28 April	Conducted fish REA surveys at Ofu and Olosega Islands.
29–30 April	Conducted fish REA surveys and plankton tows around Tutuila Island.
1–5 May	Conducted fish & benthic REA surveys; plankton tows and macroalgae collections at Rose Atoll.

6 May	Arrived at Pago Pago Harbor, American Samoa. End of Leg I. Disembarked: Ivor Williams, Kosta Stamoulis, Ray Boland, Adel Heenan, Alice Lawrence, Motusaga Vaeoso, Mareike Sudek, Tate Wester, Kelvin Gorospe, Michael Akridge, and Zach Caldwell.
7–10 May	In-port outreach & education activities and scientific presentations. Embarked: Stefan Kropidlowski, Allie Hunter, Kaylyn McCoy, Marie Ferguson, Frances Lichowski, Hanna Barkley, Victoria Luu, Elizabeth Drenkard, Damon Driessen, Stephen Matadobra, and Bernardo Vargas-Ángel.
11–15 May	Began Leg II. Transited en route to Jarvis Island. Conducted chamber and boat familiarizations; station walk-throughs and dive neurological examinations for incoming scientists.
16 May	First day of dive operations at Jarvis Island and started off in a very productive way. Teams worked along the west side and completed the following surveys: Benthic team 5 REA sites (1 deep; 2 mid-depth; 2 shallow); Fish Team 3 REA sites; and the Ocean and Climate Change – WHOI-Rutgers Team deployed 2 instrument packages containing the Acoustic Doppler Current Profiler (ADCP), pH meter, salinity-O_2-temperature, photosynthetic active radiation sensor (PAR).
17 May	Teams worked on the eastern terrace and completed the following surveys: Benthic Team 9 REA sites; Fish Team 4 REA sites; and the Ocean and Climate Change – WHOI-Rutgers Team recovered 6 Programmable Underwater Collectors (PUCs), conducted 7 photo Eco-surveys, and collected 10 sets of 2.5-L water samples for TA, DIC, nutrients, and N isotopes, in addition to two 40-L water samples for POC, and one 10-min plankton tow.
18 May	Teams worked along the south forereef and the eastern terrace and completed the following surveys: Benthic Team 5 REA sites; Fish Team 3 REA sites; and the Ocean and Climate Change – WHOI-Rutgers Team recovered 6 PUCs, swapped 2 STRs, recovered 2 WHOI temperature loggers, conducted 3 photo Eco-surveys, and collected 9 sets of 2.5-L water samples for TA, DIC, nutrients, and N isotopes. Additionally the WHOI team also collected three 40-L water samples for POC, and completed one plankton tow.
19 May	Teams worked along the west, south, and the eastern terrace and completed the following surveys: Benthic Team 6 REA sites; Fish Team 3 REA sites; and the Ocean and Climate Change – WHOI-Rutgers Team conducted 7 plankton tows and collected 10 sets of 2.5-L water samples for TA, DIC, and nutrients, and 2 water samples for salinity, nitrogen isotopes and POC. The WHOI Team also collected a total of 9 coral cores all drilled from dead colonies; 7 of which were pre-cored in November, 1 was pre-cored in 2012, and 1 new (dead as well).

20 May Teams worked along the west forereefs and eastern terrace and completed the following surveys: Benthic Team 5 REA surveys; Fish Team 4 REA sites; Ocean and Climate Change – WHOI Team installed 6 PUCs units, swapped 2 STRs, collected 7 sets of 2.5-L water samples for TA, DIC, and nutrients, salinity, and nitrogen isotopes and, 3 water samples for POC, and 1 plankton tow. The WHOI-Rutgers Team also collected a total of 4 coral cores, all drilled from partially dead colonies previously sampled in November 2015 (drilling took place on the dead portions of the above mentioned colonies).

21 May Teams completed the following surveys: Fish Team 7 REA sites; Ocean and Climate Change Team swapped collected 6 PUCs water samples, swapped 1 STR, and completed benthic photo-quadrat surveys at the 3 Jarvis Climate Stations; the WHOI-Rutgers Team completed four 50-m photo Eco-surveys, and collected 12 sets of 2.5-L water samples for TA, DIC, and nutrients, salinity, and nitrogen isotopes, 3 water samples for POC, and 4 plankton tow. The USFWS Team ashore continued their terrestrial assessments and monitoring surveys.

22 May Teams completed the following surveys: Fish Rapid Ecological Surveys at 6 sites, 14 sets of 2.5-L water samples for total alkalinity, DIC, and nutrients, salinity, and nitrogen isotopes and, 3 water samples for POC and POM, and 8 plankton tows. In addition, the teams also collected 4 coral biopsies for RNA expression, 3 coral biopsies and 8 algal samples for nitrogen isotopes, and 10 sea cucumber tissue samples for trophic dynamics studies.

23 May Teams recovered 2 sets of instrument packages containing ADCPs, pH meter, salinity-O_2-temperature, and PAR sensor. In addition, the team also collected the following samples: 5 water samples for DIC, 4 sets of 2.5-L water samples for TA, DIC, and nutrients, salinity, and nitrogen isotopes, 3 coral biopsies for RNA expression studies, and nitrogen isotope studies. In addition the BRUVs team completed 10 deployments along the south and east-facing forereefs.

24 May Teams extracted two long cores (100 cm and 150 cm, respectively) from colonies of *Porites lobata*, and collected three 20-ml pore-water samples for nutrient studies. In addition the BRUVs team completed 24 deployments, 23 of which were successful; one deployment succumbed to camera flooding.

25–30 May Transited en route to Honolulu.

31 May Arrived in Honolulu. End of project.

MISSION:

The Pacific RAMP is an integrated coral reef ecosystem assessment led by the Coral Reef Ecosystem Program (CREP) of the Pacific Islands Fisheries Science Center (PIFSC) involving multi-disciplinary coral reef surveys in ~ 40 U.S.-affiliated Pacific Islands. Pacific RAMP is sponsored by NOAA's Coral Reef Conservation Program (CRCP), a partnership between the National Marine Fisheries Service, National Ocean Service, and other NOAA agencies with the objective of improving understanding and management of coral reef ecosystems. SE-16-02 is supported by funds from NOAA PIFSC, and is intended to gather additional data necessary for assessing the status and trends of managed coral reef fish populations in the islands of American Samoa (AS) and the Pacific Remote Islands Marine National Monument areas. SE-16-02 is a supplement of the reef fish survey component of the Pacific Reef Assessment and Monitoring Program (RAMP) performed by the PIFSC aboard the NOAA Ships *Hi'ialakai* and *Oscar Elton Sette*.

The goals of the SE-16-02 Pacific Reef Assessment and Monitoring Project are as follows:
The scientific objectives of the project are:

1. Collect data on shallow-water (0–30 m deep) reef fish assemblages and reef habitat via non-extractive methods, including:
    a. CREP RAMP REA OCS fish surveys (conducted from the OES and CREP small boats) in American Samoa and Jarvis Island
    b. CREP REA CCR fish surveys (conducted from CREP small boats) in American Samoa
    c. CREP and Curtin University baited remote underwater video (BRUV) deployments at Jarvis Island in conjunction with the Global FinPrint Project
2. Collect data on shallow-water (0–30 m deep) benthos to document coral bleaching via non-extractive methods, including:
    a. CREP RAMP REA OCS benthic surveys (conducted from the OES and CREP small boats) at Rose Atoll and Jarvis Island
3. Deploy and retrieve a suite of instruments and installations, including: subsurface temperature recorders (STRs), conductivity, temperature, depth profiler (CTD), acoustic Doppler current profiler (ADCP), pH sensor (SeaFET), and programmable underwater collectors (PUCs), to enable monitoring of oceanographic, environmental, and ecological conditions of the coral reef ecosystems of Jarvis Island.
4. Conduct shallow-water CTD hydrocasts, collect discrete water samples for dissolved inorganic carbon (DIC), total alkalinity (TA), and coral cores samples in shallow depths (≤ 30 m) to examine the chemical, physical, and biological linkages supporting the coral reef ecosystems of Jarvis Island.

5. Conduct nearshore plankton tows at Tutuila Island, Rose Atoll and Jarvis Island.

6. WHOI suite of coral reef bleaching investigation operations (conducted from the OES and CREP small boats):
   a. Water sampling underway/on route (surface, 50, 100, 150 m) and onsite (surface, on corals)
   b. Instrument package deployments at two stations
   c. Plankton tows
      i. Nearshore sampling
      ii. POM sampling *Porites* coring
   d. *Porites* tissue biopsies
   e. Macroalgal collections
   f. Sea cucumber tissue collections

RESULTS:

This section provides the project research activities operational totals (Table 1); a list of the data and samples collected during project SE-16-02 and a summary of relevant observations. For more information pertaining to the data collected and the methodology employed at the sites visited, see Appendices A–F.

The coral reef ecosystems of American Samoa and Jarvis Island have been surveyed biennially since 2004 and triennially starting in 2012 through CREP's Pacific RAMP. The SE-16-02 project supplement the reef fish survey component of the Pacific Reef Assessment and Monitoring Program (RAMP) and documented the aftermath of the 2015–2016 El Niño-related coral bleaching at Rose Atoll and Jarvis Island.

Table 1. Statistics for the Pacific RAMP 2016 project in American Samoa and Jarvis Island (project SE-16-02), including the islands of Tutuila (TUT), Ofu and Olosega (OFU), Ta'u (TAU), Rose Atoll (ROS), and Jarvis. The numbers for REA sites include locations where REA benthic or fish surveys were conducted. The totals for scuba dives include all dives carried out for all activities at each island.

The following data and highlights were collected during this expedition:

Research Activity	TUT	OFU	TAU	ROS	JAR	Totals
Scuba Dives	247	34	120	171	260	**832**
Biological Surveys						
REA Sites: Benthic				16	30	**46**
WHOI: Bleaching surveys					7	**7**
REA Sites: Fish	94	11	50	47	30	**232**
BRUVs Deployments					54	**54**
Biological Sample Collections						
REA Plankton tows	12			5	10	**27**

Research Activity	TUT	OFU	TAU	ROS	JAR	Totals
WHOI: Coral cores					15	**15**
WHOI: Coral biopsies					8	**8**
WHOI: Plankton tows					14	**14**
WHOI: Algal samples					20	**20**
WHOI: Sea cucumber tissue					10	**10**
Oceanographic Moored Instruments						
STRs Retrieved					5	**5**
STRs Deployed					5	**5**
WHOI Temperature loggers deployed and retrieved					12	**12**
BLOS SeaFET recovered	1					**1**
BLOS CAU Plates recovered	13					**13**
Hydrographic Surveys						
Shallow-water CTD casts					12	**12**
Water-quality Sampling						
Shallow-water DIC water samples					12	**12**
WHOI: Shallow-water samples					59	**59**
WHOI: Shallow-water POC samples					15	**15**

Fish Ecology & Monitoring Team

Rapid Ecological Assessment (REA) Fish Surveys on both CCR and OCS:

- Number, species, and estimated sizes of all fishes observed within visually estimated 7.5-m-radius stationary-point-count (SPC) surveys
- Abundance estimates of boring and motile urchins present within SPC surveys
- Visual estimates of benthic cover, habitat type, and habitat complexity
- Digital still photographs of the benthos along transect lines
- Digital still photographs of rare or interesting fish species

Table 2. Statistics for Fish REA surveys at all islands during SE-16-02. The totals for dives include all open circuit scuba (OCS) and closed circuit rebreather (CCR) dives performed at each island.

Island	Total Sites Surveyed	CCR Survey Sites	Dives
Jarvis	30	-	60
Ofu and Olosega	11	6	22
Rose	47	15	94
Tau	50	9	100
Tutuila	94	22	188
Total	**232**	**52**	**464**

Fish Monitoring Highlights (Jarvis Island)

- Piscivore, primary consumer, and secondary consumer biomass in 2016 is pretty similar to what it was in 2015. Planktivore biomass in 2016 is about half what it was in 2015 and 2012. However, 2010 was also low—although not as low as 2016. Notable absences included the planktivorous anthias, *Luzonichthys whitleyi*, which we had seen at around 40% of sites in previous years, and typically several hundred per survey site. This year, none were recorded in 30 surveys at Jarvis. Divers also recorded very few of the Caesionid *Pterocaesio tile* this year and only at one site. *P. tile* is a major contributor to planktivore biomass in most years. It is notable and surprising that so few were observed this year, but as a note of caution, they are typically only recorded in 10–20% of surveys (but in large numbers when seen) hence they are likely to be inherently highly variable in counts.
- A large school of scalloped hammerhead sharks (*Sphyrna lewini*) was sighted several times around the island.
- A giant grouper (*Epinephelus lanceolatus*) estimated to be 1.5 m in total length was seen, which is somewhat rare.

Figure 1 -Large school of scalloped hammerhead sharks (*Sphyrna lewini*), Jarvis Island (photo credit Louis Giuseffi).

Ocean and Climate Change Monitoring

Oceanographic Instrumentation and Biological Installations:

- STR deployments at 1-, 5-, 15-, 25-m depths
- Water samples for salinity, DIC, and TA collected in concert with shallow-water (≤ 30 m) CTD casts
- Recovery of HA-15-01 instrumentation including a SeaFET Ocean pH ion selective field effect transistor sensor for accurate acidification measurements in salt water and several calcification accretion units (CAU) in collaboration with Bigelow Laboratory for Ocean Sciences (BLOS).

Ocean and Climate Change Monitoring Highlights (Jarvis Island)

- The Coral Reef Ecosystem Program has been deploying temperature sensors on the west side of Jarvis since 2004, and a time-series of the combined temperature data of these loggers shows how much temperature variability west Jarvis experiences. One of the most unique aspects of Jarvis is the upwelling, indicated by high-frequency oscillations of 2–3°C. During the recent El Niño event, which peaked at the end of 2015, there was very little upwelling, resulting in warmer waters and exacerbating the stressful conditions for corals. However, as recently as the beginning of April 2016, upwelling resumed, as indicated by the high variability in temperature at the end of the time-series. This shows that conditions are becoming more favorable for corals, hopefully allowing for a quick recovery from the thermal stress event.

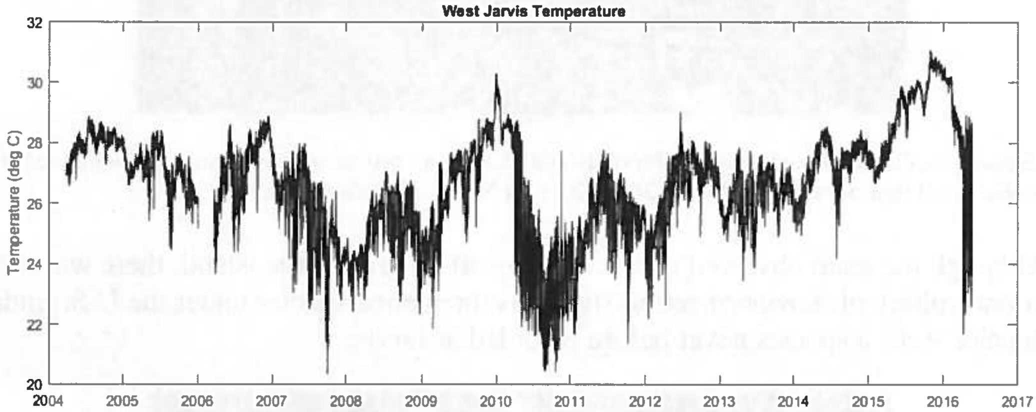

Figure 2 -Composite thermal profile on west Jarvis derived from temperature loggers deployed on west Jarvis Island.

Benthic Monitoring

REA Benthic Surveys:

- Digital still photographs of overall site character and typical benthos
- Digital still photographs of the benthos along transect lines
- Number, species or genus, size, and condition of all coral colonies observed within belt transects of known area
- Digital still photographs of diseased corals and coralline algae.

Benthic Monitoring Highlights (Jarvis Island):

- Benthic surveys revealed catastrophic coral mortality (~ 95%) all around the island as a result of the extreme high sea temperature period observed in 2015. The majority of belt-transect surveys had zero to very few coral colonies. Few remaining coral colonies were observed mainly in deep depth strata (18–30 m) and on the eastern terrace, consisting of *Porites*, *Pavona*, *Hydnophora*, and *Leptoseris*.

Figure 3 -Seascape of the benthic habitat on Jarvis Island, exhibiting profuse cyanobacterial development following the catastrophic coral mortality caused by the 2015–2016 El Niño sea-warming event.

- Although the team observed mass coral die-off all around the island, there was a sighting of one colony of *Acropora retusa* (listed as threatened species under the U.S. Endangered Species Act), a species never before recorded at Jarvis.

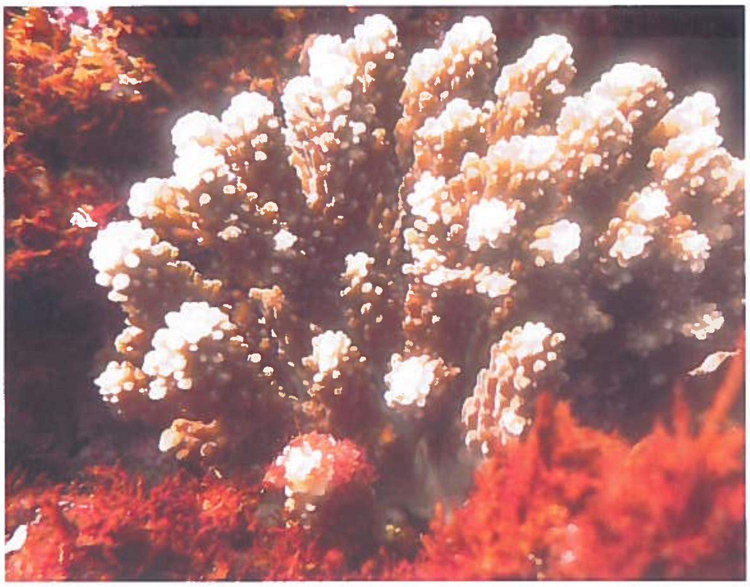

Figure 4 -Underwater photograph of the U.S. ESA-listed coral species *Acropora retusa* sighted on the south forereef at Jarvis.

Auxiliary Projects

The following data and samples were collected during this expedition:

Plankton Tow Surveys:

- Plankton tows consisted of 5-min tows with a 50-cm diameter ring nets with 80-micron and 330-micron mesh size. Twelve tows were collected around Tutuila Island and 5 evenly spaced tows around Rose atoll using the 80-micron net only.
- Ten paired tows using both the 80-micron and 330-micron mesh nets were collected at Jarvis Island

Baited Remote Underwater Video Surveys (BRUVS):

- Fifty-four successful system deployments collecting stereo digital videography to quantify the spatial distribution, abundance, and diversity of carnivorous fishes at Jarvis Island.

SCIENTIFIC PERSONNEL:

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Stefan Kropidlowski, Terrestrial Lead Biologist, USFWS
Stephen Matadobra, Chamber Operator, UH, Hyperbaric Treatment Center
Tate Wester, Fish REA Diver, UH
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Submitted by: ______________________________

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Pacific Islands Fisheries Science Center

APPENDIX A: METHODS

This appendix describes the methods and procedures used by the Coral Reef Ecosystem Program (CREP) of the NOAA Pacific Islands Fisheries Science Center and Woods Hole Oceanographic Institute during its Pacific Reef Assessment and Monitoring Program (Pacific RAMP) project SE-16-02 on the NOAA Ship *Oscar Elton Sette* during the 13 April–31 May, 2016, period.

A.1. Climate and Ocean Acidification Monitoring: Instrumentation, Biological Collections, and Water Quality

(Jeanette Clark)

For main activities were conducted for the monitoring of climate and ocean change: (1) near-shore oceanographic and water quality surveys; (2) deployment and retrieval of an array of subsurface moored instrumentation and installations to provide continuous, high-resolution time-series of physical observations or integrated, ecosystem-wide biological process data; (3) offshore oceanographic surveys characterizing physical, biological, and chemical water properties, and ocean currents around these islands; and acquisition of still photographic benthic imagery to document benthic cover and composition.

A.1.1. Moored Instruments for Time-series Observations

Subsurface Temperature Recorder (STR): provides high-resolution temperature data (SBE 39 or SBE 56). Data are internally recorded at 5-min intervals. This type of subsurface instrument is deployed at depths of 0.5–40 m. All loggers retrieved were of the type SBE 39; all loggers deployed were of the type SBE 56.

Ocean Acidification Instrumentation Suite: this suite of instrumentation is used to measure diurnal variability in the seawater carbonate chemistry at specific reef locations by employing both in-situ and discrete water sample measurements. The suite is composed of: (1) Nortek Aquadopp 2 MHz ADCP, (1) Seabird Electronics SBE-19*plus* CTD, (1) Satlantic SeaFET pH sensor, and (6) Programmable Underwater Collectors (PUC) deployed together on the seafloor. Each PUC pumps 750 ml of seawater at a designated time from just above the reef and collects the sample in a Tedlar bag pre-spiked with mercuric chloride. Each of the seven discrete water samples are then collected and later analyzed for dissolved inorganic carbon and total alkalinity, two constituents of the carbonate system which allow for further calculation of seawater pH and aragonite saturation state.

A.1.2. Hydrographic Surveys

Shallow-water (Near-shore) Conductivity, Temperature, and Depth Casts: a CTD profiler deployed from a small boat provided water column data on temperature, conductivity (which is related to salinity) and pressure, which is related to depth (SBE 19*plus* SeaCAT Profiler). A transmissometer (C-Star, WET Labs, Philomath, Ore.) provided profiles of beam transmittance, which is related to turbidity. A dissolved oxygen sensor (SBE 43, accuracy of 2% of saturation) also was attached and measurements were made in concert with CTD measurements. A CTD cast was performed at each location where a water sample was collected. The CTD is lowered by hand, off a small boat at descent rates of ~ 0.5–0.75 m s-1 to depths up to 30 m.

Portable Underwater Collector (PUC): PUC units are used to autonomously collect multiple water samples at depth at pre-programmed time intervals over a period of 24–48 hours.

A.2. Biological Monitoring: Benthic Surveys

(Hatsue Bailey, Marie Ferguson, Frances Lichowski, Mareike Sudek, and Bernardo Vargas-Ángel)

A two-stage stratified random sampling design was employed to survey the Rapid Ecological Assessment (REA) sites in American Samoa and Jarvis Island. The survey domain encompassed 93.8% of the mapped area of reef and hard bottom habitat, and was divided into strata based upon depth. Depth categories of shallow (0–6 m), moderate (> 6–18 m) and deep (> 18–30 m) were also incorporated into the stratification scheme. Allocation of sampling effort was proportional to strata area. Sites were randomly selected within each stratum.

A.2.1. Benthic composition and coral demographics

Surveys at each site were conducted within two 18-m belt transects. Adult coral colonies (≥ 5 cm) were surveyed within 4 (1.0 × 2.5 m) segments in the following manner: 0–2.5 m (segment 1); 5.0–7.5m (segment 3); 10–12.5 m (segment 5); and 15–17.5 m (segment 7). All colonies whose center fell within 0.5 m on either side of each transect line were identified to lowest taxonomic level possible (species or genus), measured for size (maximum diameter to nearest cm), and morphology was noted. In addition, partial mortality and condition of each colony was assessed. Partial mortality was estimated as percent of the colony in terms of old dead and recent dead and the cause of recent mortality was identified if possible. The condition of each colony including disease and bleaching was noted along with the extent (percent of colony affected) and level of severity (range from moderate to acute).

Juvenile coral colonies (< 5 cm) were surveyed within three (1.0 × 1.0 m) segments along the same 2 transects: 0–1.0 m (segment 1); 5.0–6.0 m (segment 3); and 10.0–11.0 m (segment 5). Juvenile colonies were distinguished in the field by a distinct tissue and skeletal boundary (not a fragment of larger colony). Each juvenile colony was identified to lowest taxonomic level (genus or species) and measured for size by recording both the maximum and perpendicular diameter to the nearest 2 mm.

Still photographs were collected to record the benthic community composition at predetermined points along the same two transect lines with a high-resolution digital camera mounted on a pole. Photographs were taken every 1 m from the 1-m to the 15-m mark. This work generates 30 photographs per site, which are later analyzed by CRED staff and partners using the computer program Coral Point Count with Excel extensions (CPCe). This analysis is the basis for estimating benthic cover and composition at each site (benthic habitat photographs at sites surveyed by the fish team are also analyzed).

A.3. Biological Monitoring: Surveys of Reef Fishes

(Kevin Lino, Paula Ayotte, Adel Heenan, Kelvin Gorospe, Kaylyn McCoy, Andrew Gray, Louis Giuseffi, Ray Boland, Julia Rose, Tate Wester, Kosta Stamoulis, Ivor Williams, Zach Caldwell, Motu Vaeoso, Britney Honisch, Alice Lawrence, Marc Nadon)

Divers conducted REA fish surveys using the stationary-point-count (SPC) method at preselected REA sites. Each team consisted of 2 divers, and conducted 1 SPC survey per site. All fish REA sites visited were selected using a stratified random sampling design in shallow (0–6 m), moderate (6–18 m), or deep (18–30 m) depth strata, in the fore-reef habitat strata. Surveys were performed using a 30-m transect line set along a single depth contour. The REA sites selected for fish surveys typically differ in location from the REA sites where benthic surveys were conducted.

Once a transect line was deployed, the 2 divers moved to the 7.5-m and 22.5-m marks on this transect line to start their SPC surveys. Each of these marks or points, with 1 diver at each, served as the center of a visually estimated cylindrical survey area with a radius of 7.5 m. During the first 5 min, divers only recorded the presence of species within their respective cylinders. Afterwards, divers went down their respective species lists, which were created from their work during the initial 5 min of a survey, sizing and counting all individuals within their cylinder, one species at a time. Cryptic species missed during the initial 5 min of a survey could still be counted, sized, and added to the original species list. Fish species observed at a REA site but not recorded during the SPCs were recorded for presence data.

A comparison component of this research involves surveying the same exact site using a pair of divers on open-circuit scuba (OCS) and then repeating the survey with another pair of divers using closed-circuit rebreathers (CCR). The survey method remains the same but the transect reels and surface marker buoy are retrieved by the second dive pair. To ensure the safety of the CCR divers by avoiding swell and drastic depth changes, no shallow sites are surveyed by this team. Dives were conducted at 12–30-m depths only for this comparison.

After a survey was completed, divers recorded benthic habitat information within their respective cylindrical survey areas. Divers visually estimated habitat complexity, habitat type, and percentage of cover for hard corals, macroalgae, crustose coralline red algae, turf algae, and sand. Urchin densities were also estimated. Every meter along the transect line, still photographs were taken of the benthos to the right side of the line. This work generates 30 photographs per site, which together with the habitat photographs at sites surveyed by the benthic team, are later analyzed, implementing Coral Point Count with Excel extensions (CPCe), to estimate the benthic cover and composition at each site.

A.4 Baited Remote Underwater Video Surveys

(Damon Driessen, Louis Giuseffi, Jamie Barlow)

Stereo baited remote underwater videos systems (BRUVS) consist of two camera housings mounted on a base bar at convergent angles which is then mounted on a galvanized steel frame. Each BRUVS frame has a bait arm which extends 1 m in front of the frame in view of both cameras, at the end of the bait arm a bait basket is attached. Approximately 800 grams of oily fish (*Sardinops spp*) was used per BRUVS deployment. Once a vessel arrives at a pre-determined GPS coordinate a BRUVS is slowly lowered over the side of the vessel until it reaches the bottom, once on the bottom the excess line and 2 surface buoys are fed out slowly. This process is repeated until all BRUVS are in the water simultaneously (2 operating vessels, 3 systems per vessel). Any systems deployed on the same day would have a minimum of 500-m separation. Each system would be allowed a soak time of no less than 1 hour. After the minimum soak time each system was retrieved in order of deployment. The remaining bait would be retained on board with each bait bag then being packed with fresh bait ready for the next deployment.

APPENDIX B: TUTUILA ISLAND

The island of Tutuila, located at 14°16′ S, 170°41′ W in the South Pacific and is the largest island in American Samoa. For information about the methods used to perform the activities discussed in this appendix, please see Appendix A: "Methods."

B.1. Biological Monitoring: Reef Fish Community

REA fish survey sites were chosen using a stratified random design. SPC surveys were conducted at 88 REA sites at Tutuila Island over 3 different habitat strata: deep, moderate, and shallow forereef (Fig.B.1.1 and Table B.1.1).

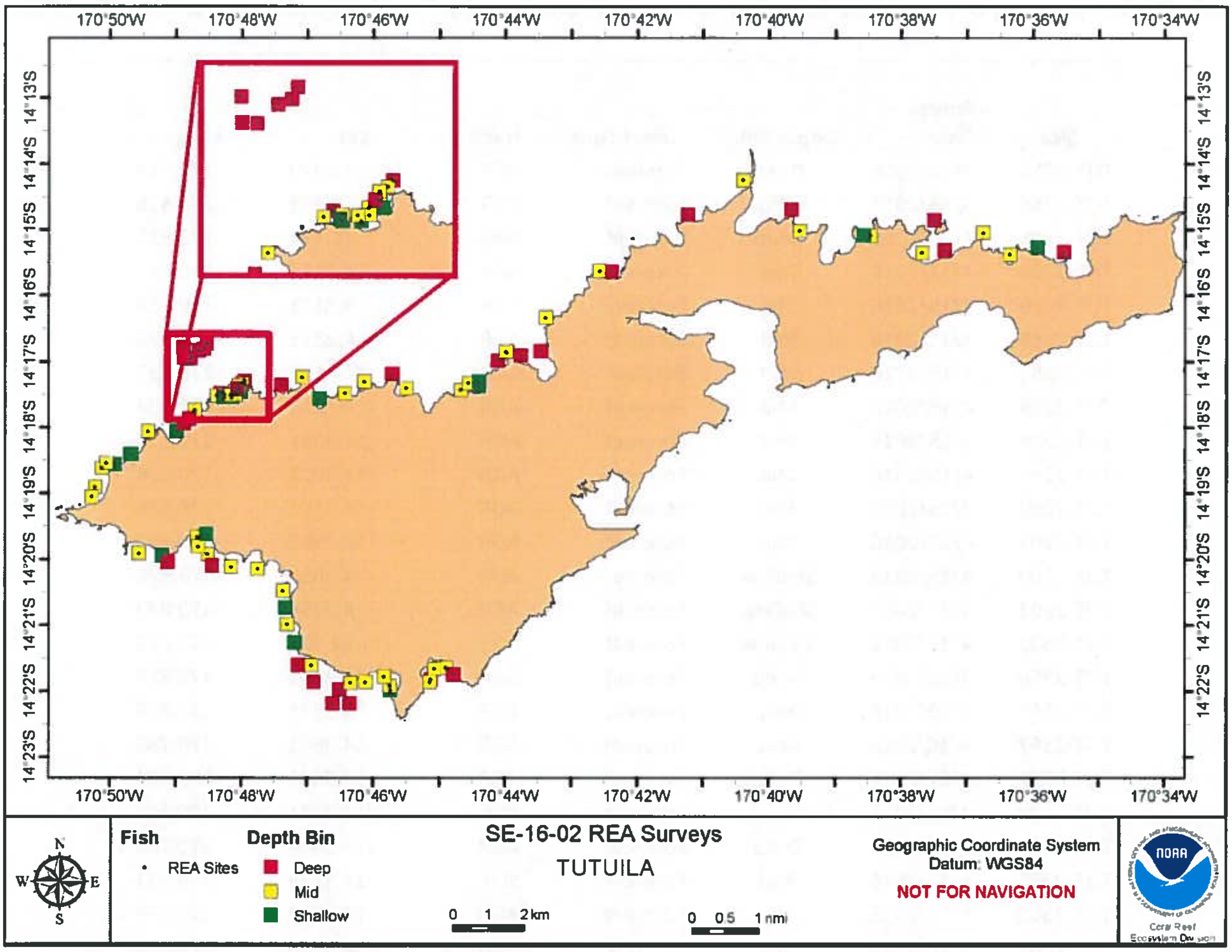

Figure B.1.1.--Locations of REA fish sites surveyed at Tutuila Island during project SE-16-02. All of these REA sites were selected using a stratified random design.

Table B.1.1.--Summary of sites where REA fish surveys were conducted at Tutuila Island during project SE-16-02.

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
TUT-2259	4/15/2016	Deep	Forereef	AGR	-14.2979	-170.813
TUT-2266	4/15/2016	Deep	Forereef	SAG	-14.299	-170.815
TUT-2266	4/15/2016	Deep	Forereef	SAG	-14.299	-170.815
TUT-2279	4/15/2016	Mid	Forereef	AGR	-14.3175	-170.838
TUT-2279	4/15/2016	Mid	Forereef	AGR	-14.3175	-170.838
TUT-2280	4/15/2016	Mid	Forereef	AGR	-14.2375	-170.673
TUT-2281	4/15/2016	Mid	Forereef	AGR	-14.3151	-170.837
TUT-2286	4/15/2016	Mid	Forereef	AGR	-14.3091	-170.834
TUT-2286	4/15/2016	Mid	Forereef	AGR	-14.3091	-170.834
TUT-2287	4/15/2016	Mid	Forereef	AGR	-14.3011	-170.824
TUT-2292	4/15/2016	Mid	Forereef	AGR	-14.3103	-170.835
TUT-2295	4/15/2016	Mid	Forereef	AGR	-14.2957	-170.812
TUT-2300	4/15/2016	Shallow	Forereef	AGR	-14.3069	-170.828
TUT-2303	4/15/2016	Shallow	Forereef	AGR	-14.3094	-170.832
TUT-2306	4/15/2016	Shallow	Forereef	AGR	-14.301	-170.816
TUT-2356	4/16/2016	Deep	Forereef	AGR	-14.3341	-170.819
TUT-2356	4/16/2016	Deep	Forereef	AGR	-14.3341	-170.819
TUT-2357	4/16/2016	Deep	Forereef	AGR	-14.3601	-170.786
TUT-2357	4/16/2016	Deep	Forereef	AGR	-14.3601	-170.786
TUT-2358	4/16/2016	Deep	Forereef	RRB	-14.3351	-170.807
TUT-2363	4/16/2016	Deep	Forereef	AGR	-14.3644	-170.782
TUT-2367	4/16/2016	Mid	Forereef	SCR	-14.3279	-170.811
TUT-2368	4/16/2016	Mid	Forereef	AGR	-14.3319	-170.826
TUT-2369	4/16/2016	Mid	Forereef	AGR	-14.3358	-170.796
TUT-2369	4/16/2016	Mid	Forereef	AGR	-14.3358	-170.796
TUT-2373	4/16/2016	Mid	Forereef	SAG	-14.3603	-170.782
TUT-2376	4/16/2016	Mid	Forereef	AGR	-14.3498	-170.788
TUT-2381	4/16/2016	Mid	Forereef	AGR	-14.3321	-170.809
TUT-2382	4/16/2016	Mid	Forereef	AGR	-14.3414	-170.789
TUT-2393	4/16/2016	Mid	Forereef	AGR	-14.3354	-170.803
TUT-2394	4/16/2016	Mid	Forereef	AGR	-14.3302	-170.811
TUT-2402	4/16/2016	Shallow	Forereef	AGR	-14.3544	-170.786
TUT-2406	4/16/2016	Shallow	Forereef	APS	-14.3271	-170.809
TUT-2411	4/16/2016	Shallow	Forereef	AGR	-14.3325	-170.82
TUT-2413	4/16/2016	Shallow	Forereef	AGR	-14.3456	-170.789
TUT-2347	4/20/2016	Mid	Forereef	AGR	-14.3632	-170.764
TUT-2348	4/20/2016	Deep	Forereef	AGR	-14.3698	-170.777
TUT-2348	4/20/2016	Deep	Forereef	AGR	-14.3698	-170.777
TUT-2350	4/20/2016	Deep	Forereef	AGR	-14.3663	-170.775
TUT-2352	4/20/2016	Deep	Forereef	AGR	-14.3626	-170.746
TUT-2352	4/20/2016	Deep	Forereef	AGR	-14.3626	-170.746
TUT-2353	4/20/2016	Deep	Forereef	AGR	-14.3698	-170.772
TUT-2353	4/20/2016	Deep	Forereef	AGR	-14.3698	-170.772
TUT-2361	4/20/2016	Deep	Forereef	AGR	-14.3638	-170.752
TUT-2371	4/20/2016	Mid	Forereef	AGR	-14.3645	-170.752
TUT-2374	4/20/2016	Mid	Forereef	AGR	-14.3647	-170.772

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
TUT-2378	4/20/2016	Mid	Forereef	AGR	-14.3612	-170.751
TUT-2384	4/20/2016	Mid	Forereef	SAG	-14.3654	-170.762
TUT-2386	4/20/2016	Mid	Forereef	AGR	-14.3644	-170.769
TUT-2404	4/20/2016	Mid	Forereef	AGR	-14.3609	-170.748
TUT-2415	4/20/2016	Shallow	Forereef	AGR	-14.3665	-170.762
TUT-2264	4/26/2016	Deep	Forereef	AGR	-14.2892	-170.79
TUT-2274	4/26/2016	Deep	Forereef	AGR	-14.2865	-170.762
TUT-2274	4/26/2016	Deep	Forereef	AGR	-14.2865	-170.762
TUT-2283	4/26/2016	Mid	Forereef	AGR	-14.2901	-170.758
TUT-2284	4/26/2016	Mid	Forereef	RRB	-14.2907	-170.745
TUT-2285	4/26/2016	Mid	Forereef	AGR	-14.2914	-170.774
TUT-2290	4/26/2016	Mid	Forereef	AGR	-14.2885	-170.769
TUT-2294	4/26/2016	Mid	Forereef	AGR	-14.2889	-170.743
TUT-2294	4/26/2016	Mid	Forereef	AGR	-14.2889	-170.743
TUT-2296	4/26/2016	Mid	Forereef	ROB	-14.2873	-170.784
TUT-2297	4/26/2016	Mid	Forereef	AGR	-14.2605	-170.71
TUT-2302	4/26/2016	Shallow	Forereef	ROB	-14.2927	-170.78
TUT-2305	4/26/2016	Shallow	Forereef	AGR	-14.2896	-170.74
TUT-2534	4/26/2016	Deep	Forereef	AGR	-14.2884	-170.799
TUT-2537	4/26/2016	Mid	Forereef	AGR	-14.2903	-170.801
TUT-2537	4/26/2016	Mid	Forereef	AGR	-14.2903	-170.801
TUT-2540	4/26/2016	Mid	Forereef	AGR	-14.289	-170.8
TUT-2258	4/27/2016	Deep	Forereef	AGR	-14.2789	-170.809
TUT-2270	4/27/2016	Deep	Forereef	APS	-14.2807	-170.811
TUT-2271	4/27/2016	Deep	Forereef	APS	-14.2826	-170.813
TUT-2288	4/27/2016	Mid	Forereef	AGR	-14.2919	-170.803
TUT-2525	4/27/2016	Deep	Forereef	AGR	-14.2801	-170.81
TUT-2525	4/27/2016	Deep	Forereef	AGR	-14.2801	-170.81
TUT-2527	4/27/2016	Deep	Forereef	AGR	-14.2799	-170.815
TUT-2527	4/27/2016	Deep	Forereef	AGR	-14.2799	-170.815
TUT-2531	4/27/2016	Deep	Forereef	AGR	-14.2825	-170.815
TUT-2536	4/27/2016	Mid	Forereef	AGR	-14.2911	-170.802
TUT-2538	4/27/2016	Mid	Forereef	AGR	-14.2921	-170.806
TUT-2539	4/27/2016	Mid	Forereef	SCR	-14.2918	-170.802
TUT-2541	4/27/2016	Shallow	Forereef	AGR	-14.2911	-170.8
TUT-2543	4/27/2016	Shallow	Forereef	AGR	-14.2925	-170.802
TUT-2544	4/27/2016	Shallow	Forereef	AGR	-14.2925	-170.804
TUT-2545	4/27/2016	Shallow	Forereef	ROB	-14.2923	-170.805
TUT-2547	4/27/2016	Deep	Forereef	AGR	-14.2915	-170.805
TUT-2549	4/27/2016	Deep	Forereef	AGR	-14.2903	-170.801
TUT-2549	4/27/2016	Deep	Forereef	AGR	-14.2903	-170.801
TUT-2550	4/27/2016	Mid	Forereef	AGR	-14.2918	-170.804
TUT-2551	4/27/2016	Mid	Forereef	AGR	-14.2894	-170.801
TUT-2310	4/29/2016	Deep	Forereef	AGR	-14.2449	-170.661
TUT-2310	4/29/2016	Deep	Forereef	AGR	-14.2449	-170.661
TUT-2314	4/29/2016	Deep	Forereef	APR	-14.2557	-170.592
TUT-2315	4/29/2016	Deep	Forereef	AGR	-14.2476	-170.625
TUT-2315	4/29/2016	Deep	Forereef	AGR	-14.2476	-170.625

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
TUT-2316	4/29/2016	Deep	Forereef	SCR	-14.2552	-170.622
TUT-2317	4/29/2016	Mid	Forereef	RRB	-14.2559	-170.628
TUT-2324	4/29/2016	Mid	Forereef	AGR	-14.2504	-170.659
TUT-2325	4/29/2016	Mid	Forereef	SAG	-14.2515	-170.641
TUT-2327	4/29/2016	Mid	Forereef	APR	-14.2564	-170.606
TUT-2328	4/29/2016	Mid	Forereef	AGR	-14.2508	-170.613
TUT-2328	4/29/2016	Mid	Forereef	AGR	-14.2508	-170.613
TUT-2336	4/29/2016	Shallow	Forereef	SAG	-14.2544	-170.599
TUT-2346	4/29/2016	Shallow	Forereef	AGR	-14.2515	-170.643
TUT-2256	4/30/2016	Deep	Forereef	AGR	-14.2606	-170.706
TUT-2256	4/30/2016	Deep	Forereef	AGR	-14.2606	-170.706
TUT-2260	4/30/2016	Deep	Forereef	AGR	-14.2461	-170.687
TUT-2261	4/30/2016	Deep	Forereef	AGR	-14.2832	-170.735
TUT-2262	4/30/2016	Deep	Forereef	APS	-14.2808	-170.724
TUT-2262	4/30/2016	Deep	Forereef	APS	-14.2808	-170.724
TUT-2263	4/30/2016	Mid	Forereef	AGR	-14.2808	-170.733
TUT-2265	4/30/2016	Deep	Forereef	RRB	-14.282	-170.729
TUT-2282	4/30/2016	Mid	Forereef	AGR	-14.281	-170.733
TUT-2291	4/30/2016	Mid	Forereef	AGR	-14.2722	-170.723
TUT-2299	4/30/2016	Shallow	Forereef	AGR	-14.2885	-170.74

APPENDIX C: OFU AND OLOSEGA ISLANDS

The islands of Ofu and Olosega, located at 14°10′ S, 169°38′ W in the central Pacific, are part of the American Samoa Archipelago For information about the methods used to perform the activities discussed in this appendix, please see Appendix A: "Methods."

C.1. Biological Monitoring: Reef Fish Community

REA fish survey sites were chosen using a stratified random design. SPC surveys were conducted at 11 REA sites at Ofu and Olosega Islands over 3 different habitat strata: deep, moderate, and shallow forereef (Fig.C.1.1 and Table C.1.1).

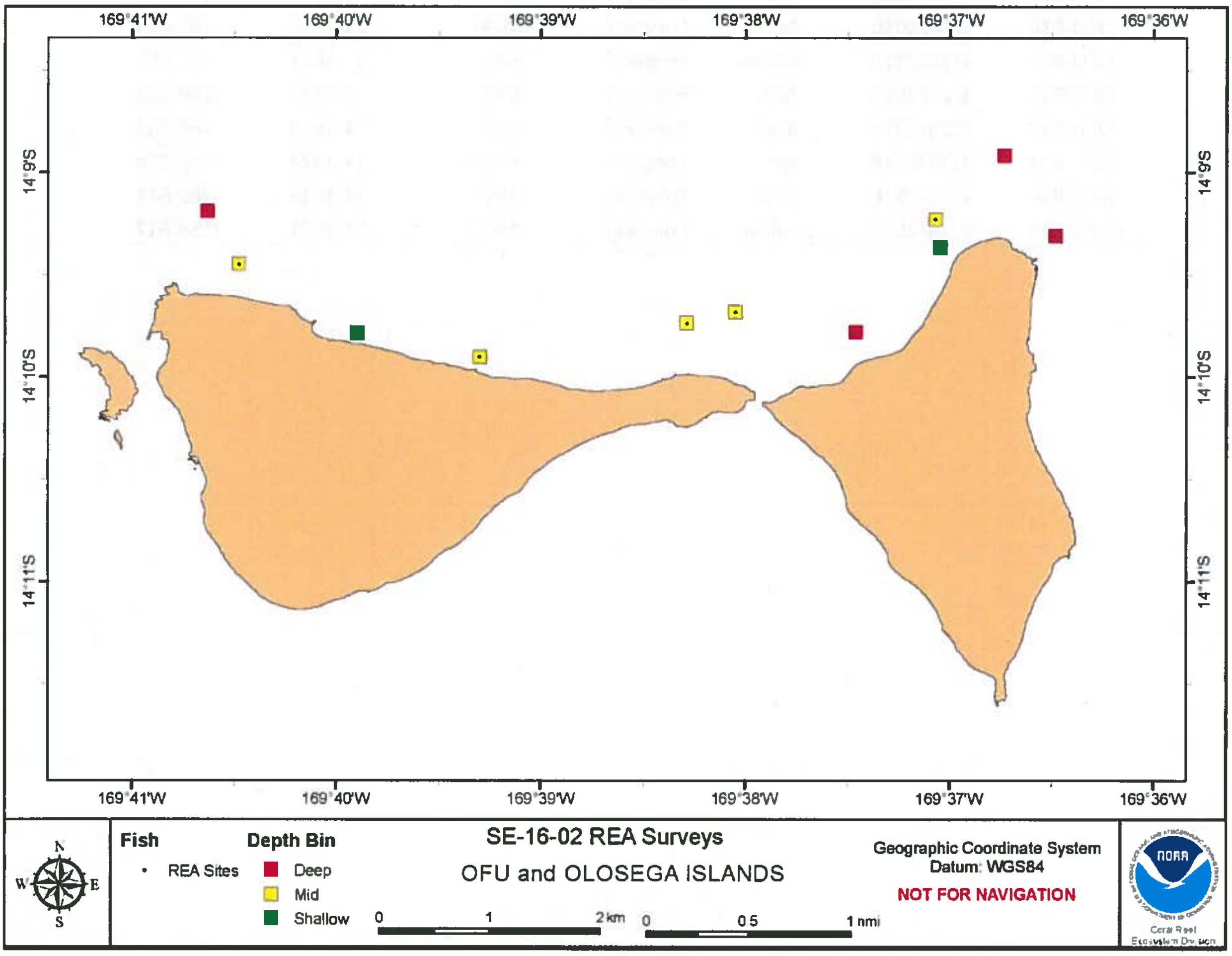

Figure C.1.1.--Locations of REA fish sites surveyed at Ofu and Olosega Islands during project SE-16-02. All of these REA sites were selected using a stratified random design.

Table C.1.1.--Summary of sites where REA fish surveys were conducted at Ofu and Olosega Islands during project SE-16-02.

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
OFU-788	4/28/2016	Deep	Forereef	AGR	-14.1552	-169.608
OFU-788	4/28/2016	Deep	Forereef	AGR	-14.1552	-169.608
OFU-792	4/28/2016	Deep	Forereef	AGR	-14.1486	-169.612
OFU-792	4/28/2016	Deep	Forereef	AGR	-14.1486	-169.612
OFU-795	4/28/2016	Deep	Forereef	RRB	-14.1532	-169.677
OFU-795	4/28/2016	Deep	Forereef	RRB	-14.1532	-169.677
OFU-800	4/28/2016	Deep	Forereef	AGR	-14.163	-169.624
OFU-800	4/28/2016	Deep	Forereef	AGR	-14.163	-169.624
OFU-827	4/28/2016	Mid	Forereef	AGR	-14.1575	-169.675
OFU-827	4/28/2016	Mid	Forereef	AGR	-14.1575	-169.675
OFU-830	4/28/2016	Mid	Forereef	AGR	-14.1538	-169.618
OFU-841	4/28/2016	Shallow	Forereef	SAG	-14.1631	-169.665
OFU-853	4/28/2016	Mid	Forereef	SAG	-14.165	-169.655
OFU-857	4/28/2016	Mid	Forereef	PAV	-14.1623	-169.638
OFU-857	4/28/2016	Mid	Forereef	PAV	-14.1623	-169.638
OFU-858	4/28/2016	Mid	Forereef	AGR	-14.1614	-169.634
OFU-879	4/28/2016	Shallow	Forereef	AGR	-14.1561	-169.617

APPENDIX D: TA‘U ISLAND

The island of Ta‘u, located at 14°14′ S, 169°24′ W in the central Pacific, is part of the American Samoa Archipelago. For information about the methods used to perform the activities discussed in this appendix, please see Appendix A: “Methods.”

D.1. Biological Monitoring: Reef Fish Community

REA fish survey sites were chosen using a stratified random design. SPC surveys were conducted at 50 REA sites at Ta‘u Island over 3 different habitat strata: deep, moderate, and shallow forereef (Fig.D.1.1 and Table D.1.1).

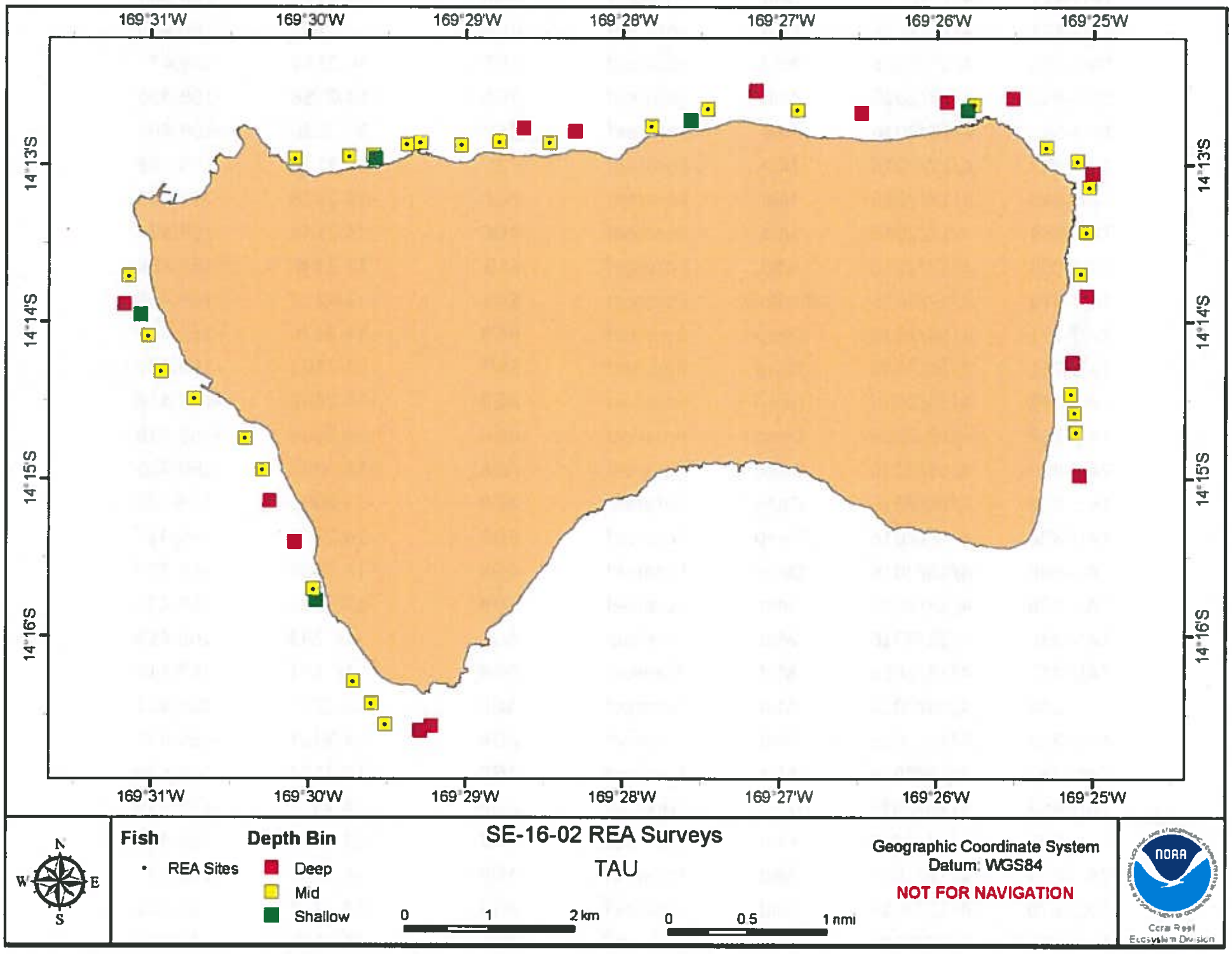

Figure D.1.1.--Locations of REA fish sites surveyed at Ta‘u Island during project SE-16-02. All of these REA sites were selected using a stratified random design.

Table D.1.1.--Summary of sites where REA fish surveys were conducted at Ta'u Island during project SE-16-02.

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
TAU-773	4/17/2016	Deep	Forereef	PAV	-14.2089	-169.453
TAU-773	4/17/2016	Deep	Forereef	PAV	-14.2089	-169.453
TAU-779	4/17/2016	Deep	Forereef	AGR	-14.2128	-169.477
TAU-779	4/17/2016	Deep	Forereef	AGR	-14.2128	-169.477
TAU-780	4/17/2016	Deep	Forereef	SAG	-14.2131	-169.472
TAU-798	4/17/2016	Deep	Forereef	AGR	-14.2112	-169.441
TAU-809	4/17/2016	Mid	Forereef	AGR	-14.2146	-169.49
TAU-811	4/17/2016	Mid	Forereef	AGR	-14.2143	-169.48
TAU-816	4/17/2016	Mid	Forereef	AGR	-14.2109	-169.448
TAU-824	4/17/2016	Shallow	Forereef	PAV	-14.2161	-169.493
TAU-827	4/17/2016	Mid	Forereef	AGR	-14.2161	-169.501
TAU-828	4/17/2016	Mid	Forereef	AGR	-14.2157	-169.493
TAU-828	4/17/2016	Mid	Forereef	AGR	-14.2157	-169.493
TAU-835	4/17/2016	Mid	Forereef	AGR	-14.2158	-169.496
TAU-836	4/17/2016	Mid	Forereef	PAV	-14.2126	-169.464
TAU-838	4/17/2016	Mid	Forereef	PAV	-14.2143	-169.488
TAU-845	4/17/2016	Mid	Forereef	AGR	-14.2108	-169.458
TAU-854	4/17/2016	Mid	Forereef	AGR	-14.2144	-169.474
TAU-869	4/17/2016	Mid	Forereef	SAG	-14.2146	-169.484
TAU-879	4/17/2016	Shallow	Forereef	SAG	-14.212	-169.459
TAU-771	4/18/2016	Deep	Forereef	AGR	-14.2176	-169.417
TAU-781	4/18/2016	Deep	Forereef	SAG	-14.2101	-169.432
TAU-797	4/18/2016	Deep	Forereef	AGR	-14.2496	-169.418
TAU-797	4/18/2016	Deep	Forereef	AGR	-14.2496	-169.418
TAU-800	4/18/2016	Deep	Forereef	AGR	-14.2096	-169.425
TAU-800	4/18/2016	Deep	Forereef	AGR	-14.2096	-169.425
TAU-808	4/18/2016	Deep	Forereef	AGR	-14.2306	-169.417
TAU-808	4/18/2016	Deep	Forereef	AGR	-14.2306	-169.417
TAU-826	4/18/2016	Mid	Forereef	AGR	-14.2163	-169.418
TAU-830	4/18/2016	Mid	Forereef	AGR	-14.243	-169.419
TAU-842	4/18/2016	Mid	Forereef	AGR	-14.241	-169.419
TAU-848	4/18/2016	Mid	Forereef	AGR	-14.2239	-169.417
TAU-851	4/18/2016	Mid	Forereef	AGR	-14.2451	-169.419
TAU-852	4/18/2016	Mid	Forereef	AGR	-14.2104	-169.429
TAU-862	4/18/2016	Deep	Forereef	AGR	-14.2377	-169.419
TAU-863	4/18/2016	Mid	Forereef	PAV	-14.2191	-169.417
TAU-865	4/18/2016	Mid	Forereef	AGR	-14.2149	-169.422
TAU-870	4/18/2016	Mid	Forereef	AGR	-14.2282	-169.418
TAU-875	4/18/2016	Shallow	Forereef	PAV	-14.2109	-169.43
TAU-783	4/19/2016	Deep	Forereef	AGR	-14.2567	-169.501
TAU-786	4/19/2016	Deep	Forereef	AGR	-14.2523	-169.504
TAU-795	4/19/2016	Deep	Forereef	RRB	-14.2315	-169.52
TAU-795	4/19/2016	Deep	Forereef	RRB	-14.2315	-169.52
TAU-804	4/19/2016	Deep	Forereef	RRB	-14.2763	-169.487
TAU-810	4/19/2016	Mid	Forereef	AGR	-14.2617	-169.499
TAU-814	4/19/2016	Mid	Forereef	RRB	-14.276	-169.492
TAU-832	4/19/2016	Mid	Forereef	AGR	-14.2739	-169.493

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
TAU-837	4/19/2016	Mid	Forereef	AGR	-14.2285	-169.519
TAU-844	4/19/2016	Mid	Forereef	PAV	-14.2349	-169.517
TAU-847	4/19/2016	Mid	Forereef	AGR	-14.2491	-169.505
TAU-856	4/19/2016	Mid	Forereef	AGR	-14.2457	-169.507
TAU-856	4/19/2016	Mid	Forereef	AGR	-14.2457	-169.507
TAU-857	4/19/2016	Mid	Forereef	AGR	-14.2386	-169.516
TAU-859	4/19/2016	Mid	Forereef	AGR	-14.2415	-169.512
TAU-864	4/19/2016	Deep	Forereef	RRB	-14.2767	-169.488
TAU-864	4/19/2016	Deep	Forereef	RRB	-14.2767	-169.488
TAU-872	4/19/2016	Mid	Forereef	AGR	-14.2715	-169.495
TAU-885	4/19/2016	Shallow	Forereef	AGR	-14.2629	-169.499
TAU-888	4/19/2016	Shallow	Forereef	AGR	-14.2326	-169.518

APPENDIX E: ROSE ATOLL

Rose Atoll, located at 14°10′ S, 169°38′ W in the central Pacific, is one of four Marine National Monuments spanning across the Pacific. The Monument area also encompasses protections afforded by the Rose Atoll National Wildlife Refuge and the Muliava Unit of the National Marine Sanctuary of American Samoa. For information about the methods used to perform the activities discussed in this appendix, please see Appendix A: "Methods."

E.1. Biological Monitoring: Benthic Surveys and Microbial Sampling

Belt-transect surveys were conducted and photographs were taken along transect lines at 16 REA sites around Rose Atoll to assess benthic composition, coral community structure, and coral and algal disease (Fig. E.1.1 and Table E.1.1).

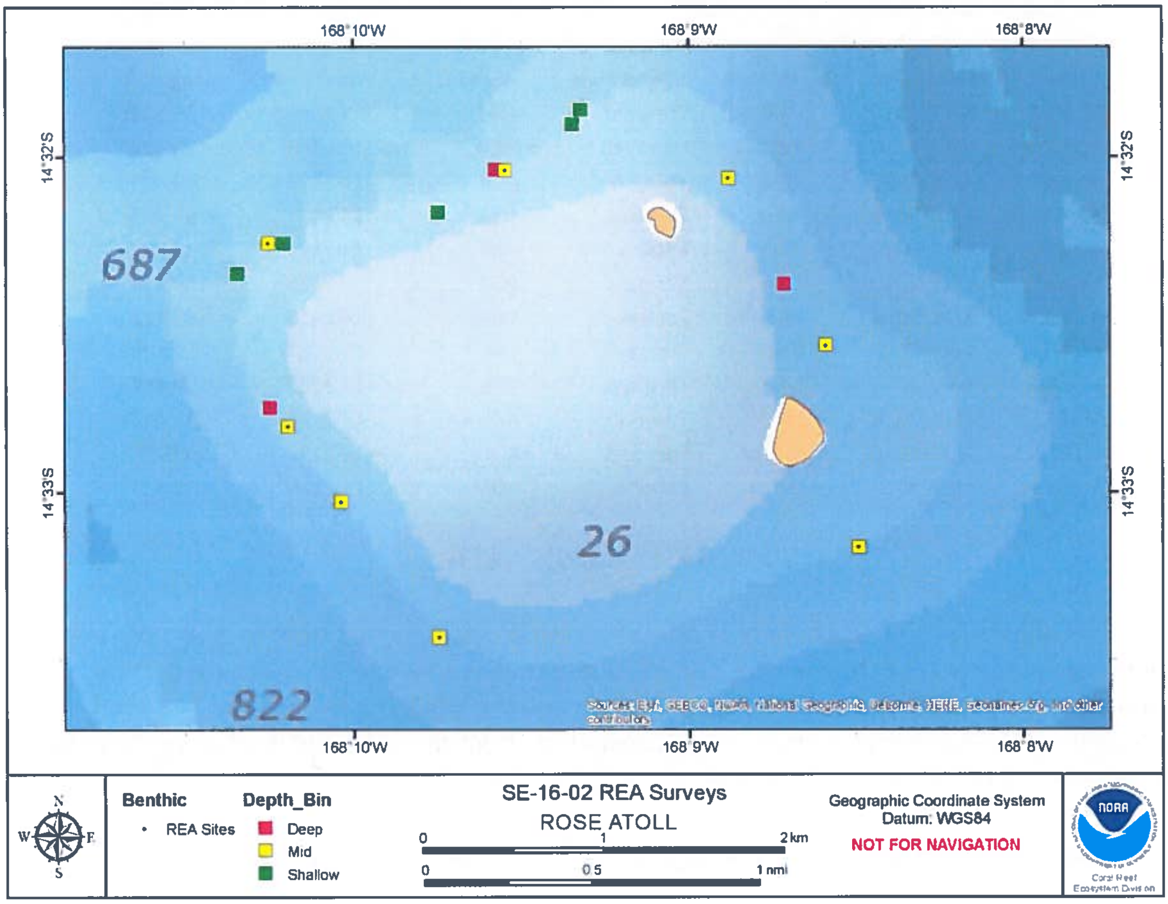

Figure E.1.1.--Locations of REA benthic sites surveyed at Rose Atoll during project SE-16-02. All of these REA sites were selected using a stratified random design.

Table E.1.1.--Summary of the REA benthic surveys collections performed at Rose Atoll during project SE-16-02.

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
ROS-855	5/1/2016	Deep	Forereef	AGR	-14.533956	-168.16
ROS-867	5/1/2016	Mid	Forereef	AGR	-14.537608	-168.171
ROS-887	5/1/2016	Mid	Forereef	AGR	-14.533982	-168.159
ROS-922	5/1/2016	Shallow	Forereef	AGR	-14.53171	-168.156
ROS-856	5/2/2016	Deep	Forereef	AGR	-14.545775	-168.171
ROS-869	5/2/2016	Mid	Forereef	AGR	-14.546732	-168.17
ROS-886	5/2/2016	Mid	Forereef	AGR	-14.550488	-168.167
ROS-896	5/2/2016	Mid	Forereef	AGR	-14.557213	-168.162
ROS-858	5/3/2016	Deep	Forereef	AGR	-14.539659	-168.145
ROS-865	5/3/2016	Mid	Forereef	AGR	-14.534382	-168.148
ROS-899	5/3/2016	Mid	Forereef	AGR	-14.542687	-168.143
ROS-902	5/3/2016	Shallow	Forereef	AGR	-14.530969	-168.155
ROS-839	5/4/2016	Shallow	Forereef	AGR	-14.536088	-168.162
ROS-857	5/4/2016	Shallow	Forereef	AGR	-14.537604	-168.17
ROS-894	5/4/2016	Mid	Forereef	AGR	-14.552743	-168.142
ROS-903	5/4/2016	Shallow	Forereef	AGR	-14.539139	-168.172

E.2. Biological Monitoring: Reef Fish Community

REA fish survey sites were chosen using a stratified random design. SPC surveys were conducted at 47 REA sites at Rose Atoll over 3 different habitat strata: deep, moderate, and shallow forereef (Fig. E.2.1 and Table E.2.1).

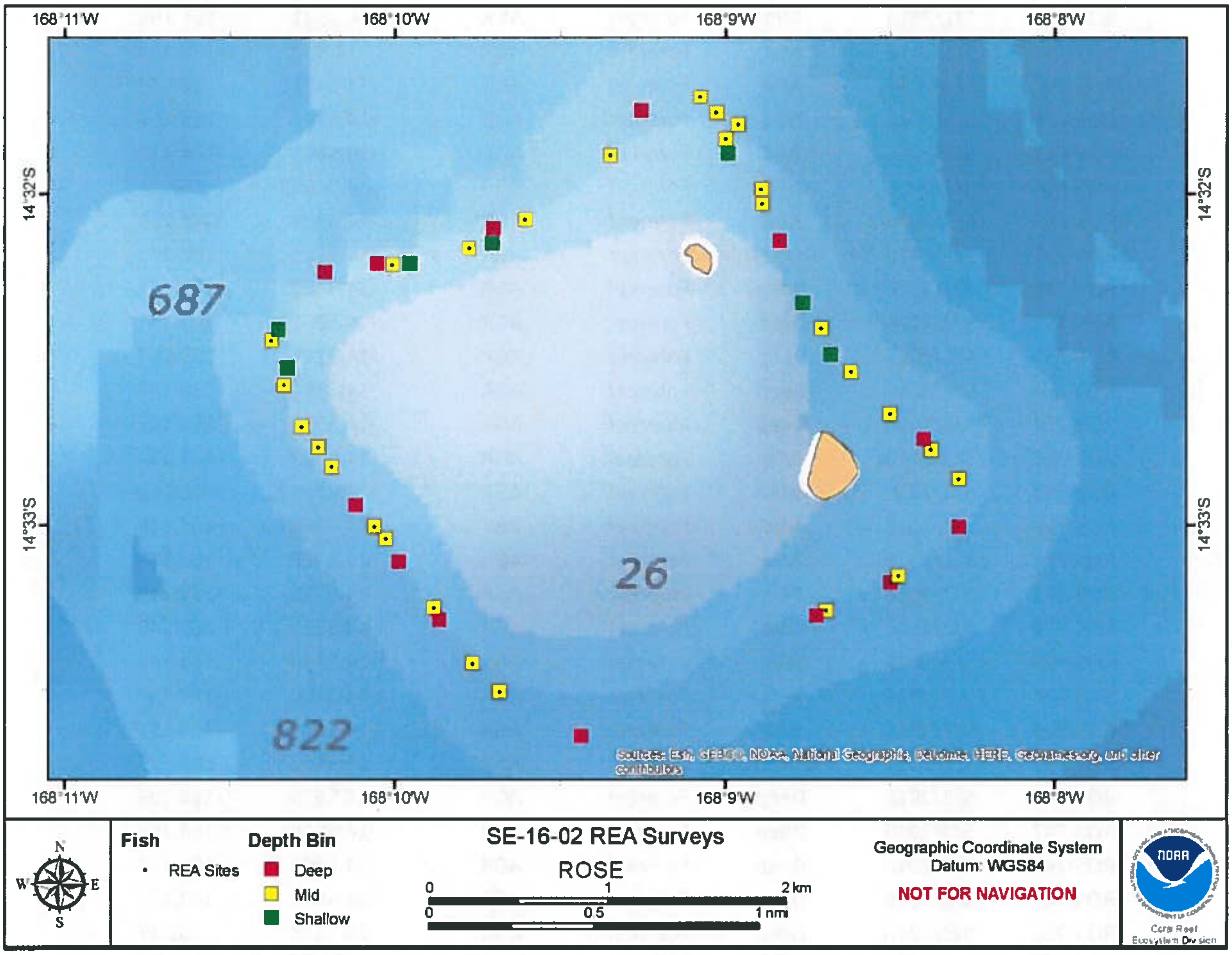

Figure E.2.1.--Locations of REA fish sites surveyed at Rose Atoll during project SE-16-02. All of these REA sites were selected using a stratified random design.

Table E.2.1.--Summary of sites where REA fish surveys were conducted at Rose Atoll during project SE-16-02.

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
ROS-753	5/1/2016	Deep	Forereef	AGR	-14.5548	-168.164
ROS-755	5/1/2016	Mid	Forereef	AGR	-14.5542	-168.165
ROS-759	5/1/2016	Mid	Forereef	AGR	-14.5501	-168.168
ROS-764	5/1/2016	Mid	Forereef	AGR	-14.557	-168.163
ROS-768	5/1/2016	Mid	Forereef	AGR	-14.5471	-168.17
ROS-773	5/1/2016	Mid	Forereef	AGR	-14.5507	-168.167
ROS-783	5/1/2016	Mid	Forereef	AGR	-14.5407	-168.173
ROS-784	5/1/2016	Mid	Forereef	AGR	-14.5462	-168.14
ROS-786	5/1/2016	Mid	Forereef	AGR	-14.5584	-168.161
ROS-791	5/1/2016	Shallow	Forereef	AGR	-14.5421	-168.172
ROS-748	5/2/2016	Deep	Forereef	AGR	-14.5351	-168.162
ROS-751	5/2/2016	Deep	Forereef	AGR	-14.5291	-168.154
ROS-751	5/2/2016	Deep	Forereef	AGR	-14.5291	-168.154
ROS-754	5/2/2016	Deep	Forereef	AGR	-14.5357	-168.147
ROS-754	5/2/2016	Deep	Forereef	AGR	-14.5357	-168.147
ROS-756	5/2/2016	Mid	Forereef	AGR	-14.5423	-168.144
ROS-763	5/2/2016	Mid	Forereef	AGR	-14.5346	-168.16
ROS-769	5/2/2016	Mid	Forereef	AGR	-14.5298	-168.149
ROS-770	5/2/2016	Mid	Forereef	AGR	-14.5477	-168.138
ROS-772	5/2/2016	Mid	Forereef	AGR	-14.5331	-168.148
ROS-772	5/2/2016	Mid	Forereef	AGR	-14.5331	-168.148
ROS-775	5/2/2016	Mid	Forereef	AGR	-14.5444	-168.142
ROS-776	5/2/2016	Mid	Forereef	AGR	-14.5369	-168.167
ROS-785	5/2/2016	Mid	Forereef	AGR	-14.5284	-168.151
ROS-789	5/2/2016	Shallow	Forereef	AGR	-14.5402	-168.173
ROS-747	5/3/2016	Deep	Forereef	AGR	-14.5519	-168.166
ROS-747	5/3/2016	Deep	Forereef	AGR	-14.5519	-168.166
ROS-749	5/3/2016	Deep	Forereef	AGR	-14.5606	-168.157
ROS-749	5/3/2016	Deep	Forereef	AGR	-14.5606	-168.157
ROS-750	5/3/2016	Deep	Forereef	AGR	-14.5373	-168.17
ROS-758	5/3/2016	Mid	Forereef	AGR	-14.5451	-168.171
ROS-760	5/3/2016	Mid	Forereef	AGR	-14.5461	-168.171
ROS-760	5/3/2016	Mid	Forereef	AGR	-14.5461	-168.171
ROS-767	5/3/2016	Mid	Forereef	AGR	-14.5361	-168.163
ROS-771	5/3/2016	Mid	Forereef	AGR	-14.543	-168.172
ROS-779	5/3/2016	Mid	Forereef	AGR	-14.5314	-168.156
ROS-780	5/3/2016	Mid	Forereef	AGR	-14.5292	-168.15
ROS-781	5/3/2016	Mid	Forereef	AGR	-14.5305	-168.15
ROS-782	5/3/2016	Shallow	Forereef	SAG	-14.5358	-168.162
ROS-797	5/3/2016	Shallow	Forereef	AGR	-14.5313	-168.15
ROS-757	5/4/2016	Shallow	Forereef	AGR	-14.5368	-168.166
ROS-761	5/4/2016	Mid	Forereef	AGR	-14.5543	-168.145
ROS-778	5/4/2016	Deep	Forereef	AGR	-14.5529	-168.142
ROS-778	5/4/2016	Deep	Forereef	AGR	-14.5529	-168.142
ROS-787	5/4/2016	Shallow	Forereef	AGR	-14.5388	-168.146
ROS-804	5/4/2016	Mid	Forereef	AGR	-14.5401	-168.145

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Lat	Long
ROS-804	5/4/2016	Mid	Forereef	AGR	-14.5401	-168.145
ROS-806	5/4/2016	Shallow	Forereef	AGR	-14.5414	-168.145
ROS-808	5/4/2016	Deep	Forereef	RRB	-14.5546	-168.145
ROS-808	5/4/2016	Deep	Forereef	RRB	-14.5546	-168.145
ROS-745	5/5/2016	Deep	Forereef	AGR	-14.5368	-168.168
ROS-745	5/5/2016	Deep	Forereef	AGR	-14.5368	-168.168
ROS-752	5/5/2016	Deep	Forereef	AGR	-14.549	-168.169
ROS-752	5/5/2016	Deep	Forereef	AGR	-14.549	-168.169
ROS-777	5/5/2016	Mid	Forereef	AGR	-14.5526	-168.141
ROS-777	5/5/2016	Mid	Forereef	AGR	-14.5526	-168.141
ROS-795	5/5/2016	Mid	Forereef	AGR	-14.5338	-168.148
ROS-795	5/5/2016	Mid	Forereef	AGR	-14.5338	-168.148
ROS-799	5/5/2016	Deep	Forereef	AGR	-14.5501	-168.138
ROS-799	5/5/2016	Deep	Forereef	AGR	-14.5501	-168.138
ROS-801	5/5/2016	Deep	Forereef	AGR	-14.5457	-168.14
ROS-801	5/5/2016	Deep	Forereef	AGR	-14.5457	-168.14

APPENDIX F: JARVIS ISLAND

Jarvis island, located at 0°22′ S; 160°01′ W in the central Pacific, is 1 of 7 units comprising the Pacific Remote Islands Marine National Monument. The Monument area also encompasses protections afforded by U.S Fish and Wildlife Service Refuge system. For information about the methods used to perform the activities discussed in this appendix, please see Appendix A: "Methods."

F.1 Ocean and Climate Monitoring

At nearshore locations around Jarvis Island, 12 shallow-water CTD casts were performed, 12 water samples were collected for analysis of dissolved inorganic carbon (DIC), total alkalinity (TA), and salinity. In addition, 5 STRs were retrieved and 5 STRs were deployed and 3 benthic photo-documentation at 3 NCRMP stations. Also, two sets of oceanographic instrument packages containing ADCP, pH meter, salinity-O_2-temperature, and photosynthetic active radiation (PAR) sensor were deployed and retrieved (Fig. F.1.1and Table F.1.1).

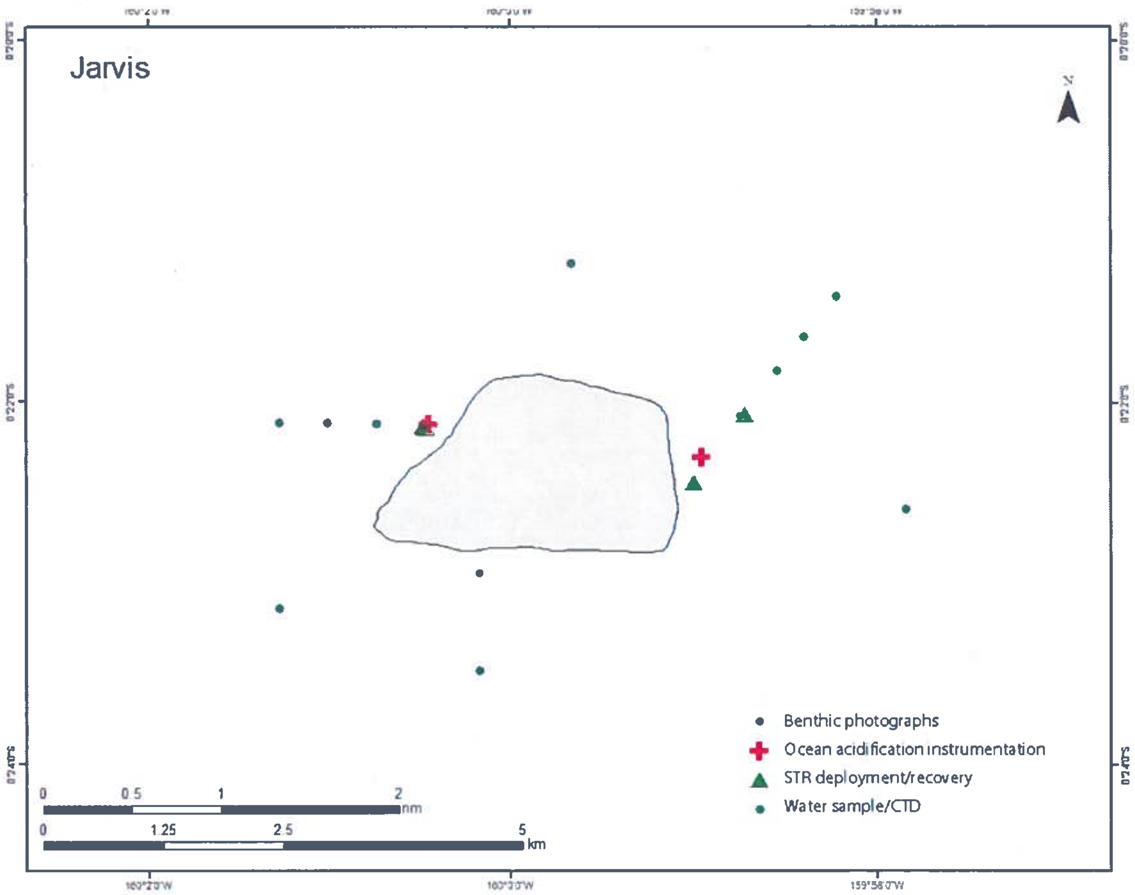

Figure F.1.1.-- Mooring sites where oceanographic instruments were retrieved or deployed and locations of near-shore CTD casts and water sampling performed at Jarvis Island during project SE-16-02.

Table F.1.1.--Geographic coordinates and depths of the moored oceanographic instruments (STR), shallow-water CTD casts, and benthic photo-documentation that were retrieved/deployed and procured at Jarvis Island during project SE-16-02.

Name	Latitude	Longitude	Depth	Action Taken
W_NE_1	-0.36061	-159.973	1m	Water sample, CTD
W_NE_15	-0.35686	-159.97	1m	Water sample, CTD
W_W_1	-0.36861	-160.017	1m	Water sample, CTD
W_S_1	-0.39137	-160.003	1m	Water sample, CTD
W_W_15	-0.36856	-160.021	1m	Water sample, CTD
W_NE_5	-0.36373	-159.976	1m	Water sample, CTD
W_W_5	-0.36872	-160.013	1m	Water sample, CTD
W_N_1	-0.35388	-159.995	1m	Water sample, CTD
W_SW_1	-0.38569	-160.021	1m	Water sample, CTD
W_E_1	-0.37642	-159.964	1m	Water sample, CTD
JAR-01	-0.36783	-159.979	1m, 15m	Water sample, CTD
JAR-11	-0.36901	-160.008	1m, 15m	Water sample, CTD
JAR_OCEAN_025	-0.37394	-159.983	5m	STR recovery, deployment
JAR_OCEAN_029	-0.36776	-159.979	15m	STR recovery, deployment

Name	Latitude	Longitude	Depth	Action Taken
JAR_OCEAN_015	-0.36896	-160.008	15m	STR recovery, deployment
JAR_OCEAN_021	-0.36891	-160.008	25m	STR recovery, deployment
JAR_OCEAN_022	-0.36907	-160.008	5m	STR recovery, deployment
WHOI_E	-0.36867	-160.008	7m	Ocean acidification instrumentation deployed
WHOI_W	-0.37169	-159.983	7m	Ocean acidification instrumentation deployed
JAR-01	-0.36783	-159.979	15m	Benthic photographs
JAR-11	-0.36901	-160.008	15m	Benthic photographs
JAR-04	-0.38235	-160.003	15m	Benthic photographs

F.2. Biological Monitoring: Benthic Surveys and Microbial Sampling

Belt-transect surveys were conducted and photographs were taken along transect lines at 30 REA sites around Jarvis Island to assess benthic composition, coral community structure, and coral and algal disease. For more information about collections made at REA sites, see Table G.1.1 in Appendix G: "Biological Collections."

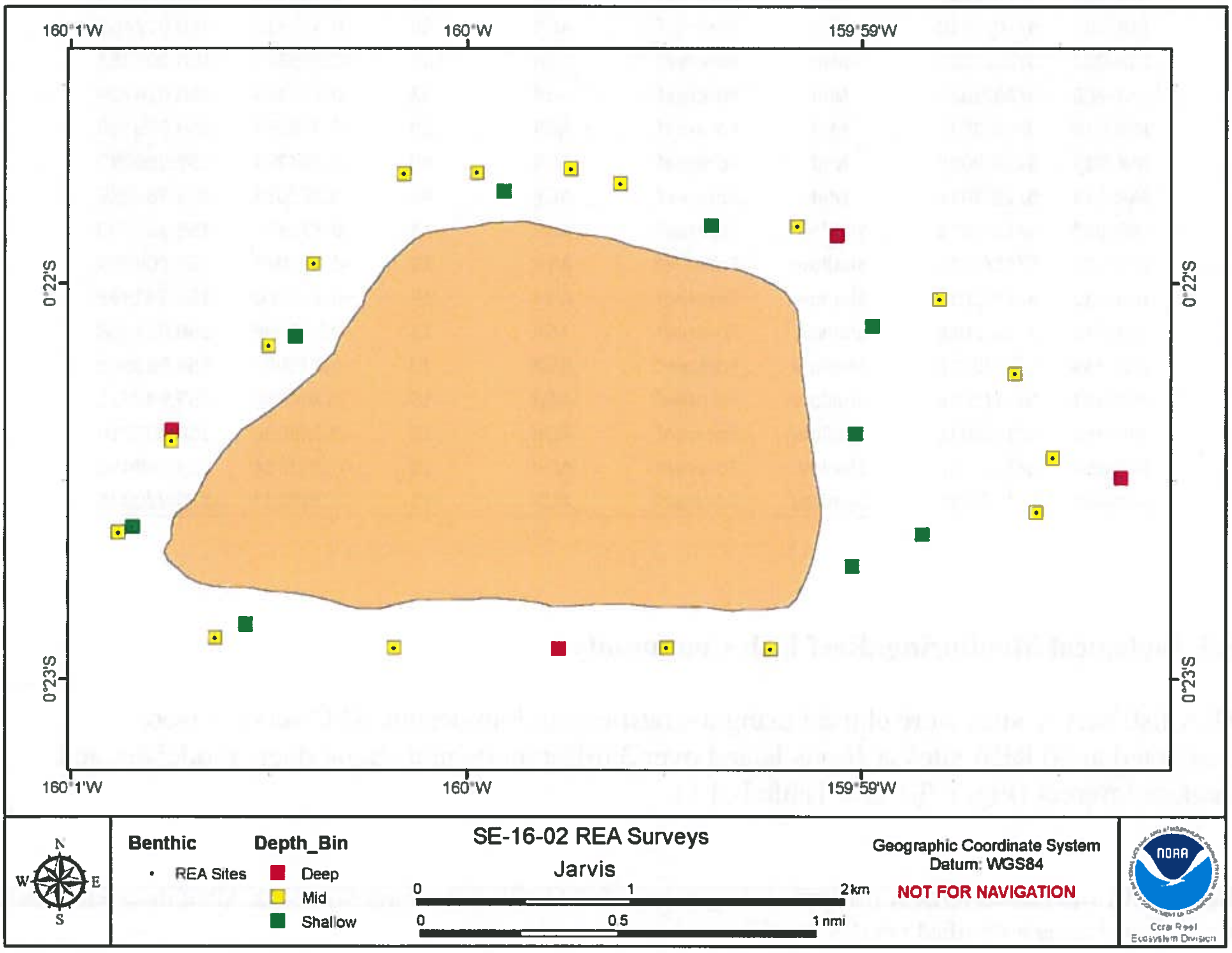

Figure F.2.1.--Locations of REA benthic sites surveyed at Jarvis Island during project SE-16-02. All of these REA sites were selected using a stratified random design.

Table F.2.1.--Summary of the REA benthic surveys and microbial water collections performed at Jarvis Island during project SE-16-02.

Site	Survey Date	Depth Zone	Reef Zone	Habitat	Depth (ft)	Lat	Long
JAR-850	5/17/2016	Deep	Forereef	AGR	74	-0.374871	-159.972405
JAR-854	5/17/2016	Deep	Forereef	RRB	80	-0.364671	-159.984391
JAR-860	5/16/2016	Deep	Forereef	AGR	77	-0.372845	-160.012433
JAR-866	5/18/2016	Deep	Forereef	AGR	75	-0.382067	-159.996138
JAR-871	5/16/2016	Mid	Forereef	AGR	48	-0.365859	-160.006471
JAR-875	5/19/2016	Mid	Forereef	AGR	33	-0.367362	-159.980068
JAR-878	5/20/2016	Mid	Forereef	AGR	40	-0.381599	-160.010627
JAR-882	5/19/2016	Mid	Forereef	AGR	33	-0.362030	-159.999614
JAR-885	5/16/2016	Mid	Forereef	AGR	45	-0.362077	-160.002658
JAR-886	5/17/2016	Mid	Forereef	AGR	27	-0.370484	-159.976916
JAR-887	5/19/2016	Mid	Forereef	AGR	38	-0.361864	-159.995651
JAR-888	5/18/2016	Mid	Forereef	AGR	31	-0.382031	-160.003073
JAR-891	5/17/2016	Mid	Forereef	AGR	31	-0.376318	-159.975981
JAR-893	5/18/2016	Mid	Forereef	AGR	44	-0.382008	-159.991574
JAR-895	5/19/2016	Mid	Forereef	AGR	41	-0.362487	-159.993550
JAR-901	5/20/2016	Mid	Forereef	AGR	45	-0.373319	-160.012461
JAR-902	5/20/2016	Mid	Forereef	AGR	45	-0.369321	-160.008363
JAR-906	5/20/2016	Mid	Forereef	AGR	33	-0.377165	-160.014704
JAR-910	5/19/2016	Mid	Forereef	AGR	28	-0.374037	-159.975300
JAR-913	5/19/2016	Mid	Forereef	AGR	40	-0.364281	-159.986082
JAR-918	5/18/2016	Mid	Forereef	AGR	46	-0.382084	-159.987186
JAR-920	5/17/2016	Shallow	Forereef	AGR	14	-0.378586	-159.983735
JAR-921	5/18/2016	Shallow	Forereef	AGR	19	-0.381048	-160.009369
JAR-932	5/17/2016	Shallow	Forereef	AGR	18	-0.368500	-159.982893
JAR-936	5/20/2016	Shallow	Forereef	AGR	18	-0.376938	-160.014108
JAR-939	5/17/2016	Shallow	Forereef	AGR	19	-0.373009	-159.983608
JAR-941	5/17/2016	Shallow	Forereef	AGR	16	-0.364250	-159.989711
JAR-951	5/16/2016	Shallow	Forereef	AGR	15	-0.368930	-160.007250
JAR-954	5/16/2016	Shallow	Forereef	AGR	19	-0.362814	-159.998456
JAR-959	5/17/2016	Shallow	Forereef	AGR	21	-0.377263	-159.980826

F.3. Biological Monitoring: Reef Fish Community

REA fish survey sites were chosen using a stratified random design. SPC surveys were conducted at 30 REA sites at Jarvis Island over 3 different habitat strata: deep, moderate, and shallow forereef (Fig. F.3.1 and Table F.3.1).

Figure F.3.1.--Locations of REA fish sites surveyed at Jarvis Island during project SE-16-02. All of these REA sites were selected using a stratified random design.

Table F.3.1.--Summary of sites where REA fish surveys were conducted at Jarvis Island during project SE-16-02.

REA Site	Date	Depth Bin	Reef Zone	Depth (m)	Latitude	Longitude
JAR-732	5/18/2016	Deep	Forereef	19.6	-0.37581	-159.972
JAR-734	5/21/2016	Deep	Forereef	22.8	-0.38248	-159.98
JAR-736	5/22/2016	Deep	Forereef	19.9	-0.38202	-160.006
JAR-738	5/16/2016	Deep	Forereef	21.8	-0.36317	-160.005
JAR-752	5/20/2016	Mid	Forereef	13.0	-0.38183	-159.999
JAR-755	5/17/2016	Mid	Forereef	15.7	-0.3671	-159.98
JAR-757	5/18/2016	Mid	Forereef	9.2	-0.37682	-159.975
JAR-759	5/16/2016	Mid	Forereef	12.1	-0.36665	-160.007
JAR-760	5/17/2016	Mid	Forereef	7.7	-0.37989	-159.98
JAR-762	5/21/2016	Mid	Forereef	15.2	-0.38244	-159.976
JAR-763	5/16/2016	Mid	Forereef	10.9	-0.36203	-160.001
JAR-765	5/20/2016	Mid	Forereef	12.9	-0.38199	-159.996
JAR-769	5/22/2016	Mid	Forereef	10.2	-0.36901	-160.008
JAR-770	5/21/2016	Mid	Forereef	8.6	-0.3802	-159.976
JAR-773	5/22/2016	Mid	Forereef	9.1	-0.37125	-159.976
JAR-775	5/19/2016	Mid	Forereef	11.5	-0.38189	-159.99
JAR-780	5/21/2016	Mid	Forereef	9.3	-0.36525	-159.984
JAR-782	5/19/2016	Mid	Forereef	10.4	-0.37349	-160.013
JAR-788	5/21/2016	Mid	Forereef	16.2	-0.36353	-159.989
JAR-794	5/18/2016	Shallow	Forereef	6.0	-0.37744	-159.978
JAR-800	5/20/2016	Shallow	Forereef	4.1	-0.38101	-160.009
JAR-802	5/17/2016	Shallow	Forereef	5.5	-0.37261	-159.984
JAR-803	5/22/2016	Shallow	Forereef	4.3	-0.37471	-160.013
JAR-805	5/20/2016	Shallow	Forereef	3.4	-0.3727	-160.012
JAR-807	5/21/2016	Shallow	Forereef	5.4	-0.36753	-159.983
JAR-808	5/21/2016	Shallow	Forereef	5.7	-0.37608	-159.983
JAR-819	5/17/2016	Shallow	Forereef	5.7	-0.37014	-159.981
JAR-822	5/22/2016	Shallow	Forereef	4.3	-0.38104	-160.011
JAR-823	5/22/2016	Shallow	Forereef	5.8	-0.36281	-159.996

F.4 Baited Remote Underwater Video Surveys

A total of 58 BRUVS were deployed over a 3-day period (23–25 May), of which 43 were successful (Fig. F.4.1 and Table F.4.1). Deployment depths ranged from 5 m to 21 m. A deployment was deemed a fail if the bait or bait bag was removed within the first 45 minutes of soak time, if the field of view is substantially obscured, or if the system was facing towards the surface. In the event of a fail a repeat deployment at the same site would be completed the next day, if time permitted.

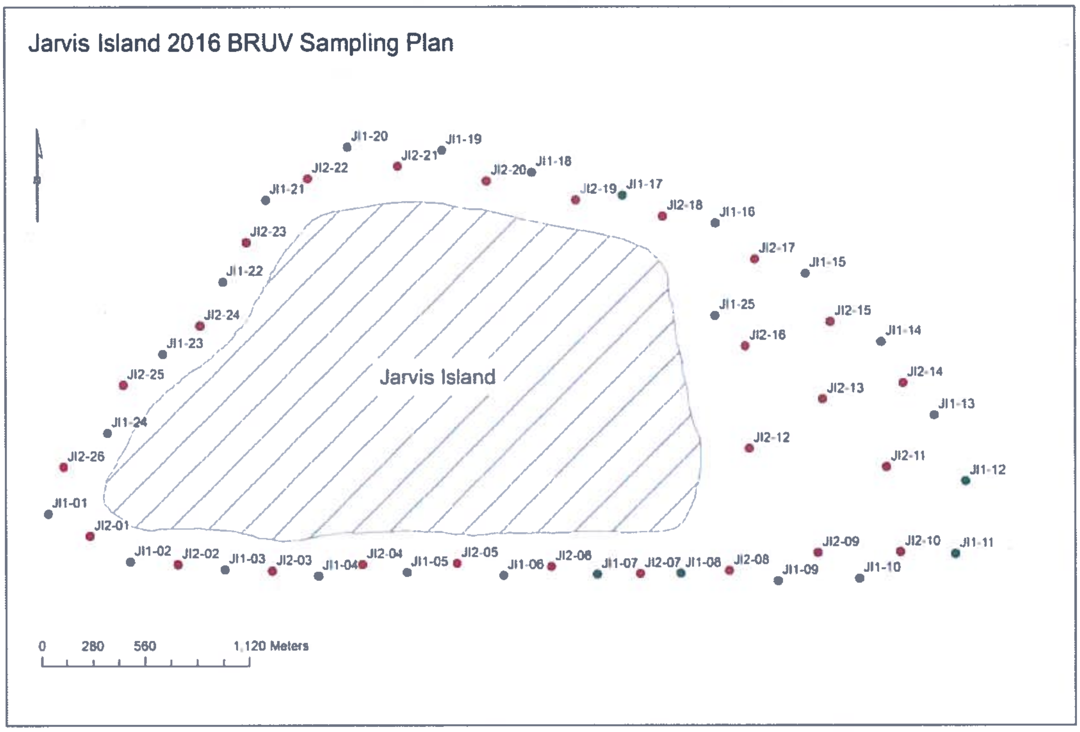

Figure F.4.1.--Locations of BRUVS deployments at Jarvis Island during project SE-16-02.

Table F.4.1.--Summary of sites where BRUVS were conducted at Jarvis Island during project SE-16-02.

OpCode	Date	Latitude	Longitude	Depth (m)	Status
JI1-01	24/05/2016	-0.3787	-160.01558	13	Good
JI1-02	24/05/2016	-0.381329	-160.01203	9	Good
JI1-03	24/05/2016	-0.381689	-160.0077	9	Good
JI1-04	24/05/2016	-0.382155	-160.00312	8	Good
JI1-05	23/05/2016	-0.381995	-159.99863	21	Fail
JI1-05R	24/05/2016	-0.381685	-159.99856	8	Fail
JI1-06	23/05/2016	-0.382152	-159.99402	17	Fail
JI1-06R	24/05/2016	-0.381813	-159.99435	8	Good
JI1-07	23/05/2016	-0.382105	-159.98945	20	Fail
JI1-07R	25/05/2016	-0.381981	-159.98969	11	Good
JI1-08	23/05/2016	-0.382087	-159.98553	10	Good
JI1-09	23/05/2016	-0.382466	-159.98083	19	Fail
JI1-09R	25/05/2016	-0.382388	-159.98088	15	Good
JI1-10	23/05/2016	-0.382366	-159.9768	13	Good
JI1-10R	25/05/2016	-0.382277	-159.97686	13	Fail
JI1-11	23/05/2016	-0.381109	-159.97239	14	Good
JI1-11R	25/05/2016	-0.381088	-159.97227	20	Good
JI1-12	23/05/2016	-0.377572	-159.97176	13	Fail
JI1-13	23/05/2016	-0.374357	-159.97334	12	Fail
JI1-13R	25/05/2016	-0.374423	-159.97336	7.2	Fail
JI1-14	23/05/2016	-0.3706911	-159.9761	7	Good
JI1-15	23/05/2016			14	Fail
JI1-15R	25/05/2016	-0.3676773	-159.97929	11.2	Good

OpCode	Date	Latitude	Longitude	Depth (m)	Status
JI1-16	23/05/2016	-0.3650871	-159.98376	12	Good
JI1-17	24/05/2016	-0.363612	-159.98863	12.9	Good
JI1-18	24/05/2016	-0.362549	-159.9932	12.5	Good
JI1-19	24/05/2016	-0.361669	-159.99744	12.7	Good
JI1-20	24/05/2016	-0.361701	-160.00156	12.5	Good
JI1-21	24/05/2016	-0.363926	-160.00531	9	Fail
JI1-22	24/05/2016	-0.367962	-160.00762	15	Good
JI1-23	24/05/2016	-0.371391	-160.0107	14	Good
JI1-24	24/05/2016	-0.375108	-160.01324	10	Good
JI1-25	24/05/2016	-0.369518	-159.98371	5	Fail
JI2-01	25/05/2016	-0.38016	-160.01406	5	Fail
JI2-02	25/05/2016	-0.381566	-160.00983	7.5	Good
JI2-03	25/05/2016	-0.381871	-160.00529	5.5	Good
JI2-04	25/05/2016	-0.381832	-160.00073	8	Fail
JI2-05	24/05/2016	-0.381835	-159.99616	6.5	Good
JI2-06	24/05/2016	-0.381837	-159.99179	9.1	Good
JI2-07	24/05/2016	-0.38196	-159.98777	11.5	Good
JI2-08	24/05/2016	-0.382108	-159.98316	10	Good
JI2-09	24/05/2016	-0.381121	-159.9789	9	Good
JI2-10	25/05/2016	-0.381065	-159.97494	8.8	Good
JI2-11	25/05/2016	-0.376846	-159.97562	8.3	Fail
JI2-12	24/05/2016	-0.376042	-159.98219	5.4	Good
JI2-13	24/05/2016	-0.373552	-159.97862	8.5	Good
JI2-14	25/05/2016	-0.372751	-159.97485	7.5	Good
JI2-16	24/05/2016	-0.370953	-159.98231	5	Good
JI2-17	24/05/2016	-0.36601	-159.98196	11.9	Good
JI2-18	25/05/2016	-0.364701	-159.98627	7	Good
JI2-19	25/05/2016	-0.363913	-159.99048	6.7	Good
JI2-20	25/05/2016	-0.362972	-159.99489	8.7	Good
JI2-21	25/05/2016	-0.362191	-159.99924	8.9	Good
JI2-22	25/05/2016	-0.362812	-160.00353	7.6	Good
JI2-23	25/05/2016	-0.365703	-160.00625	6.7	Good
JI2-24	25/05/2016	-0.369992	-160.00872	7	Good
JI2-25	25/05/2016	-0.372675	-160.01221	13	Good
JI2-26	25/05/2016	-0.377066	-160.01472	13	Good

APPENDIX G: WOODS HOLE OCEANOGRAPHIC INSTITUTION

G.1 Oceanographic instrument packages

Instrument packages were deployed on the west and east sides of Jarvis Island to assess diurnal variability in oceanographic physical and chemical conditions (Fig. G.1.1 and Table G.1.1. These instrument packages included: 1) Sunburst SAMI pH sensor, 2) Seabird MicroCAT conductivity and temperature recorder, 3) RBR dissolved oxygen sensor, 4) Lowell tilt current meter, and 5) photosynthetically active radiation (PAR) sensor (only deployed on the west side). Instruments were affixed to a frame that was secured by divers to the seafloor. All instruments were deployed on 16 May 2016 and recovered on 23 May 2016.

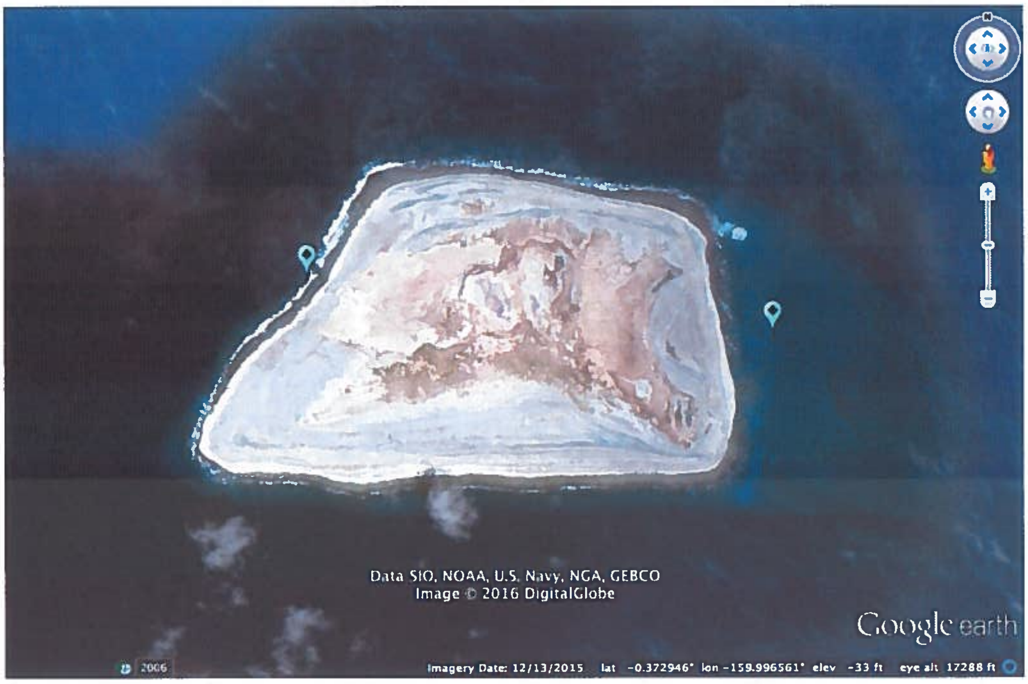

Figure G.1.1 --Locations of oceanographic instrument deployments at Jarvis Island during project SE-16-02.

Table G.1.1 -- Summary of oceanographic instrument deployments for reef physical and chemical environmental monitoring at Jarvis Island during project SE-16-02.

Site	Lat (N)	Lon (E)	Instrument	Depth(ft)
Jarvis West	-0.36867	-160.00771	SAMI pH	30
Jarvis West	-0.36867	-160.00771	Tilt current meter	30
Jarvis West	-0.36867	-160.00771	Dissolved Oxygen	30
Jarvis West	-0.36867	-160.00771	Microcat	30
Jarvis West	-0.36867	-160.00771	PAR	30
Jarvis East	-0.37169	-159.98277	SAMI pH	15
Jarvis East	-0.37169	-159.98277	Tilt current meter	15
Jarvis East	-0.37169	-159.98277	Dissolved Oxygen	15
Jarvis East	-0.37169	-159.98277	Microcat	15

G.2 Temperature logger deployment

Moored temperature loggers (HOBO U22 data loggers) with a 1-hr logging interval were deployed in pairs at 6 sites (3–25 m) on the west and east sites of Jarvis to provide long-term, high-resolution temperature data (Fig G.2.1 and Table G.2.1). Loggers were marked with subsurface moorings to aid in future recovery. In addition, temperature loggers deployed in September 2012 and November 2015 at 3 of the 6 sites were recovered.

Figure G.2.1. -- Temperature logger deployment locations at Jarvis Island during project SE-16-02.

Table G.2.1 -- Locations of moored temperature loggers. Two loggers were deployed at each site adjacent to a subsurface mooring at Jarvis Island during project SE-16-02.

Site	Lat (N)	Lon (E)	Depth(ft)
Jarvis West	-0.36907	-160.00797	15
Jarvis West	-0.36907	-160.00797	15
Jarvis West	-0.36901	-160.00818	50
Jarvis West	-0.36901	-160.00818	50
Jarvis West	-0.36901	-160.00818	80
Jarvis West	-0.36901	-160.00818	80
Jarvis East	-0.37394	-159.98342	15
Jarvis East	-0.37394	-159.98342	15
Jarvis East	-0.37112	-159.98367	15
Jarvis East	-0.37112	-159.98367	15
Jarvis East	-0.36776	-159.97881	60
Jarvis East	-0.36776	-159.97881	60

G.3 Coral bleaching and mortality surveys

Repeat benthic surveys were conducted at reef sites previously surveyed during the height of bleaching in November 2015. Surveys were conducted at 4 depths on the west side (5–10 ft, 15–

25 ft, 30–50 ft, and 60–80 ft) and 3 depths on the east side (14–18 ft, 40–50 ft, and 55–75 ft) (Fig G.3.1 and Table G.3.1). At each depth, 3 × 50 m transects were laid out and a 0.5 m × 0.5 m area of benthic cover photographed every meter using a camera mounted on a pole. This procedure generates 50 photos per transect and 150 total photos per depth bin. Data will be analyzed at WHOI using Coral Point Count with Excel extensions to estimate coral bleaching and mortality since November 2015.

Figure G.3.1. - Locations of coral bleaching and mortality surveys at Jarvis Island during project SE-16-02.

Table G.3.1. --Summary of coral bleaching and mortality benthic survey locations at Jarvis Island during project SE-16-02.

Site	Date	Latitude (N)	Longitude (E)	Depth Bin	Depth (ft)
West Jarvis	5/21/16	-0.36906785	-160.00797138	Shallow	5–10
West Jarvis	5/17/16	-0.36906785	-160.00797138	Shallow	15–25
West Jarvis	5/17/16	-0.36901396	-160.00817840	Mid	30–50
West Jarvis	5/17/16	-0.36901396	-160.00817840	Deep	60–80
East Jarvis	5/18/16	-0.37393631	-159.98342160	Shallow	14–18
East Jarvis	5/18/16	-0.36782934	-159.97911940	Mid	40–50
East Jarvis	5/18/16	-0.36782934	-159.97911940	Deep	55–75

G.4. Coral core collection

Skeletal cores were collected from 15 massive *Porites* corals, 12 of which were previously cored in September 2012 and November 2015 (Figure G.4.1 and Table G.4.1). Cores were collected using underwater pneumatic drills with 3.8-cm diameter diamond drill bits. Coring was conducted only on dead colonies or dead portions of colonies with partial mortality. Coral holes were filled and plugged with underwater epoxy to prevent further damage to the coral. Short cores (20–40 cm in length) were collected from 13 colonies, and long cores (100–150 cm) were collected from two colonies. Skeletal cores will be shipped back to WHOI and CT-scanned for analysis.

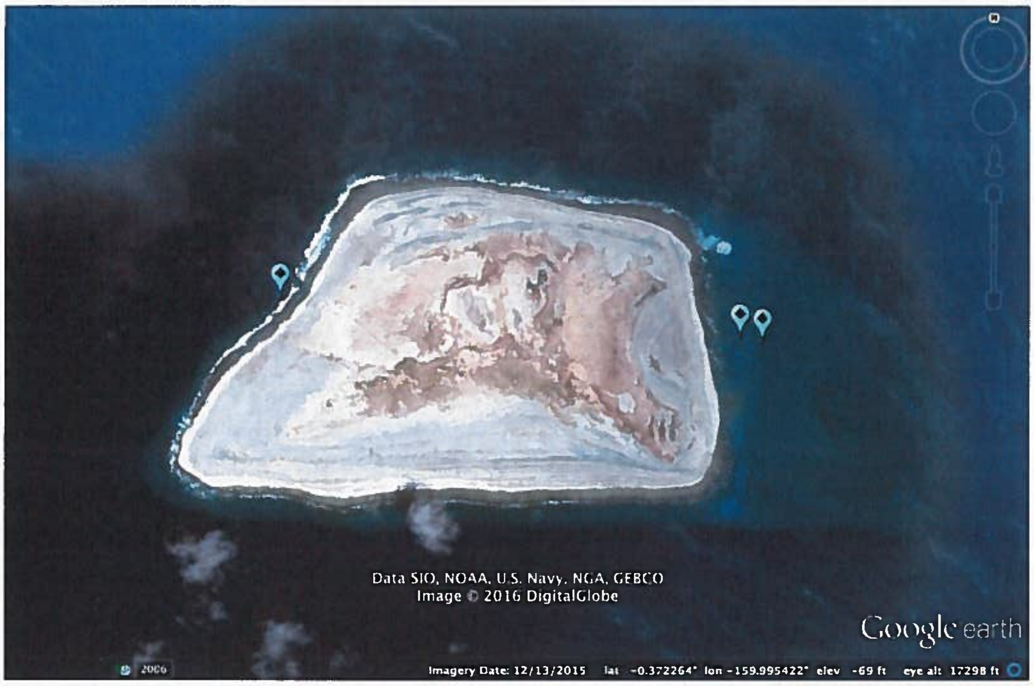

Figure G.4.1. - Coral coring locations at Jarvis Island during project SE-16-02.

Table G.4.1. -- Coral skeletal core and tissue sample collections for Jarvis Island during project SE-16-02. Short (20–40 cm) and long (100–150 cm) cores were collected from dead areas of massive Porites corals. Resampled corals were previously cored in September 2012 (1 coral: 497) or November 2012 (12 corals). Tissue samples were collected from colonies with > 50% live tissue remaining.

Site	ID	Latitude	Longitude	Depth (ft)	Length	Coral Core	Re-sampled	Tissue Sample
West Jarvis	497	-0.36898	-160.00813	50	Short	X	X	
West Jarvis	1206	-0.36898	-160.00813	36	Short	X	X	X
West Jarvis	1207	-0.36898	-160.00813	32	Short	X	X	
West Jarvis	1208	-0.36898	-160.00813	36	Short	X	X	
West Jarvis	1209	-0.36898	-160.00813	26	Short	X	X	X
West Jarvis	1211	-0.36897	-160.00812	26	Short	X	X	
West Jarvis	1212	-0.36898	-160.00813	13	Short	X	X	X
West Jarvis	1215	-0.36898	-160.00813	14	Short	X	X	
West Jarvis	1216	-0.37137	-159.98248	15	Short	X	X	
East Jarvis	1200	-0.37137	-159.98248	20	Short	X	X	X
East Jarvis	1201	-0.37137	-159.98248	20	Short	X	X	X
East Jarvis	1202	-0.37137	-159.98248	20	Short	X	X	X
East Jarvis	1203	-0.37137	-159.98248	20	Short	X	X	X
East Jarvis	1204	-0.37137	-159.98248	20	Short	X	X	
East Jarvis	1217	-0.37112	-159.98367	20	Long	X		X
East Jarvis	1220	-0.37112	-159.98367	20	Long	X		

G.5. Coral tissue sampling

Tissue samples of living coral were sampled from 8 *Porites lobata* colonies that were previously sampled during the height of bleaching in November 201 5 (Figure G.4.1 and Table G.4.1). A small ~ 2 cm^2 patch of tissue was removed using a hammer and flat head screwdriver and preserved upon surfacing in a 20-mL plastic scintillation vial filled with RNA later, then left to incubate overnight at 4°C fridge overnight and subsequently frozen at - 20°C. Due to the massive mortality observed at Jarvis, tissue samples were only collected from corals with > 50% tissue remaining. These samples will be used for analysis of the connectivity and population genetics of Jarvis corals using microsatellite markers as well for gene expression analyses of corals undergoing natural bleaching.

G.6. Macroalgae sampling

A total of 20 benthic macroalgae samples were collected from 5 sites on the west side of Jarvis Island and from 2 sites on the east side. The species collected include: *Dictyosphaeria cavernosa, Dictyosphaeria verluysi, Halimeda* sp., *Lobophora variegata,* Cyanobacteria, *Valonia sp.,* and *Caulerpa serrulata.* The samples were collected by divers, cleaned and stored in a -20°C freezer, and then transferred to a dry shipper. These samples will be freeze-dried in the laboratory, ground up, and analyzed using an elemental analyzer with an isotope ratio mass spectrometer (EA-IRMS) for d15N and d13C to aid in evaluating the nutrient biogeochemistry of the reef and in comparing the species specific variation of isotopic signals in primary producers on the island.

G.7 Sea cucumber sampling

Ten *Holothuria atra* samples were collected, 5 from each side of Jarvis. Small skin samples (~1 g) were removed from the side of each animal, and animals were returned to the reef after sampling. Skin samples were frozen and will be transported back to WHOI for stable isotope analysis.

G.8. Water sampling

A total of 59 water samples collected for carbonate and nutrient chemistry (Figure G.8.1 and Table G.8.1). A 2.5-L Niskin sampler was lowered into the water on spectra line to the desired depth and held at depth for 1 minute to allow the temperature depth recorders to equilibrate. A messenger weight was sent down the line to trigger the bottle at the desired depth. The Niskin was brought back onto the small boat to be sampled for 1) total alkalinity/dissolved inorganic carbon (TA/DIC), 2) salinity, 3) dissolved inorganic nitrogen isotope composition (DIN d15N), 4) nutrient concentrations. A piece of silicone tubing was attached to the petcock and rinsed thoroughly between Niskin casts for sampling. TA/DIC 200-mL glass sample bottles were rinsed 3 times with sample water, then filled from the bottom and allowed to overflow for 15 sec. TA/DIC samples were poisoned with 50 uL of mercuric chloride. Salinity 150-mL glass bottles were rinsed 3 times with sample water and then filled to the shoulder. DIN d15N 150-mL HDPE plastic bottles were rinsed 3 times with 0.2-um filtered sample water and then filled to the shoulder. Nutrient concentration 20-mL plastic bottles were rinsed 3 times with 0.2-um filtered sample water and then filled to the shoulder. DIN d15N and nutrient concentration samples were placed immediately in a cooler with Techni-Ice and placed into a - 20°C freezer on return to the ship.

Figure G.8.1. --Carbon and nutrient chemistry water sampling locations Coral coring locations at Jarvis Island during project SE-16-02.

Table G.8.1. -- Summary of carbon and nutrient chemistry water samples collected.at Jarvis Island during project SE-16-02.

Date (Local)	Location	Latitude	Longitude	Site Depth (m)	Sample Depth (m)	TA/ DIC	Sal	DIN d15N	Nut
17-May-16	W T1	-0.36955	-160.00860	20	20	X	X	X	X
	W T2	-0.36944	-160.00839	10	10	X	X	X	X
	W Trans	-0.36944	-160.00839	10	0	X	X	X	X
	W T3	-0.36931	-160.00819	3	3	X	X	X	X
	W N	-0.36636	-160.00676	10	7	X	X	X	X
	W N	-0.36636	-160.00676	10	1	X	X	X	X
	W T0	-0.3683	-160.00931	200	1	X	X	X	X
	W T0	-0.3683	-160.00931	200	10	X	X	X	X
	W S	-0.3747	-160.01299	10	9	X	X	X	X
	W S	-0.3747	-160.01299	10	1	X	X	X	X
18-May-16	E T3	-0.36858	-159.97874	11	10	X	X	X	X
	E T3	-0.36858	-159.97874	11	1	X	X	X	X
	E T2	-0.36978	-159.98163	6.6	6	X	X	X	X
	E T2	-0.36978	-159.98163	6.6	1	X	X	X	X
	E T1	-0.37098	-159.9839	4.5	4	X	X	X	X
	E T1	-0.37098	-159.9839	4.5	1	X	X	X	X
	Jarvis North	-0.36271	-159.99495	12	10	X	X	X	X
	Jarvis North	-0.36271	-159.99495	12	1	X	X	X	X
	W T2	-0.36944	-160.00839	10	10	X	X	X	X

Date (Local)	Location	Latitude	Longitude	Site Depth (m)	Sample Depth (m)	TA/ DIC	Sal	DIN d15N	Nut
19-May-15	JAR 1			10	10	X	X	X	X
	W T3	-0.36931	-160.00819	4.5	4.5	X	X	X	X
20-May-15	W T1	-0.36955	-160.00860	5	5	X	X	X	X
	W T2	-0.36944	-160.00839	9.8	8	X	X	X	X
	W Trans	-0.36944	-160.00839	9.8	1	X	X	X	X
	W T3	-0.36931	-160.00819	20.5	20	X	X	X	X
	W T0	-0.3683	-160.00931	190	1	X	X	X	X
	W T0	-0.3683	-160.00931	190	150	X	X	X	X
	W T0	-0.3683	-160.00931	190	10	X	X	X	X
	W T0	-0.3683	-160.00931	190	20	X	X	X	X
21-May-15	W 1.5	-0.36856	-160.02144	NA	1	X	X	X	X
	W 1.5	-0.36856	-160.02144	NA	150	X	X	X	X
	W 1.5	-0.36856	-160.02144	NA	100	X	X	X	X
	W 1.5	-0.36856	-160.02144	NA	50	X	X	X	X
	W 1	-0.36861	-160.01704	NA	1	X	X	X	X
	W 0.5	-0.36872	-160.01253	NA	1	X	X	X	X
	W N	-0.36636	-160.00676	11	1	X	X	X	X
	W N	-0.36636	-160.00676	11	10	X	X	X	X
	W Trans	-0.36944	-160.00839	11	1	X	X	X	X
	W T2	-0.36944	-160.00839	11	10	X	X	X	X
	W S	-0.3747	-160.01299	11	1	X	X	X	X
	W S	-0.3747	-160.01299	11	10	X	X	X	X
22-May-15	E T3	-0.36871	-159.9781	11	1	X	X	X	X
	E T3	-0.36871	-159.9781	11	10	X	X	X	X
	E T2	-0.36978	-159.98163	6.5	1	X	X	X	X
	E T2	-0.36978	-159.98163	6.5	6	X	X	X	X
	E T1	-0.37098	-159.9839	4.5	1	X	X	X	X
	E T1	-0.37098	-159.9839	4.5	4	X	X	X	X
	E N	-0.37361	-159.9832	4.5	1	X	X	X	X
	E N	-0.37361	-159.9832	4.5	4	X	X	X	X
	E S	-0.37926	-159.98293	6.5	1	X	X	X	X
	E S	-0.37926	-159.98293	6.5	6	X	X	X	X
	E Mac 2	-0.37768	-159.97719	7.5	1	X	X	X	X
	E Mac 2	-0.37768	-159.97719	7.5	7	X	X	X	X
	E Offshore	-0.37643	-159.9642	NA	100	X	X	X	X
	E Offshore	-0.37643	-159.9642	NA	150	X	X	X	X
23-May-15	W T3	-0.36931	-160.00819	4.7	4	X	X	X	X
	W Trans	-0.36944	-160.00839	13	1	X	X	X	X
	W T2	-0.36944	-160.00839	13	10	X	X	X	X
	W T1	-0.36955	-160.00860	23	20	X	X	X	X

G.9. Particulate Organic Matter

A total of 15 particulate organic matter samples were collected for nutrient biogeochemistry analyses (Table G.9.1). A 20-L Nalgene carboy was rinsed 3 times and then used to collect water (> 15 L) at the surface from the small boats. The water was filtered across a 0.3-um glass fiber filter (Advantec GF75, pre-combusted for 4 hours at 400°C) using a Coleman peristaltic pump at mid-speed. The filter was then transferred onto a piece of combusted aluminum foil inside a petri dish and sealed. The POM samples were placed immediately into a cooler with Techni-Ice and placed into a - 20°C freezer upon return to the ship. The filtered volume was recorded for each POM sample. The POM samples will be analyzed for d15N to aid in evaluating the nutrient biogeochemistry of the reef.

Table G.9.1. -- Summary of particulate organic matter water samples collected.at Jarvis Island during project SE-16-02.

Sample	Date (Local)	Location	Latitude	Longitude	Filter Size (um)	Volume (L)	Depth (m)
JPON1	17-May-16	W Trans	-0.36944	-160.00839	0.3	13	0
JPON2	17-May-16	W Trans	-0.36944	-160.00839	0.3	16	0
JPON3	18-May-16	E T3	-0.36858	-159.97874	0.3	20	0
JPON4	18-May-16	E T1	-0.37098	-159.9839	0.3	15	0
JPON5	18-May-16	W Trans	-0.36944	-160.00839	0.3	14	0
JPON6	19-May-16	W S	-0.3747	-160.01299	0.3	11	0
JPON7	19-May-16	W N	-0.36636	-160.00676	0.3	20	0
JPON8	20-May-16	W Trans	-0.36944	-160.00839	0.3	11	10
JPON9	20-May-16	W T0	-0.3683	-160.00931	0.3	14.5	0
JPON10	21-May-16	W 1.5	-0.36856	-160.02144	0.3	18	0
JPON11	21-May-16	W N	-0.36636	-160.00676	0.3	16	0
JPON12	21-May-16	W S	-0.3747	-160.01299	0.3	15	0
JPON13	22-May-16	E T3	-0.36858	-159.97874	0.3	17.5	0
JPON14	22-May-16	E S	-0.37926	-159.98293	0.3	17	0
JPON15	22-May-16	E N	-0.37361	-159.9832	0.3	12	0

G.10. Plankton Tows

Plankton tows were conducted from the small boats off of the stern. The net used was 0.5 m in diameter and 1.5 m in length with a 35-um mesh size. Tows were conducted at approximately 1.5 knots for 5 min, with flowmeter readings taken at the beginning and end.

Approximately 10 g (wet weight) were collected per tow. The plankton were transferred from the codend to a 1L amber Nalgene plastic bottle and kept in a cooler with Techni-Ice until return to the ship, at which point the contents were sieved across nylon mesh into 4 size fractions (35-250 um, 250–500 um, 500–1000 um, and > 1000 um). These size fractions were vacuum filtered onto 0.7-um glass fiber filters (Whatman GF/F, pre-combusted for 4 hours at 400°C). The filter was then transferred onto a piece of combusted aluminum foil inside a petri dish and sealed. The samples were placed into a - 20°C freezer aboard the ship. The plankton samples will be freeze-dried in the laboratory and analyzed using an elemental analyzer with an isotope ratio mass spectrometer (EA-IRMS) for d15N and d13C to aid in evaluating the nutrient biogeochemistry of the reef and identifying the plankton size class on which the corals likely feed.

Table G.10.1. -- Summary of plankton tows locations at Jarvis Island during project SE-16-02.

Sample	Date (Local)	Location	Start Latitude	Start Longitude	End Latitude	End Longitude
Tow 1	17-May-16	W S	NA	NA	NA	NA
Tow 2	18-May-16	E T1	NA	NA	NA	NA
Tow 3	19-May-16	W S	-0.37737239	-160.0148145	-0.37600866	-160.01450
Tow 4	19-May-16	W Trans	-0.37031868	-160.0088898	-0.36813461	-160.00760
Tow 5	19-May-16	W N	-0.36753531	-160.0077193	-0.37171578	-159.9828812
Tow 6	20-May-16	W T0	-0.36789539	-160.0094926	-0.37008055	-160.0120892
Tow 7	21-May-16	W 1.5	-0.36907	-160.02231	NA	NA
Tow 8	21-May-16	W S	-0.37583	-160.01357	-0.37348	-160.01239
Tow 9	21-May-16	W Trans	-0.37073	-160.00925	-0.36968	-160.00838
Tow 10	21-May-16	W N	-0.36754	-160.00725	-0.36566	-160.00633
Tow 11	22-May-16	E Offshore	NA	NA	NA	NA
Tow 12	22-May-16	E T3	-0.36965	-159.97958	-0.36724	-159.97813
Tow 13	22-May-16	E N	-0.37509	-159.98314	-0.37235	-159.98334
Tow 14	22-May-16	E S	-0.37973	-159.98326	-0.37653	-159.98343