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

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CRUISE REPORT[1]

VESSEL: *Oscar Elton Sette*, Cruise 03-07 (OES-08)

PERIOD: 19 August – 30 September 2003

AREA OF OPERATION: Commonwealth of the Mariana Islands and Guam

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Division, Pacific Islands Fisheries Science Center, National Marine Fisheries Service, NOAA, and partner agencies conducted reef ecosystem assessment/monitoring in waters surrounding the Commonwealth of the Mariana Islands and Guam. This Mariana Archipelago Reef Assessment and Monitoring Program (MARAMP) cruise is part of NOAA's Coral Reef Conservation Program (CRCP) to conduct biennial coral reef ecosystem monitoring at each of the U.S.-affiliated Pacific Islands.

ITINERARY:

19 Aug — Deployed Coral Reef Early Warning System (CREWS) buoy in Managaha Reserve in Saipan Lagoon.

20-21 Aug — Conducted shipboard orientation, dive safety management drills, and fire and abandon ship drills. Conducted fish and benthic Rapid Ecological Assessment (REA) team and towed-diver protocol training dives off leeward Saipan.

22 Aug — Departed Saipan Harbor to begin cruise. Conducted six towed-diver habitat/fish surveys, two towed snorkeler turtle surveys, three benthic and two fish REA surveys along the north and east sides of Saipan. Conducted 20 shallow water conductivity-temperature-depth (CTD) casts around Saipan. Deployed settlement plates around anchor for CREWS buoy. Conducted two Tethered Optical Assessment Device (TOAD) camera drop surveys, four acoustic Doppler current profiler (ADCP) transects, and four deepwater (500 m) CTDs around Saipan.

23 Aug — Conducted six towed-diver habitat/fish surveys, three towed-diver turtle surveys, three benthic and fish REA surveys, nine shallow water CTDs, four TOAD camera drops, and one bioacoustic survey around Tinian Island. Rescued four distressed recreational divers from exposed rocky shoreline along windward side of Tinian after their small boat flooded and capsized. Departed Saipan/Tinian around 2200 en route to Sarigan Island. Deployed surface velocity program (SVP) drifter.

[1] PIFSC Cruise Report CR-06-006
Issued 31 May 2006

24 Aug Arrived Sarigan Island. Conducted six towed-diver habitat/fish surveys and three towed-diver turtle/fish surveys around island perimeter. Conducted three fish and benthic REA surveys along leeward side. Deployed subsurface temperature (STR) recorder on leeward side.Conducted geodetic surveys on west side of island. Conducted nine shallow water CTDs, three TOAD camera drops, four deepwater CTDs, four ADCP transects, and two bioacoustic surveys. Departed Sarigan Island en route to Zealandia Bank.

25 Aug Arrived Zealandia Bank. Conducted bathymetric survey around two pinnacles. Conducted two fish and benthic surveys around pinnacles. Deployed wave and tide Recorder (WTR). Conducted two TOAD camera drops, two bioacoustic surveys, four deepwater CTDs, and four ADCP transects around Zealandia Bank. Transited to Agrihan Island.

26 Aug Arrived Pagan Island. Conducted six towed-diver habitat/fish surveys, four towed-diver turtle surveys, two fish and one benthic REA surveys, and several shallow water CTDs around northeast quadrant of Pagan. Squally weather prevented additional REA surveys from being completed along this exposed shore. The geodetic shore party was unable to land on the east side of the island. Conducted five TOAD camera drop surveys along southwest side of Pagan. Conducted two deepwater CTDs and two ADCP transects around perimeter.

27 Aug Arrived Agrihan Island. Conducted six towed-diver habitat/fish surveys, three towed-diver turtle/fish surveys, three fish and benthic REA surveys, and several shallow water CTDs around east, south, and southwest sides of Agrihan. Conducted geodetic surveys on southwest side of island. Conducted three TOAD camera drop surveys along east and south sides of Agrihan. Conducted four deepwater CTDs, four ADCP transects, and two bioacoustic transects.

28 Aug Departed Agrihan en route to Stingray Shoals. Deployed SVP drifter.

29 Aug Conducted bathymetric survey of previously uncharted Stingray Shoals. Conducted four towed-diver habitat/fish and turtle surveys, two fish and benthic REA surveys, five TOAD camera drop surveys, and three bioacoustic surveys. Transited to Uracas Island.

30 Aug Arrived Uracas Island at 1430. Conducted two towed-diver fish/habitat surveys, one bathymetric survey, one fish and benthic REA survey, and eight shallow water CTDs. Attempted several TOAD surveys but could not safely get close enough to island to reach adequate depths. Attempted, without success, to locate Uracas Banks (charted to be about 8 nmi north of Uracas Island with water depths of 70 and 76 fathoms). Neither of two charted banks was located. Conducted three deepwater CTDs and four bioacoustic surveys.

31 Aug Conducted six towed-diver habitat/fish surveys and four towed-diver turtle surveys around perimeter of Uracas Island. Conducted three benthic and fish REA surveys. Deployed subsurface temperature recorder #3932718-1064 at position 20°32.227'N, 145°53.860'E in 1.5 m of water. Departed Uracas Island. Conducted bathymetric survey and four bioacoustic surveys over unnamed bank 8 nmi southeast of Uracas Island. Charted depth of bank is 76 fathoms; surveyed depth was found to be 54 m. Conducted two TOAD drop camera surveys over unnamed bank. Transited to Supply Reef.

1 Sep Conducted shallow water bathymetric survey of Supply Reef from small boat, one fish and benthic REA survey, and one partial towed-diver habitat/fish survey over Supply

Reef. Deployed wave and tide recorder # 2632718-0377 at position 20°08.405'N, 145°05.915'E. Conducted shipboard bathymetric survey around Supply Reef. No shallow soundings were found for the second charted position of Supply Reef. Conducted two bioacoustic surveys, two TOAD camera drop surveys, and four deepwater CTDs around Supply Reef. Departed Supply Reef, deployed SVP drifter #29108 at position 20°11.071'N, 145°04.611'E, and transited to Maug Islands.

2 Sep — Arrived at Maug Islands at 0700. Conducted 6 towed-diver habitat/fish surveys, 3 towed-diver turtle surveys, 3 fish and benthic REA surveys, 13 shallow water CTDs around Maug Islands. Conducted two bioacoustic surveys, four TOAD camera drop surveys, two ADCP transects, and two deepwater CTDs around Maug.

3 Sep — Conducted 6 towed-diver habitat/fish surveys, 3 towed-diver turtle surveys, 3 fish and benthic REA surveys, and 12 shallow water CTDs around Maug Islands. Deployed SST buoy #268-018 inside the lagoon at Maug on the northwest side of East Island near the northeast pass at position 20°01.752'N, 145°13.930'E in 7.5 m of water. Deployed subsurface temperature recorder #3932718-1049 in the shallow reef on the west side of West Island at position 20°01.065'N, 145°12.464'E in 2.5 m of water. Conducted two bioacoustic surveys, three TOAD camera drop surveys, two ADCP transects, and two deepwater CTDs around Maug.

4 Sep — Conducted four towed-diver habitat/fish surveys, three towed-diver turtle surveys, three fish and benthic REA surveys, eight shallow water CTDs, and two video surveys around Maug Islands. Conducted three TOAD camera drop surveys in Maug lagoon and two ADCP transects around Maug. Departed Maug and transited to Asuncion Island.

5 Sep — Arrived Asuncion Island at 0700. Conducted six towed-diver habitat/fish surveys, three towed-diver turtle surveys, three fish and benthic REA surveys, and eight shallow water CTDs around Asuncion Island. Conducted six TOAD camera drop surveys, two ADCP transects, and one deepwater CTD around Asuncion. Deployed subsurface temperature recorder #3932718-1049 at position 19°41.605'N, 145°23.383'E in 3.5 m of water. The CTD tow-blocked during retrieval because of a winch controller failure causing the wire to part and the CTD and rosette to crash to the deck, severely damaging the frame and block. Transited to Agrihan Island.

6 Sep — Arrived Agrihan Island. Conducted six towed-diver habitat/fish surveys, two towed-diver turtle surveys, three fish and benthic REA surveys, and eight shallow water CTDs around the northwest and west sides of Agrihan Island. Deployed one subsurface temperature recorder #3932718-1042 at lat. 18°45.995'N, long. 145°38.296'E in 2 m of water. Conducted six TOAD camera drop surveys, two ADCP transects, and three bioacoustic surveys around Agrihan. Transited to Pagan Island.

7 Sep — Arrived Pagan Island. Conducted six towed-diver habitat/fish surveys, three towed-diver turtle surveys, three fish and benthic REA surveys, and eight shallow water CTDs around the northwest and west sides of Pagan Island. Deployed SST buoy #268-019 at lat. 18°07.647'N, long. 145°45.437'E in 5 m of water. Conducted three TOAD camera drop surveys, two ADCP transects, one bioacoustic survey, and one deepwater (350 m) CTD around Pagan.

8 Sep — Conducted six towed-diver habitat/fish surveys, three towed-diver turtle surveys, three fish and benthic REA surveys, and eight shallow water CTDs around the southwest and

southeast sides of Pagan Island. Departed for Saipan at 1800 because of a medical/personnel emergency.

9 Sep — Anchored off Saipan at 1130. Onloaded six 55-gallon drums of gasoline for small boats. Disembarked one crewmember with Officer escort. Weighed anchor at 1800. Conducted seven TOAD camera drop surveys of Garapan anchorage areas off west Saipan. Collected surface chlorophyll samples. Transited to Anatahan Island.

10 Sep — Arrived at Anatahan Island at 0700. Observed surface slick and bubbling off northeast coast of Anatahan Island. Conducted 6 towed-diver habitat/fish surveys, 3 fish and benthic REA surveys, 24 shallow water CTDs, 2 aborted towed-diver turtle/fish surveys. Visibility was extremely poor (0.5 – 2.0 m) at most sites causing difficult working conditions for all diving operations. Deployed subsurface temperature recorder #3932718-1067 at lat. 16°20.077'N, long. 145°38.719'E in 5.8 m of water. Conducted five TOAD camera drop surveys, one ADCP transects, and three bioacoustic surveys around Anatahan. Transited to Guguan Island.

11 Sep — Arrived at Guguan Island at 0700. Conducted 6 towed-diver habitat/fish and 3 towed-diver turtle/fish surveys around entire island, 3 fish and benthic REA surveys, 10 shallow water CTDs, 3 TOAD camera drop surveys, 2 bioacoustic surveys, 2 deepwater CTDs, and 4 ADCP transects. Deployed sursurface temperature recorder #3932718-1068 at lat. 17°18.440'N, long. 145°49.884'E in 6 m of water. Transited to Alamagan Island.

12 Sep — Arrived at Alamagan Island at 0700. Conducted 6 towed-diver habitat/fish and 3 towed-diver turtle/fish surveys around entire island, 3 fish and benthic REA surveys, 1 reef fish collection dive, 14 shallow water CTDs, 6 TOAD camera drop surveys, 2 bioacoustic surveys, 2 deepwater CTDs, and 4 ADCP transects. Deployed sursurface temperature recorder #3932718-1110 at lat. 17°37.124'N, long. 145°49.404'E in 3 m of water. Transited to Pagan Island.

13 Sep — Arrived at Pagan Island at 0700. Conducted three towed-diver habitat/fish and three towed-diver turtle/fish surveys along southeast shore, one deep fish and benthic REA survey, one shallow benthic REA survey, one reef fish collection dive, six shallow water CTDs, and one bioacoustic survey. Departed Pagan Island en route to Pathfinder Bank.

14 Sep — Arrived at Pathfinder Bank at 0630. Conducted bathymetric survey, four towed-diver habitat/fish and turtle surveys, two fish and benthic REA surveys, four TOAD drop camera surveys , one bioacoustic survey, and one deepwater CTD. Departed Pathfinder Bank en route to Arakane Reef. Deployed SVP satellite-tracked drifter #29103 at position 16 26.594’N 143 05.160’E.

15 Sep — Arrived at Arakane Reef at 0600. Conducted bathymetric survey, six towed-diver habitat/fish and turtle surveys, two fish and benthic REA surveys, four TOAD drop camera surveys, two bioacoustic surveys, two deepwater CTDs, and two ADCP transects. TOAD suffered minor damage during collision with bottom. Departed Arakane Reef en route to Esmeralda Bank.

16 Sep — Arrived at Esmeralda Bank at 1430. Conducted bathymetric surveys, four TOAD drop camera surveys, two deepwater CTDs, and two ADCP transects. Departed Esmeralda Bank at 0530 en route to Tatsumi Reef.

17 Sep Arrived at Tatsumi Reef at 0730. Conducted two towed-diver habitat/fish surveys and one towed-diver turtle survey over Tatsumi Reef. Transited to Aguijan Island. Conducted 4 towed-diver habitat/fish surveys, 2 towed-diver turtle/fish surveys, 2 fish and benthic REA surveys, and 12 shallow water CTDs. Deployed sursurface temperature recorder #3932718-1111 at lat. 14°50.101'N, long. 145°31.958'E in 3.8 m of water. Disembarked Mike Trianni, Kate Moots, Robert Schroeder, and Ken Cochrane to Division of Fish and Wildlife 8 m vessel for transit to Saipan to conduct fish REA surveys. Conducted three TOAD drop camera surveys. Departed Aguijan en route to Anatahan Island.

18 Sep Arrived at Anatahan Island at 0700. Conducted six towed-diver habitat/fish surveys, three towed-diver turtle/fish surveys, and three benthic REA surveys. Deployed sursurface temperature recorder #3932718-1113 at lat. 16°19.975'N, long. 145°42.162'E in 3.5 m of water. Departed Anatahan at 1715 en route to Saipan. Arrived Saipan at 2330 to embark Robert Schroeder, Michael Trianni, and Kate Moots. Departed Saipan en route to Rota Island.

19 Sep Arrived Rota Island at 0730. Conducted six towed-diver habitat/fish surveys, three turtle/fish surveys, three fish and benthic REA surveys, four TOAD drop camera surveys, two bioacoustic surveys, two deepwater CTDs, and four ADCP transects.

20 Sep Conducted six towed-diver habitat/fish surveys, three turtle/fish surveys, three fish and benthic REA surveys, six TOAD drop camera surveys, three bioacoustic surveys, and one ADCP transect. Deployed sea surface temperature buoy #268-013 at lat. 14°06.779'N, long. 145°10.002'E in 12.7 m of water. Deployed SVP satellite-tracked drifter #29099 at position 13°59.418’N 145°00.313’E. Departed Rota en route to Guam.

21 Sep Arrived Guam at 0830 to conclude Leg I. Cleared Customs, Immigration and Agriculture at ~1000 to commence Guam welcoming reception. Conducted interviews for KGTF-TV Guam for Public TV kids environmental education. Attended Fiesta Reception hosted by the Guam Fishermen’s Co-op and the Western Pacific Regional Fishery Management Council in honor of the officers, crew, and scientists aboard the *Oscar Elton Sette*. Disembarked Trianni, Moots, Castro, Houk, and Malay.

23 Sep Embarked scientists Minton, Capone, Tibbatts, and Wustig. Commenced Leg II operations at 0730. Ship departed Apra Harbor at 1000. Conducted 6 towed-diver habitat/fish surveys, 3 towed-diver turtle/fish surveys, 3 benthic and fish REA surveys, and 10 shallow water CTDs around the southwest and south quandrant of Guam. Conducted four TOAD drop camera surveys, one deepwater CTD, and two bioacoustic surveys. Departed Guam en route to Santa Rosa Reef.

24 Sep Arrived at Santa Rosa Reef at ~0630. Initiated reconnaissance bathymetric survey. Because of adverse weather and sea conditions, departed Santa Rosa Reef en route to Guam. Conducted three towed-diver habitat/fish surveys, two fish and benthic REA surveys, two towed-diver turtle/fish surveys, and five shallow water CTDs along the northwestern shore of Guam. Deployed sea surface temperature buoy #268-014 in the Tumon Bay Marine Reserve at lat. 13°31.141'N, long. 144°47.867'E in 12.4 m of water. Transited to 11-mile bank and conducted three TOAD camera drop surveys there. Transited to Galvez Bank to conduct reconnaissance bathymetric survey. Transited back to east side of Guam.

25 Sep Arrived at Guam at 0700. Conducted six towed-diver habitat/fish surveys, three towed-diver turtle/fish surveys, two fish and benthic REA surveys, and seven shallow water

CTDs along the east and north sides of Guam. Conducted two bioacoustic surveys, four TOAD camera drop surveys, one deepwater CTD, and one ADCP transect. Attempted to locate 100-fathom bank north of Guam without success.

26 Sep — Conducted five towed-diver habitat/fish surveys, three towed-diver turtle/fish surveys, two REA surveys, and seven shallow water CTDs. Attempted to survey Icehouse Bank based on positions provided by local fishermen and agency representatives. Bank was not located near reported positions. Conducted bioacoustic transect. Transited to Galvez Bank.

27 Sep — Arrived at Galvez Bank at 0530. Conducted bathymetric survey. Weather and sea conditions too rough to launch small boats. Conducted 11 TOAD camera drop surveys and 1 ADCP transect around Galvez Bank. Transited to Santa Rosa Reef.

28 Sep — Arrived at Santa Rosa Reef at 0600. Conducted bathymetric survey. Conducted three towed-diver habitat/fish surveys and two fish and benthic REA surveys. Deployed Ocean Data Platform #27-007 at position 12°50.2916'N, 144°25.0704'E in 19.8 m of water. Conducted seven TOAD camera drop surveys, two bioacoustic surveys, one deepwater CTD, and an ADCP transect around Santa Rosa Reef. Deployed SVP satellite-tracked drifter #29100 at position 12°54.626'N, 144°24.958'E.

29 Sep — Arrived Guam to end cruise. Disembarked Leberer, Tibbatts, Wusstig, Capone, Minton, Hoeke, Timmers, Zgliczynski, Laughlin, Bak, and Kolinski. Loaded AHI multibeam survey launch on board for transit back to Honolulu.

30 Sep — Disembarked Brainard, Holzwarth, Vroom, Schroeder, Tanay, Minkel, and Rooney.

CRUISE STATISTICS:

Towed Diver Habitat/Fish Surveys	161	(~400 km of habitat, 134 hrs of video, ~32,000 digital photos)
Towed Diver Turtle/Fish Surveys	82	(~178 km of habitat)
Non-tow Turtle Surveys	5	
Fish Rapid Ecological Assessments	87	
Fish collection surveys	3	(Maug, Alamagan, Pagan)
Benthic Rapid Ecological Assessments	86	
CREWS buoys deployed	1	(Saipan)
SST buoys deployed	4	(Pagan, Maug, Rota, Guam)
Ocean Data Platforms deployed	1	(Guam)
Wave and Tide Recorders deployed	2	(Zealandia Bank, Supply Reef)
Subsurface Temperature Recorders Deployed	11	(Sarigan, Uracas, Maug, Asuncion, Agrihan, Pagan, Anatahan (2), Guguan, Alamagan, Aguijan)
TOAD drop camera surveys	126	
QTC acoustic habitat surveys	136	
Bioacoustic Transects	52	210.9 km
Deepwater CTDs (to 500 m)	46	
Shallow water CTDs (to 30 m)	227	
ADCP transects	67	777.8 km of transects
SVP drifter deployments	5	
Bathymetric surveys (ship)	6	(Zealandia Reef, Stingray Shoals, Supply Reef, Pathfinder Bank, 2 unnamed banks)
Multibeam bathymetric surveys (*AHI*)	6	(Saipan, Tinian, Marpi, Tatsumi, Rota, Guam) covering 244.2 sq km
Geodetic surveys	10	(Sarigan, Pagan, Agrihan, Asuncion, Maug, Uracas, Anatahan, Guguan, Alamagan, Aguijan)
SCUBA dives	1,204	dives

RESULTS:
See Appendices A-J.

SCIENTIFIC PERSONNEL:
Scientific Party:
Rusty Brainard, Ph.D., Chief Scientist, Towed Diver Team - Habitat, NOAA Fisheries, Pacific Islands Fisheries Science Center (PIFSC), Coral Reef Ecosystem Division (CRED)
Molly Timmers, Towed Diver Team - Habitat, University of Hawaii (UH), Joint Institute for Marine and Atmospheric Research (JIMAR), PIFSC, CRED
Brian Zgliczynski, Towed Diver Team - Fish, NOAA Fisheries, PIFSC, CRED
Joe Laughlin, Towed Diver Team -Fish, UH, JIMAR, PIFSC, CRED
Robert Schroeder, Ph.D., Fish Team, UH, JIMAR, PIFSC, CRED
Mike Trianni, Fish Team, Commonwealth of the Northern Mariana Islands, Division of Fish and Wildlife (DFW) (leg I only)
Kate Moots, Ph.D., Fish Team, CNMI, DFW (leg I only)
Peter Vroom, Ph.D., Benthic Team - Algae, UH, JIMAR, PIFSC, CRED
Fran Castro, Benthic Team - Algae/Inverts, CNMI, DEQ (leg I only)
Peter Houk, Benthic Team - Corals, CNMI, DEQ (leg I only)
Trina Leberer, Benthic Team - Corals/Inverts, Guam, DAWR
Machel Malay, Benthic Team - Inverts, Univ. of Florida (leg I only)
Stephani Holzwarth, Oceanography/Towed Diver Team - Fish, UH, JIMAR, PIFSC, CRED
Steve Kolinski, Ph.D., Oceanography/Towed Diver Team - Turtles, UH, JIMAR, Pacific Islands Regional Office (PIRO)
Ron Hoeke, Oceanography/Towed Diver Team - Oceanography, UH, JIMAR, PIFSC, CRED
John Rooney, Ph.D., Habitat Mapping Team - Towed Camera, UH, JIMAR, PIFSC, CRED
Ken Cochrane, Habitat Mapping Team - GIS, CNMI, CRM
David Minkel, Habitat Mapping Team - Geodetic, NOAA – NOS - NGS
Dennis Tanay, Habitat Mapping Team - Bioacoustics, UH
Sun He Bak, Data Manager, UH, JIMAR, PIFSC, CRED
Phil White, Senior Survey Tech, NOAA ship *Oscar Elton Sette*
Brent Tibbatts, Fish Team, Guam – DAWR (Leg II only)
Mark Capone, Fish Team, University of Guam Marine Laboratory (Leg II only)
Shawn Wusstig, Benthic Team - Algae, Guam – DAWR (Leg II only)
Dwayne Minton, Ph.D., Benthic Team - Inverts, Guam – NPS (Leg II only)
ENS Kelley Stroud, Benthic Team - corals, NOAA ship *Oscar Elton Sette*
ENS Monty Spencer, Benthic Team - corals, NOAA ship *Oscar Elton Sette*
Scott Ferguson, Habitat Mapping Team, R/V AHI, UH, JIMAR, PIFSC, CRED
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Attachments

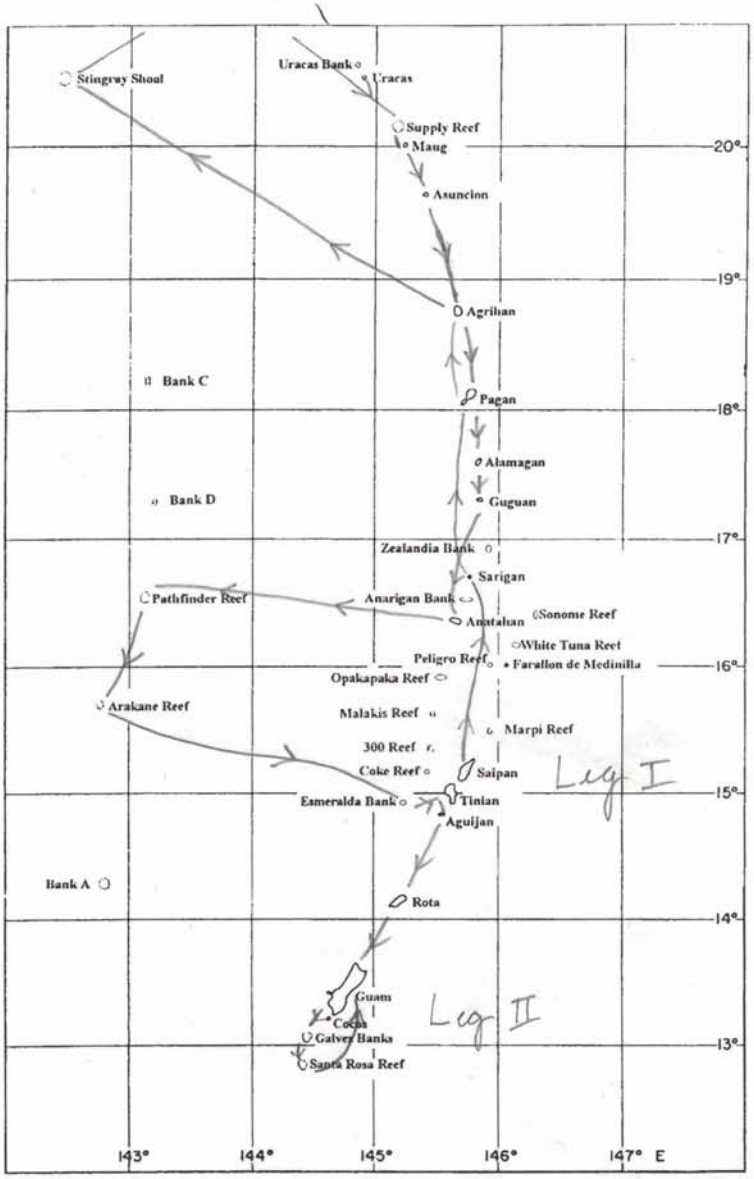

Figure 1.—The Mariana Archipelago. Track of the NOAA ship Oscar Elton Sette Cruise OES-03-07 (OES-08) Leg I, August 13 to September 21, 2003. Leg II, September 23-29, 2003.

Appendix A: **Fish Rapid Ecological Assessment (REA) Team Activity Report** (*Robert Schroeder, Mike Trianni, Kate Moots, Brent Tibbatts, and Mark Capone*)

August 22–28, 2003

From August 22 to 27, the fish census team surveyed 15 stations—2 stations at Saipan, 3 stations at Tinian, 3 stations at Sarigan, 2 stations at Zealandia Bank, 2 stations at Pagan, and 3 stations at Agrihan. Quantitative belt transects (BLT) and stationary point counts (SPC) were conducted at 13 stations, and qualitative REA surveys were performed at the 2 stations at Zealandia Banks. Stations were generally selected from the windward sides of the islands because of favorable weather. The benthic team followed the fish team at all census sites (except for one station at Pagan).

Fish transect stations consisted of three consecutive 25-m lines set along a single depth contour at 13–15 m. As each line was set, the observers swam about 5 m apart along either side along each side of the line, counting and recording size classes for all fishes >20 cm total length (TL) within an area 4 m wide and 4 m high. At the end of each 25-m line, the divers turned around and, while remaining on either side of the line, began counting and recording size classes of all fishes within 2 m of their side of the line and 4 m off the bottom. Four SPCs were made at each transect station, generally ~15 m from the transect line. During a 5-minute period, SPCs were performed when the diver counted and recorded the size classes of all fishes >25 cm TL that were located in a cylindrical volume 10 m in radius. 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 recorded all species observed during the dive. These observations of diverse fishes were combined with fish observed by other divers (benthic team, tow team, or mooring team) and were identified for the purpose of developing an island-wide listing of all fishes surveyed.

The total number of coral reef fish species previously documented for each of the islands (or bank) was 598 for Saipan, 299 for Tinian, 80 for Sarigan, 66 for Zealandia Bank, 185 for Pagan, and 124 for Agrihan. The islands of Saipan and Tinian were surveyed most thoroughly prior to this cruise. The total number of species we observed at Sarigan was 172, at Zealandia Bank 127, at Pagan 161, and at Agrihan 177. Many of these species were new records for these islands, as very few surveys were conducted previously at most of these islands. Many species were also present in the size ranges at which they recruit from the plankton, or as very young juveniles. In general, sharks and reef-associated apex predators were rare, although more common north of Saipan. Grey reef sharks, (*Carcharhinus amblyrhynchos*), reef whitetip sharks (*Triaenodon obesus*), reef blacktip sharks (*Carcharhinus melanopterus*) and tawny nurse sharks (*Nebrius ferrugineus*) were the only species of sharks observed by the fish team. In general, large fish appeared to be rare, and in much lower densities than the NWHI and Line and Phoenix Islands. However, at Agrihan Island, one site yielded the highest diversity of fishes thus far, including a wide variety of surgeon and unicorn fish, as well as large individuals of the groupers *Cephalopholis argus* and *Epinephelus fasciatus*.

At all localities north of Saipan, divers observed a triggerfish that was similar to the pinktail triggerfish (*Melichthys vidua*), but which differed because it had an orange tail, yellow/orange dorsal and anal fins, and a dark bar extending from the lower margin of the eye to the base of the pectoral fin. Jack Randall replied to our e-mail that this was probably a juvenile color form of *M. vidua,* which recruits to the reef at sizes up to 16 cm TL. But some individuals we observed were longer than 20 cm.

Many individuals of a wrasse and bronze razorfish (*Xyrichtys celebicus*) were seen swimming in loose aggregations over the black sands off the southwest shore of Agrihan at a depth of about 13 m. Throughout Micronesia, this species had only been previously reported from Calalan Bank (Guam) and by the presence of a single specimen from Bikini Lagoon.

August 29–September 6, 2003

From August 29 to September 6, the fish census team surveyed 23 stations— 2 at Stingray Shoals, 4 at Uracas, 1 at Supply Reef, 10 at Maug, 3 at Asuncion, and 3 at Agrihan. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys were conducted following the same methodology as described in the first report. In addition, a few fish were collected at Maug.

The total number of coral reef fish species previously documented for each of the islands (or banks) was 0 for Stingray Shoals, 37 for Uracas, 0 for Supply Reef, 222 for Maug, 57 for Asuncion, and 124 for Agrihan. The total number of species we observed at these islands/banks was: 127 at Stingray Shoals, 200 at Uracas, 67 at Supply Reef, 240 at Maug (plus 15 new records in fish collections), 198 at Asuncion, and 214 at Agrihan. Many of these species were new records for these islands, as very few surveys were conducted previously at most of these islands. Many species were also present in the size ranges at which they recruit from the plankton, or as very young juveniles. The pinktail triggerfish (*Melichthys vidua*) continued to be observed and it was found to possess an orange tail, yellow/orange dorsal and anal fins, and a dark bar extending from the lower margin of the eye to the base of the pectoral fin. Some also appeared to have a slightly different mouth and body texture.

In general, sharks and large reef-associated apex predators continued to be rare at these islands/banks, although more common than in Saipan or Tinian, and in much lower densities than the NWHI and Line and Phoenix Islands. The rare giant grouper *Epinephelus lanceolatus* was observed at Uracas and Maug. Large individuals of the snappers *Macolor niger* and *M. macularis* were also relatively common at Uracas.

Stingray Shoals was characterized by having only two small pinnacles at diving depths. While fish were abundant, there appeared to be a lack of large predators, at least relative to some other remote U.S. Pacific Islands. Evidence of fishing activity was present, including numerous anchors and longline gear on the reef. Other possible explanations for the apparent paucity of predators may be because of a possible absence of nutrient enhancing upwellings (e.g., as at the equatorial islands) or the limited area of reef development (compared to the extensive reefs and shoals in the NWHI).

Only one dive was made at Supply Reef which had only a very small area shallow enough to survey and strong currents.

Maug had a diversity of habitat types with a deep lagoon. Gas was observed bubbling from the substrate near the northern end of the lagoon of East Island, which was characterized by algae-covered boulders and silty sand substrate, but also had many of the fish species common to rich coral habitats. Coral reef development was richest along the west side of West Island. A wide diversity of fish was observed. We suggest this area has strong potential for consideration as a no-take marine protected area (MPA), consistent with federal mandates for coral reefs.

The crosshatch trigger fish, *Xanthichthys mento,* was observed at Stingray, Uracas, and Maug. This species was previously only recorded in Micronesia at Wake Island, although it was expected to be found in the northernmost islands and banks of the Marianas. Another interesting find at Stingray and later at Uracas and Maug was the spotted knifejaw, *Oplegnathus punctatus*, previously known from the Marianas based on a single specimen collected in Guam 30 years ago. Another interesting observation was the xanthic (yellow) phase of *Kyphosus bigibbus*.

The angelfish *Genicanthus watanabe*, considered rare in Micronesia and only found in deep water, was occasionally seen even in shallow water at Stingray, Uracas, and Maug.

September 6-13, 2003

From September 7 to 13, the fish census team surveyed 17 stations—8 (more) at Pagan, 3 at Anatahan, 3 at Guguan, and 3 at Alamagan. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys were conducted following the same methodology as described in the first report. In addition, a few fish were collected at Alamagan and Pagan.

In general, sharks and other large predators continued to be rare at these islands, as at other northern islands/banks surveyed earlier in the archipelago. The total number of coral reef fish species previously documented for each of the islands (or banks) was 185 for Pagan, 178 for Anatahan, 86 for Guguan, and 22 for Alamagan. The total number of species we observed at these islands (including our visits earlier in the cruise) was 230 for Pagan (53 species collected), 161 for Anatahan, 211 for Guguan, and 208 for Alamagan (51 species collected). Many of these species were new island records, as few previous surveys were conducted. New recruits and young juveniles continued to be very common on these reefs. Young orangespine unicornfish (*hangon*), *Naso lituratus,* were present in the hundreds at most stations, many with evidence of disease (white markings on body) and some lying dead or near

death on the bottom. They also exhibited aggressive behavior to each other. Many other species were also present in the size ranges at which they recruit from the plankton, or as very young juveniles. As the survey moved to more southerly islands, the Hawaiian bristletooth, *Ctenochaetus hawaiiensis,* appeared less common and the striped bristletooth, *Ctenochaetus striatus,* and the brown surgeonfish, *Acanthurus nigrofuscus,* seemed to achieve larger sizes.

Pagan:

Pagan is one of the larger northern islands of the CNMI. As such, it has the potential for a greater diversity of habitats than many of the other islands, but the fish populations did not seem to be significantly different from other islands surveyed. A greater number of species was observed, likely as a result of greater sampling effort across a variety of habitats. Pagan is where mass die-off of juvenile *Naso lituratus* was first observed. Previously, *N. lituratus* were observed in mass numbers in a deteriorated physical state in many of the islands north of Pagan, but upon our return to Pagan a mass die-off had begun. An interesting wall feature is present on the southwest side of the island, with a diversity of fishes exceeding all other sites. An interesting observation was that of the arrowhead soapfish, *Belonoperca chabanaudi*, the first observation of the cruise for this cryptic species.

Anatahan:

Underwater visibility around most of the island averaged 0.5 – 2.0 m because of heavy ash—sediment in the water from the May 9, 2003 volcanic eruption of this island. Heavy ash deposits also covered much of the island that killed a substantial portion of the trees and vegetation. Rainfall continues to wash ash onto the reefs, and the seas and ocean swells continue to remix this sediment in the water column and deposit it onto the reefs. Coral reefs along the north side were largely buried in ash with only the highest points protruding above. At some places gas bubbles were observed percolating from the substrate. Poor visibility precluded accurate quantification of the sparse fish community present at the 9–15 m depth range. No fish were seen along some transect lines. In contrast, a site along the west side of the island off a rocky cliff provided about 12-m visibility and high hard-substrate relief, but was heavily coated with ash deposits with evidence of many corals recently killed and buried. Soft corals were proliferating atop one high pinnacle. In spite of a disturbance of this magnitude, many fish, including some large ones, were present at this site. Herbivorous parrotfishes and surgeonfishes were also present, in spite of reports of no living algae at the site. No other sites with workable visibility were found around the island, although the south side was not surveyed because of even stronger seas and swell conditions. It appears likely that the sedimentation impact to the coral reef community around Anatahan may continue for many years.

Guguan:

The reefs showed a lot of rugosity, especially along the western side—high topographic relief with lots of holes, crevices, and corals. There were large numbers of twinspot snapper, *Lutjanus bohar,* and black snapper, *Macolor niger.* An interesting observation was the record of a smalltooth emperor, *Lethrinus microdon.* Emperors of the genus *Lethrinus* had been noticeably absent from observations in the northern islands. The waters above the reefs were filled with large numbers of small fishes, many of which were recent recruits to the reef. This island is already a terrestrial reserve and has been proposed as a CNMI no-take marine reserve. We recommend that this island's marine communities be set aside as an MPA.

Alamagan:

Up to a dozen adult blacktip grouper, *Epinephelus fasciatus*, were congregated together around a small rock outcropping on a relatively flat section of reef along the west side of the island, possibly a spawning aggregation. A redmouth grouper, *Aethaloperca rogaa*, was seen at Alamagan, one of the few localities it was previously known from in Micronesia. This species is considered rare across Micronesia, although it may be common in certain areas of southwestern Palau. Similarly, the blackblotch lizardfish, *Synodus jaculum,* had only previously been reported from Guam, Kosrae, and Palau. In addition, two

longnose emperors, *Lethrinus olivaceous*, were observed, yet this species had only been seen at one other location thus far during the cruise.

September 14-21, 2003

From September 14 to 20, the fish census team surveyed 15 stations— 2 at Pathfinder Reef, 2 at Arakane Bank, 2 at Aguijan (Goat) Island, 3 (additional) at Saipan, and 6 at Rota. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys were conducted following the same methodology as described in the first report.

In general, sharks and other large predators continued to be rare at these islands, as at other northern islands/banks surveyed earlier in the archipelago. The total number of coral reef fish species previously documented for each of the islands (or banks) was 0 for Pathfinder, 0 for Arakane, 126 for Goat, 598 for Saipan, and 268 for Rota. The total number of species we observed at these islands (including our visits earlier in the cruise) was 138 for Pathfinder, 141 for Arakane, 204 for Goat, 179 for Saipan, and 267 for Rota. Many of the species documented at Pathfinder and Arakane were new island records, as few previous shallow-water surveys were conducted at these remote banks. In general, the southern islands appeared to have many more emperors (lethrinids), more diverse wrasses (labrids) squirrelfish (holocentrids), and parrotfish (scarids), and more rays (dasyatids, myliobatids), while fewer groupers (serranids), snappers (lutjanids), and sharks were present. High densities of recently recruited young juveniles of the orangespine unicornfish (*hangon*), *Naso lituratus,* were not observed on these reefs, as was common at the more northerly sites visited.

Pathfinder:

The bathymetry at Pathfinder Bank was characterized by low substrate relief resembling "gently rolling hills" transected by slightly deeper winding hard pavement "stream beds." Current was high and little sand or other sediment was present. Fish diversity was moderate, lower than the southern islands but higher than the northern islands. As at the main island chain, large predators and sharks were again not common.

Arakane:

Bathymetry and reef structure here were similar to that at Pathfinder, but with more relief allowing for slightly more fish. Fish diversity was moderate. High densities of juvenile bluehead wrasse (*Thalassoma amplycephalum*) were observed.

Aguijan:

Species diversity at Aguijan Island was relatively high. Reefs, particularly along the southwest were well developed (high diversity of fish and corals, heterogeneous substrate types, and high substrate relief). Large individuals of emperors (*Lethrinus* spp.) were observed here, which were rare or absent at the northern islands. We strongly recommend this area as a candidate for a no-take MPA.

Saipan:

The fish team surveyed Saipan for an additional day (in lieu of heavily silted Anatahan) to increase the sample size for a more valid comparison of this heavily populated and fished island to the remote, largely uninhabited northern islands. Stations along the south (Boy Scout) and west (Susupe region of Saipan lagoon) were characterized by high substrate relief and fish diversity. These areas also have potential as candidates for an MPA designation.

Rota:

Several of the sites surveyed here were predominantly flat pavement substrate with few live corals. Very high densities (like mid-water clouds) of the red-toothed triggerfish (*Odontus niger*) were common at most sites. Strong current along the north precluded use of the belt transect method and very few large fish were sighted on SPCs, with the exception of a school of about 100 large great barracuda (*Sphyraena barracuda*) that swam by with the current. Another exception was found on the northeast side

of the island where an SPC survey in a deep trench surrounded by flat habitat yielded many large fish including emperors (*Lethrinus olivaceous, L. microdon*), gray reef shark, snapper (*Lutjanus bohar*) and the very rare humphead parrotfish (*Bolbometapon muricatum*), the first large one seen in the cruise. Reefs inside the bay at Sasanhaya (a CNMI fish reserve) had high substrate relief but were predominantly algal covered, possibly a lingering effect of last year's two major super typhoons that hit the island, or a result of major ordnance being detonated in the bay in the mid-1990s.

September 23-29, 2003

From September 23 to 28, the fish census team surveyed 11 stations around Guam, including 2 stations at Santa Rosa Bank. Quantitative belt transects (BLT), stationary point counts (SPC), and qualitative REA surveys were conducted following the same methodology as described in the first report for CNMI.

Guam

Surveys were conducted on all sides of the main island (except the south) below Apra Harbor, Fouha, Achang Reef, Tumon Bay, Haputo Beach, Talofofo Bay, Pati Point, Pagat, and Jinapsan Beach. At most sites (except the north) visibility was rather poor (~20 ft) as a result of recent heavy rains and terrestrial run-off.

Substrate type was typical reef-slope hard pavement with generally small live corals and calcareous and other algae. Some sites included small spur-and-groove zones. Algae appeared to dominate and siltation was seen at sites near river mouths in the south.

Over 800 coral reef fish species are known from Guam. Our 4-day survey documented 232 species. No sharks were observed by the fish census team, although the fish towed-diver surveys did observe black-tip and white-tip sharks. Large fish were not abundant at any of the sites surveyed. Juveniles were present but few, unlike the more northern Marianas Archipelago where recruitment for several species was considerable.

The highest diversity of fish and live corals and most rugose substrate was found at the northern end of the island at Jinapsan Beach. Deep trenches and caves enhanced fish habitat. This area may have potential as a candidate for MPA designation, but it already receives some protection by the U.S. Air Force restricting shore access and by the prevalence of the typically harsh sea surface and current conditions most of the year.

SPC surveys for large fish at each site suggest that fish larger than 25 cm are uncommon in most areas around Guam. This is not surprising considering that Guam sustains a large population and its waters are heavily fished. The north and northeast areas (Ritidian, Pati Pt., Pagat) had the greatest number of fish >25 cm as well as the largest fish surveyed. Of the observed fish larger than 25 cm the most common size classes were 25 cm and 30 cm. The most common species surveyed were bullethead parrotfish, *Chlorurus sordidus,* and orangespine unicornfish, *Naso lituratus,* none of which were larger than the 25-cm class.

Quantitative belt transect surveys found fish larger than 20 cm to be uncommon in most areas around Guam. Heavy fishing and habitat loss are probable causes. The north and northeast areas had the greatest species diversity, as well as the largest number of large (>20 cm) fish. The most common species observed were the brown surgeonfish (*Acanthurus nigrofuscus*) and the red ribbon wrasse (*Thalassoma quinquevittatum*). In two of the belt transect sites (Orote and Fouha), large groups of recruits of two species (*Odonus niger* and *Naso hexacanthus*) were seen. The blacktongue unicornfish (*N. hexacanthus)* is not a common species on Guam, and it will be interesting to see if this large recruitment leads to an increase in the abundance in future fisheries take. No honeycomb grouper (*Epenephelus merra)* were seen in any belt transect. This was unusual, as *E. merra* is the most abundant grouper taken in Guam's inshore fishery, as well as the most abundant grouper seen in the DAWR MPA fish counts.

Santa Rosa Bank

Sea conditions were deemed unworkable at all offshore banks except Santa Rosa, south of Guam. Substrate bathymetry resembled that of Pathfinder and Arakane, with gently rolling hills separated by

winding sand/rubble/pavement stream-like valleys. Current was negligible during both dives here, but large swells produced bottom surge. Again, there was a notable absence of large fish and sharks (only one small back-tip shark was seen). Fish density and species richness were low to moderate at the first site, characterized by more live corals, and low at the second site, characterized by largely algal and sand-covered hard substrate. The few fish seen on SPC counts included emperors (*Lethrinus* sp.) and the orangeband surgeonfish (*Acanthurus olivaceus*).

Appendix B-D: **Benthic Team Activity Report: Corals, Algae, Macroinvertebrates** (*Peter Vroom, Fran Castro, Peter Houk, Trina Leberer, Machal Malay, Dwayne Minton, Shawn Wustig*)

August 22– 28, 2003

Summary of Work Completed to Date:

Site name	Date	Benthic transect data	Coral population data	Coral biodiversity data
SAI-1	8/22/2003	2 x 50m	Yes	Yes
SAI-2	8/22/2003	No data, video problems	Yes	Yes
SAI-3	8/22/2003	2 x 25m	No, already exists in CNMI Database	Yes
TIN-1	8/23/2003	1 x 25m, 2 x 50m	Yes	Yes
TIN-2	8/23/2003	Completed by CNMI MMT	No, already exists in CNMI Database	Yes
TIN-3	8/23/2003	1 x 25m	No, already exists in CNMI Database	Yes
SAR-1	8/24/2003	2 x 25m, 1 x 50m	Yes	Yes
SAR-2	8/24/2003	3 x 50m	Yes	Yes
SAR-3	8/24/2003	3 x 50m	Yes	Yes
ZEA-1	8/25/2003	No	No	Yes
ZEA-2	8/25/2003	No	No	Yes
PAG-1	8/26/2003	3 x 50m	Yes	Yes
AGR-1	8/27/2003	3 x 50m	Yes	Yes
AGR-2	8/27/2003	3 x 50m	Yes	Yes
AGR-3	8/27/2003	2 x 25m	Yes	Yes

General Summary of Coral and Benthic Work Completed:

On the first couple of days we were having difficulties with equipment and getting used to the protocols. As a result, there are gaps in data collection for Saipan and Tinian Island. We now have these problems worked out and plan to continue on schedule. All data listed as completed by CNMI Marine Monitoring Team (MMT) were previously collected at the site(s) using the exact same protocols within the past 6 months. These data will be submitted at the end of the cruise.

Overview of Initial Findings for Coral and Benthic Communities:

All of the Northern Mariana Islands surveyed thus far show a significant decrease in the overall biodiversity of scleractinian corals compared with the Southern Mariana Islands (256 species previously known). For comparability between sites, CREI fish and benthic protocols consistently survey the limited depth range of the reef slope of 9.1–15.2 m. As a result of a limited number of survey sites and depth limitations, there have been 50–80 species recorded for the Southern Islands and only 30–40 species recorded for the Northern Islands. The dominant coral genus Acropora has diminished from 10–20 species to 3 species upon moving to the volcanic Northern Islands. This overall decrease may be a result of several things including 1) a lack of available habitat required for the high diversity of corals expected in this region, 2) a lack of viable larvae traveling into these remote islands, and 3) a preference for many corals to settle upon existing limestone reefs and not on volcanic bedrock. The invertebrate and fish communities do not appear to follow this trend; however, no data are yet available to discuss this further.

At Sarigan Island corals were healthy and showed no signs of climate-induced bleaching. Upon reaching Pagan and Agrihan there were signs of a previous bleaching event in the form of dead Pocillopora and Acropora skeletons covered with algae. This is presumable from the June to July 2001 bleaching event which affected the Saipan Lagoon. Additionally, among all corals surveyed, approximately 50–70 % were bleached or stressed as shown by fluorescent colors. This is an indication that there is a bleaching event at the present time.

In summary there have been no well developed reefs found thus far, with the average coral colony size decreasing from the Southern to Northern Mariana Islands. To some extent, this may also be a result of previous bleaching events. The relative abundances of branching corals have decreased

northward as well. These findings are consistent with previous coral community work completed by Randall, 1995.

Algal highlights:

- Turf algae are the main space occupiers in the benthic community for all islands sampled (Saipan, Tinian, Sarigan, Zealandia Bank, Pagan, and Agrihan)
- Although red algae are expected to be the most diverse macroalgal group represented in tropical locations, green algae appear to be most common in terms of biomass.
- An unknown alga that is possibly a species of *Coelarthrum* was found growing under rocky overhangs at a 12.2 m depth on Agrihan. Once identification is confirmed, this would be the first record of *Coelarthrum* for the CNMI.
- Sarigan had a surprisingly low number of algal species, possibly as a result of the recent eruption of neighboring Anatahan. Much of the benthos was covered with ash-like sand that may be smothering some types of benthic organisms.
- Although too early to make definitive statements about algal diversity in the CNMI, it appears that the number of algal species commonly found during benthic surveys is decreasing as we move north through the island chain.

Site descriptions and species ranks:

Saipan – at least 26 species of macroalgae recorded (species of turf algae not included)

SAI 1 - Close to Bird Island, backreef region, 6.1 m depth, with occasional deeper sand channels. *Tricleocarpa fragilis* was extremely common in large bunches. Montipora sp. common.

SAI 2b – Tank Beach, backreef slope, 9.1-13.7 m depth. *Halimeda taenicola, Chlorodesmis* sp., *Galaxaura marginata* common.

SAI 4b – Laulau Bay, by cement steps. Steep slope ranging from 3.0-18.3 m deep. We worked shallow (less than 30 ft.). Turf and crustose coralline dominant, several *Halimeda s*pp., *Tydemania expeditionis*.

Tinian – at least 23 species of macroalgae recorded (species of turf algae not included)

TIN 1 – Long Beach, backreef region, spur and groove reef formation, 10.7-16.8 m depth. *Halimeda taenicola* very common. *Acropora* sp. and *Porites* rus common corals. Lots of algal species found during random swim including *Predaea weldii, Ventricaria ventricosa*; large patches of *Chlorodesmis* sp., *Turbinaria ornata, Padina* sp., *Peyssonnelia inamoena, Portieria hornemannii*, and a globose *Caulerpa*.

TIN 2 – South Point Tinian, backreef region, spur and groove reef formation, 10.7-16.8 m depth. *Halimeda taenicola* prevalent. *Ventricaria ventricosa* was the only alga found during the random swim that was not included in our photoquadrats.

TIN 3 – Barcinas Bay, backreef region, spur and groove reef formation, 10.7-16.8 m depth. Large sand patches in grooves of reef. Branched coralline algae very common; patches of *Udotea argentea*. All algal species found during the random swim were also recorded in our photoquadrats.

Sarigan – at least 13 species of macroalgae recorded (species of turf algae not included)

SAR 1 – Southwest corner, near rockslide. Huge boulders littered the bottom, and volcanic ash from the eruption of Anatahan blanketed the benthos. The scene was reminiscent of a moonscape. There was very little coral or algal cover, although lots of fish were still present. There was a robust turf algal community under a thin layer of ash/sand. Algae collected during the random swim included: *Caulerpa serrulata, Rhipilia sinuosa, Rhipidosiphon javensis, Neomeris* sp., and a cyanophyte.

SAR 2, SAR 3 – similar backreef sites. A cover of ash over the seafloor was still prevalent, but not nearly as deep or dense as at SAR 1. Large boulders and shelves were covered with turf. Macroalgae were relatively scarce, but dense (especially *Halimeda taenicola*) in places. *Rhipilia sinuosa, Rhipidosiphon javensis, Ventricaria ventricosa, Caulerpa filicoides*, and a species of *Halimeda* with small segments (*H. opuntia*???) were also collected.

Zealandia Bank – at least six species of macroalgae recorded (species of turf algae not included)
ZEA 1, ZEA 2 – Pinnacles jutting up from at least 45.7 m. Vertical walls with little horizontal substrate. Strong currents around corners (no photoquadrats taken). Turf algae abundant, relatively little macroalgae. *Halimeda taenicola*, a species of *Halimeda* with small segments, *Ventricaria ventricosa*, and a densely filamentous, bright red blue-green were found at both sites. *Avrainvillea* (*amadelpha*?) found at ZEA 1.

Pagan – at least eight species of macroalgae recorded (species of turf algae not included)
PAG 1 – protected bay, 12.2 m. Turf algae extremely prevalent over all surfaces. A cyanophyte, a dichotomously branched coralline, and *Dicytosphaeria cavernosa* were also common in photoquadrats. *Caulerpa serrulata* and *Neomeris* sp. also occurred in photoquads. Large patches of *Asparagopsis taxiformis* and a species of *Halimeda* with small segments were found during the random swim.

Agrihan – at least 15 species of macroalgae recorded (species of turf algae not included)
AGR 1 – Southeast corner, 10.7-13.7 m depth, very surgy. Spur and groove reef formation with sand channels. A tiny, pinnate species of *Caulerpa* (possibly *Caulerpella*?) grew in large patches among the turf community. *Coelarthrum* sp. attached to underside of overhanging rocks. Large patches of *Asparagopsis taxiformis* occurred sporadically. Other algal species observed included: *Ventricaria ventricosa*, *Caulerpa peltata*, *Neomeris* sp., and a species of *Halimeda*.
AGR 2 – South point of island, 10.7-13.7 m depth; no current or surge. Reef with large sand patches. Macroalgae scarce, although a dense turf community grew over all hard surfaces. *Rhipidosiphon javensis* was common growing under overhangs. *Neomeris* sp. and *Ventricaria ventricosa* were also found.
AGR 3 – Sandy area with small patches of reef, 10.7-13.7 m depth; strong (2 knot) current, southwest side of island. Species of *Padina, Dictyota*, and *Neomeris* were common. *Halimeda taenicola, Dictyosphaeria cavernosa, Ventricaria ventricosa*, and *Rhipidosiphon javensis* were found during the random swim.

Macroinvertebrates

SAI-1

High surface relief, *Montipora*-dominated. The holothuroid *Stichopus chloronotus* was abundant.

SAI-2

Reef at 9.1 m (no slope), live corals generally small. Cover was mostly bare rock with *Halimeda*. The soft coral *Cladiella* sp. was quite common.

SAI-3

Shallow site at 7.0 m. *Porites* rus plentiful, and the echinoids *Diadema savignyi* and *Echinostrephus aciculatus* were very abundant.

TIN-1

Eastern/windward side. Spur-groove formations, corals mostly small, benthic substrate was mostly rock and *Halimeda*. The sponge *Dysidea granulosa* was very common. Note presence of crinoids.

TIN-2

Southwest side, reef slope wall. Small corals. Crinoids not uncommon.

TIN-3

Reef dominated by *Porites* rus. In general the invertebrate fauna did not appear to be very diverse. Cyanobacterial mats (rust-colored or green) very common. The *Linckia laevigata* (seastar) that I

saw was a bright royal blue color (like in the Philippines), not the dull blue-olive-brownish color that's more common in this region.

SAR-1

Volcanic island. This site was very near a rockfall, hence large boulders were all over the sea floor, with a fine grey sand/ash carpeting the bottom. Sponges were very abundant — a lemon-yellow boring sponge was quite common, so was a black volcano-like sponge. The asteroid *Linckia multifora* (and to a lesser extent the giant clam Tridacna maxima) was exceedingly common.

SAR-2

Rocky with small corals, narrow valleys of grey sand/ash in between the rock walls. A lot of sponges carpeting the rocks. Medium-sized *Porites* heads common, which explains the abundance of the coral hermit crab *Pagurita kroppi* and the Christmas-tree worm *Spirobranchus giganteus*.

SAR-3

Also had some large boulders, but not as much as SAR-1. More like a typical reef, with small coral recruits on the rocks. The sea urchin *Echinostrephus aciculatus* was superabundant.

ZEA-1

Zealandia is comprised of a couple of rock pinnacles that rise abruptly from a 36.8 m sea floor. Strong surge and many large fish. Invertebrate fauna not so diverse, although sponges thickly carpet the rocks. A transect survey was not done at this site as a result of unfavorable water conditions. Commonly observed species: a pale-yellow sponge with large oscula, the black volcano sponge, the plume-like hydroid *Gymangium* sp. The seastar *Linckia multifora* is not only very common but is also very large, bigger than I've ever seen them before.

ZEA-2

Second pinnacle very similar to first, though there is less fish at this site. But the invertebrate fauna is about the same as in the previous site.

Preliminary invertebrate species list for the first 12 sites surveyed in the CNMI:

	SAI-1	SAI-2	SAI-3	TIN-1	TIN-2	TIN-3	SAR-1	SAR-2	SAR-3	ZEA-1	ZEA-2	PAG-1
PORIFERA												
Stylissa massa						+						
Dysidea granulosa		+	+	+	+	+						
Dysidea sp. 1		+	+		+			+			+	
Dysidea sp. 3					+							
Xestospongia exigua		+										
Axinella sp 1									+			
Monachora clathrata					+			+		+	+	
lemon-yellow boring sponge							+	+				
black "volcano" sponge							+	+	+	+	+	
grey-black encrusting sponge								+				
pale yellow sponge, large oscula										+	+	
CNIDARIA												
Palythoa	+	+							+			
Discosoma howesi		+										
Discosoma sp.		+										
Millepora sp.		+			+					+	+	
Cladiella sp.		+		+								
Lobophytum sp.				+				+	+			
Sarcophyton sp.	+	+		+	+	+	+	+	+			
Sinularia sp.		+	+	+	+	+		+	+			
Distichopora violacea										+		
Stylaster sp.							+			+		
Gymangium sp.	+	+					+	+		+	+	
Halopteris sp.								+				
POLYCHAETA												
Spirobranchus giganteus	+	+		+	+		+	+	+	+	+	
Protula sp.			+									
Sabella sp			+									
Terebella sp.			+									
MOLLUSKS												
Astralium sp.	+	+		+		+						
Trochus niloticus	+		+			+						
Tectus pyramis					+						+	

	SAI-1	SAI-2	SAI-3	TIN-1	TIN-2	TIN-3	SAR-1	SAR-2	SAR-3	ZEA-1	ZEA-2	PAG-1
Dendropoma maxima	+	+		+			+	+	+			
Coralliophila violacea				+	+			+				
Drupa sp		+	+									
Conus sp						+						
Cypraea moneta							+					
Drupa ricina									+			
Tridacna maxima	+	+	+	+	+		+	+	+			+
Thuridilla bayeri		+	+									
Hexabranchus sanguineus		+										
Phyllidia pustulosa			+									
Octopus sp							+					+
CRUSTACEA												
Paguritta kroppi	+		+			+	+	+	+			
Dardanus lagopodes			+									
Calcinus areolatus		+										
Calcinus lineapropodus		+						+				
Calcinus guahan	+											
Trapezia sp.		+										
Ciliopagurus strigatus		+										
Panulirus albimarginata	+											
ECHINOIDEA												
Echinostrephus aciculatus	+	+	+	+	+	+	+	+	+			+
Echinostrephus molari												+
Diadema savignyi			+			+	+	+	+			+
Echinothrix calamaris		+	+				+		+	+		+
Echinothrix diadema	+	+	+	+	+			+		+		
Echinometra mathaei	+	+			+	+	+	+	+			+
Echinometra sp. A						+						
CRINOIDEA												
Crinoid sp. 1				+								
Crinoid sp. 2				+								
Crinoid sp. 3				+								
Crinoid sp. 3					+							
Criniod sp. 4					+							
Crinoid sp. 5					+							

	SAI-1	SAI-2	SAI-3	TIN-1	TIN-2	TIN-3	SAR-1	SAR-2	SAR-3	ZEA-1	ZEA-2	PAG-1
ASTEROIDEA												
Acanthaster planci	+		+									
Linckia laevigata				+	+					+		+
Linckia multifora	+		+		+		+	+		+		+
Culcita novaguineae			+									
HOLOTHUROIDEA												
Actinopyga mauritiana								+				
Holothuria atra	+	+		+								
Holothuria whitmaei												+
Holothuria edulis			+									
Pearsonothuria graeffei					+							
Stichopus chloronotus	+	+	+		+							+
ASCIDIACEA												
Polycarpa cryptocarpa								+				

August 29 – September 6, 2003

The Benthic team has completed 22 surveys since Progress Report 1. Highlights from these surveys are provided below.

Stingray Shoals

- This bank consisted of a surprisingly well-developed reef despite having only 17 species of coral encountered in REA.
- The coral *Montipora angulata* was surveyed for the first time in the NMI. This species was previously reported only in the tropical Pacific region and possibly Okinawa.
- Dominant corals at the site included *Pocillopora* spp. and "massive" types of *Porites*.
- Algal diversity was surprisingly low, with both sites (STI-1 and STI-2) visited dominated by only one species of red algae.
- Fishing-related debris provided evidence of some human impacts.

Uracas

- Very steep, sloping, boulder habitat surrounds the island, providing little habitat for corals (only 29 species found on REA).
- The reef was most developed on the southwest side (leeward), similar to other steep volcanic islands.
- Dominant corals included small encrusting colonies of *Pavona varians, Leptastrea purpurea*, and *Montastrea curta*.
- Algal diversity was relatively low (13+ species of macroalgae), probably because of the relatively undeveloped nature of the reef systems. Large boulders covered with turf algae, and large patches of black sand characterized most sites.
- Large bivalves, cemented to the volcanic boulders, were very common. The grapsid crab *Percnon* sp. was also abundant in this habitat.

Supply Reef

- Rough conditions limited the team to only one dive, resulting in only 12 species of coral found.
- Notably, three species of *Acropora* were collected, more than on any other bank or shoal surveyed thus far.
- A brown blade-like alga called *Lobophora variegata* commonly grew in between fingers of coral.

Maug

- This island possessed the most developed reefs encountered in the NMI so far, with 73 species of coral found in REA surveys.
- The most diverse reefs were found on the southwest, leeward side of the three-island group.
- The extent and diversity of habitats found on Maug, including a unique pinnacle in the center of the lagoon, are probably important factors leading to the high diversity and development found within coral communities.
- The submerged, sheltered interior of the volcanic crater contains a unique habitat where *Goniastrea edwardsi* dominates the edge of the steep walls and provides framework for other corals and invertebrates.
- Vents that released warm (37.8ºC +) water and gas bubbles were prevalent at a site located inside the crater on the northern end of the east island. A layer of yellow silt, clinging to everything, also characterized the site. Algal cover was extraordinarily dense around the vents, with several species of green and brown algae growing luxuriantly. Algal density of this magnitude was not observed anywhere else in the NMI.
- This inner lagoon also supports a more diverse and abundant invertebrate fauna than any other island or shoal surveyed thus far. Holothurians (sea cucumbers) were notably abundant, and rocky areas near shore yielded an abundance of cryptofauna (flatworms, polychaete worms, ascidians, etc.).

- Giant clams (*Tridacna maxima*) were large and quite abundant, particularly on the inside of the north island, indicating low fishing pressure on this particular resource.

Asuncion

- Most of the island consists of steep, sloping, boulder habitats providing little habitat for coral community development.
- There are some well-developed reefs on the south/southwestern side at which 66 species of coral were found.
- The high number of coral species found on Asuncion may be due to these leeward habitats and the proximity of the island to Maug, which may be a source of larvae.
- Well-developed reef systems supported a high number of macroalgal species. As with many other islands visited in the NMI, green algae were far more common than other algal evolutionary lineages. An encrusting form of *Lobophora variegata* (as opposed to the fan shaped form found at Supply Reef) was common on rocks at all sites visited.
- Soft corals were abundant at the site located on the northwest side of the island.
- Large octopuses were notably common at the southwestern site.

Agrihan

- Some well-developed reefs on the south/southwestern leeward side at which 57 species of coral were found.
- A boulder/rubble dominated site also surveyed on which only 16 species were found.
- *Halimeda*, a green, sediment producing alga that is abundant in most tropical ecosystems was relatively scarce, only being reported from two of our six sites. Individuals of *Halimeda* that were observed were generally tiny in stature, indicating that most sediment in this region must be produced from coral or geologic activity.

September 6–13, 2003

The Benthic team completed 17 surveys since September 6, 2003. Highlights from these surveys are provided below.

Pagan (9/7-8/03; 9/13/03)

- In general, the reefs around Pagan Island are not well developed, with approximately 40–60 species of coral found. This may be as a result of frequent storms stirring up silt in the many sand and boulder flats around the island creating turbid environments not conducive to coral recruitment and growth.
- One exception to this was a single site on the southwest side of the island where 78 species of coral were found.
- One interesting observation is that Pagan seems to be the line where bleaching of corals beyond 50% occurs. All islands north have 50% or greater bleaching recorded at REA sites, and all islands south have 50% or less recorded.
- *Tdyemania expeditionis*, a calcified green alga, is normally reported growing in shallow (<9.1 m) tropical regions. However, we found it to be common at 18-30-m depths on the west side of Pagan.
- Several types of gorgonians (*Acabaria* sp.) and black coral were also seen during the deep REA on the west side of the island.
- Soft corals were abundant in sites on the north coast and the southeast and southwest coasts.

Anatahan (9/10/03)

- The recent eruption sent fine, particulate ash over much of the nearshore environment, which is easily stirred up and results in very low (0.5–2 m) visibility around much of the island.

- As a result only 10–15 species of corals were found at most sites, with one site on the southwest side of the island containing 44 species. There is evidence of a well developed reef previously existing based upon a nice diversity of recently dead coral skeletons observed at all REA sites.
- The southwest side had a high abundance of coral-dwelling commensals, such as the Christmas tree worm *Spirobranchus giganteus*.
- Sites on the north side of the island were covered in deep ash, and visibility in the water column was reduced to less than a meter. Only two species of green algae were found growing on emergent rocks.

Guguan (9/11/03)

- Despite the small size of the island, 50–66 species of coral were found around the island.
- The reefs along the northeast side were well developed with larger coral colonies found, and many recruits of the branching corals *Acropora* and *Pocillopora* spp.
- *Portieria hornemannii*, a feathery red alga, has been found occasionally in the CNMI, but in very low numbers. However, populations of this alga on the east side of Guguan were high, with large tufts commonly scattered over the reef system.
- On the northwest side of the island, the "coral killer" sponge *Terpios hoshinota* was very common, covering large areas of corals.
- In all the sites surveyed, sponges were the dominant invertebrates on the benthos.

Alamagan (9/12/03)

- Similar to Guguan Island, surveys around Alamagan found 56–70 species of corals and well-developed ancient reefs. Reefs on the northeast side of the island had the highest diversity and the most structure.
- There is evidence to suggest that land-based pollution along the northwest side of the island, possibly in the form of freshwater runoff, is affecting these reefs. The coral community found at this site was almost devoid of branching corals, with massive and encrusting corals dominating the reefs.
- The benthos on the northwest exposure of the island was dominated by species of the coral *Astreopora* and the green turf algae *Chlorodesmis*. Ancient, massive *Porites* coral heads were also common at this site.
- The west side of this island contained the densest beds of *Halimeda taenicola*, a calcified, sediment-producing alga, found thus far in the CNMI.
- Soft corals and stylasterids were abundant at sites ALA-1 and ALA-2.
- An unidentified grey sponge carpeted some areas of the southwest side of the island, smothering corals in a manner similar to *Terpios hoshinota*, but this was clearly a different species.

September 14–21, 2003

The Benthic team completed 15 surveys since September 13, 2003. Highlights from these surveys are provided below.

Pathfinder Bank (9/14/03)

- In general, the reefs associated with Pathfinder Bank were well developed with 44 species of coral found on 2 dives. Similar to other banks visited, the community is dominated by species of *Pocillopora*, with *Acropora* species being rare. Coral community size classes showed high abundances of large coral heads, further suggesting the community is well developed.
- The lack of diversity is attributed to the small size of the bank and the lack of protected habitats for a higher diversity of corals to grow in.
- Reefs had a rather scoured look, and most algal species were cropped short. *Halimeda taenicola*, a robust, sediment-producing green alga, was the most common plant found.
- Soft corals (*Sinularia* spp.) were also an abundant component of the benthos.

Arakane Reef *(9/15/03)*

- Similar to Pathfinder Bank, well-developed reefs were found, with communities dominated by large corals. Species of *Pocillopora* were again recorded in high abundances, *Acropora* species in very low abundances.
- The diversity was similar to pathfinder with 40 species of coral found. Notably, a unique species of *Cyphastrea* (c.f. *microphthalma*) was found to be an abundant component of the coral community, composed of colonies with a range of growth types from encrusting to columnar, found below the large *Pocillopora* coral heads.
- Arakane Reef was the northernmost island/bank where *Microdictyon okamurai*, a common green algal genus in tropical waters, was found in abundance.
- Large gastropods were strikingly abundant, particularly the turban shell *Turbo argyrostomus*, the top shell *Tectus pyramis*, and the spider conch *Lambis lambis*.
- Similar to Pathfinder Bank, soft corals (*Sinularia* spp.) were an abundant component of the benthos.

Aguijan *(9/17/03)*

- Aguijan held the highest diversity of all reefs surveyed thus far, with 82 species of coral found in a single dive. Communities were healthy and dominated by large colonies of species of *Pocillopora* and *Acropora*.
- The reefs just off the northwest coast of the island had the best development and were largest in size.
- Algal species composition was similar to the island of Tinian, the major island north of Aguijan.

Anatahan *(9/18/03)*

- We were fortunate to have a second chance to survey these reefs with better oceanographic conditions. As a result, we discovered that the eruption might not have significantly affected all of Anatahan's reefs.
- A range of coral diversity, with as many as 68 species and as few as 22 species, was found depending on location of survey. We have established study sites on reefs that were not strongly affected from the eruption, and a reef that was heavily impacted.
- Visibility in the water column had greatly improved during our second visit to this island, and reef surveys were easier to conduct. Reefs on the southeastern corner of the island fared better than other places following the eruption. Turf algae were present beneath a veneer of ash, whereas most other sites exhibited essentially no algal growth.
- The seastar *Linckia multifora* and the echinoid *Echinostrephus aciculatus* were by far the dominant invertebrates on the benthos.

Rota *(9/19-20/03)*

- Reefs in Rota were previously surveyed extensively and the present surveys helped to fill in a few gaps. Surveys showed poorly developed reefs on the north/northeast exposure where the currents and sea conditions are usually substantial. Reefs along the northwest and southwest are more developed with previous surveys finding over 85 species of coral (based upon more than 5 dives per site).
- Crown-of-thorns (COT) starfish (*Acanthaster planci*) were observed around the entire island in moderate numbers. In general, these starfish were found preying upon *Pocillopora*, *Acropora*, *Astreopora*, and *Montipora* corals. The analysis of video surveys will help to quantify any significant effects.
- Dense algal beds covered most of the substrate around the island not occupied by corals. Algal diversity was far greater than on islands to the north, with over 46 species recorded during initial, cursory surveys.
- Holothurians appeared to be more abundant and diverse than in the northern islands. Notably, the edible beche-de-mer *Holothuria whitmaei* (formerly named *Holothuria nobilis*) was common both inside the marine protected area at survey site ROT-3 and at survey site ROT-6.

September 23–29, 2003

The Benthic team has completed 11 surveys since September 23, 2003. Highlights from these surveys are provided below.

Guam (9/23/03–9/26/03)

- Reefs in Guam were previously surveyed extensively and approximately 400 species of corals were recorded here. However, the present surveys helped to fill in a few gaps and will provide long-term monitoring sites in some key locations. Sixty-five species of corals were recorded in the nine surveys completed around Guam on this trip. The lowest coral cover was seen at GUA-1, adjacent to the Orote Point Landfill. This site was used as a dumping area for a large amount of metallic debris post World War II. The debris was only removed from the reef about 2 years ago. The U.S. Navy is also monitoring the site because of elevated levels of PCBs found in certain taxa. Coral cover and diversity were both high at sites surveyed on the north and northeast exposures. These sites are less likely to be impacted by land-based sources of pollution because of low human population densities and the geology of the island.
- Reefs around Guam are better developed and richer in algal species than northern islands in the Mariana Archipelago.
- Approximately 50 species of macroalgae were tentatively identified from the nine sites visited and will probably increase to over 100 species once epiphytes and turf algae are examined microscopically.
- Algal species composition suggests a more tropical marine climate than northern islands, with species such as *Caulerpa racemosa, Halimeda distorta, H. gigas, H. micronesica, Gibsmithia hawaiiensis*, and an unidentified species of *Wrangelia* being collected for the first time during our expedition.
- Approximately 70 macroinvertebrate taxa were identified at nine survey sites. Microinvertebrate collections were made at most sites; these will need further processing but it is estimated these will yield an invertebrate checklist of approximately 300-350 species. Considering the restricted methodology, time, location, depth and habitat types surveyed, this checklist is consistent with what is already known about the island's invertebrate fauna.
- Macroinvertebrates, specifically echinoderms, were less diverse and abundant than expected at most sites. Relatively few urchins were observed other than *Echinostrephus aciculatus*, which was common at most sites. Sea cucumbers were often rare or absent at many sites. Tumon Bay (GUA-4) was an exception; echinoderm diversity was highest at this site. Other than *Linkia multifera*, which was ubiquitous, other sea stars were rare.
- Sponges and ascidians were common at all sites and comprised a significant percentage of the benthic community. More taxonomic work needs to be done with these groups.
- *Tridacna maxima* was observed at many dive sites. At all sites, individuals were predominately small (<12 cm). At less accessible sites, such as near Ritidian (GUA-9) and off Pati Pt. (GUA-7), some larger *Tridacna* were observed, approximately 20 cm, but these sizes are well below the maximum attainable by this species (~40 cm).
- Crown-of-thorns sea stars (*Acanthaster planci*) were observed at only one site, Tumon Bay (GUA-4). This is interesting considering that reports on the island suggest that an increase in COTs has been observed since Typhoon Pongsoña. Most reports have come from the west coast, however, from Apra Harbor north to Tumon Bay. Only Tumon Bay (GUA-4) was sampled in this range and the reported increases may be restricted to this area of the island. (The tow teams may have more data on this.)

Santa Rosa Bank (9/28/03)

- Coral cover and diversity were lower at Santa Rosa Bank than at other sites surveyed around Guam, with only 35 species of coral recorded during 2 dives. Faviids, pocilloporids, and the coral *Platygyra pini* were predominant.
- Algal biomass at Santa Rosa was dense compared to similar Guam habitats, possibly because of low numbers of herbivorous fish.
- At least 20 species of macroalgae were tentatively identified from just 2 dives.
- Three species of *Tridacna* were found at Santa Rosa Bank: *T. maxima, T. squamosa, and T. derasa*. *T. derasa* is not considered native to Guam (it was intentionally introduced), and the origin of the population on Santa Rosa Bank is unclear. Is this a native population or an extension of the Guam population that was not believed to have successfully reproduced after its introduction?

Appendix E: **Towed Diver Team Activity Report** (*Rusty Brainard, Molly Timmers, Brian Zgliczynski, Joe Laughlin, and Stephani Holzwarth*)

August 22–28, August, 2003

Thirty towed-diver habitat and fish surveys were conducted at Saipan, Tinian, Sarigan, Pagan, and Agrihan (six at each island). Each towed-diver survey covered about 2 km of benthic habitat. The habitat towboard has a downward-looking high resolution digital camera with dual strobes which takes photos every 15 s. The fish towboard has a forward-looking video camera for continuously recording fish distributions and habitat complexity. GPS positions, high resolution temperature, and depth are recorded every 5 s. No towed-diver surveys were conducted at Zealandia Bank because of the extremely limited spatial extent of shallow habitat. At Zealandia, the towboard team conducted acoustic bathymetric surveys of the areas surrounding the two exposed pinnacles. Towed-diver habitat/fish surveys were conducted from the north to the southeast side of Saipan and from the east to the southwest side of Tinian. Towed-diver habitat/fish surveys were conducted around the entire perimeter of Sarigan Island. Half of the shoreline of Agrihan was surveyed from northeast to the southwest. About 1/3 of the coastline at Pagan was surveyed from east to the northwest. Remaining portions of Agrihan and Pagan are expected to be surveyed when the ship returns later on the cruise.

Benthic Observations: (Molly Timmers and Rusty Brainard)

Saipan

Along the north and northeast shore we observed the dominant habitat to be continuous reef. As we towed the east side, the dominant habitat consisted of rock boulders and pavement. Along the southeast shore in LauLau Bay, the dominant habitats changed to continuous reef and spur and groove. For the six towed-diver habitat surveys, ~4.5% of the coral habitat appeared pale and ~4.9% appeared white. During one 5-minute interval along a tow on the east shore, 38 COTs were observed with associated coral damage. A total of 50 COTs and 11 giant clams (GC) were observed during 6 towed-diver surveys.

Tinian

Along the east shore we observed the dominant habitats to be pavement and spur and groove. Approximately 2% of the coral habitat appeared white and about 5% appeared pale. Along the south shore, pavement and spur and groove were observed. In addition, we observed patch reef outside of Tinian harbor. Outside of the harbor we observed eight man-made metal objects in addition to an area dominated by fire coral. A total of 18 COTs and 15 giant clams were observed.

Sarigan

Along the east and south shore, the dominant habitat consisted of rock boulders with an occasional area of continuous reef containing approximately 50% live coral. As we progressed along the west shore, the dominant habitat changed to pavement and approximately 5% of the coral habitat appeared pale. Along the north shore, the dominant habitat consisted of rock boulders, pavement, and occasional spur and groove sections. A field of whip coral was observed along the northwest shore. Black sand was the predominant sand type. Some areas had high abundance of octocorals. A total of 2 COTs and 38 giant clams were observed.

Pagan

Along the east shore, the dominant habitats were pavement and rock boulders. Along the north shore we observed the dominant habitat to be pavement. Black sand was the predominant sand type. A total of 3 COTs and 37 giant clams were observed. Averaged over the six habitat surveys, 30.9% of the coral appeared pale and 3.4% appeared white. Live coral cover in some areas was predominantly octocorals. This represents a huge change from the conditions of the coral at the more southerly islands surveyed (Sarigan, Tinian, and Saipan).

Agrihan

Along the east shore, the dominant habitat observed consisted of rock boulders and pavement. Along the south shore the dominant habitat consisted of continuous reef, pavement, and sand flats. We witnessed an increase in soft coral presence in the coral habitat along the south shore. Along the southwest shore we observed the dominant habitat to consist of sand flats. Black sand was the predominant sand type. Some areas had high abundances of octocorals. A total of 20 giant clams and no COTs were observed. Averaged over the six towed-diver surveys, 24% of the coral appeared pale and 3.2% appeared white, similar to what was observed at Pagan. These results suggest that a mild to moderate coral bleaching event may have been occurring in the Northern Islands at the time of our surveys, possibly as a result of anomalously warm temperatures.

Fish Observations: (Brian Zgliczynski, Joe Laughlin, and Stephani Holzwarth)

After completing 5 days of towed-diver fish surveys the most noteworthy observations were sightings of a 120-cm total length (TL) Bumphead Parrotfish (*Bolbometopon muricatum*) at Pagan Island and a 100-cm TL Humphead Wrasse (*Cheilinus undulatus*) at Sarigan Island. Both the Bumphead Parrotfish and Napolean Wrasse are highly prized foodfishes throughout the Indo-Pacific and are therefore rarely encountered. Initial observations and preliminary data from the surveys show that the Twinspot Snapper (*Lutjanus bohar*) and the Black Snapper (*Macolor niger*) were the most common fishes greater than 50-cm TL observed. Both are common throughout the Indo-Pacific and *L. bohar* is considered one of the most ciguatoxic coral reef fishes. Thus far, 42 turtles were observed during the 5 days of surveys. Finally, it was noted that the numbers of fishes greater than 50-cm TL steadily increased as surveys have moved northward away from the more populated Southern Islands.

August 29–September 6, 2003

Thirty towed-diver habitat and fish surveys were conducted at Stingray Shoals (4), Uracas Island (8), Supply Reef (1 partial), Maug (16), Asuncion (6), and Agrihan (6). Each towed-diver survey covered about 2 km of benthic habitat. The habitat towboard has a downward-looking high resolution digital camera with synchronized strobes programmed to take photos every 15 s. The fish towboard has a forward-looking video camera for continuously recording fish distributions and habitat complexity. GPS positions, high resolution temperature, and depth are recorded every 5 s.

Benthic Observations: (Molly Timmers and Rusty Brainard)

Stingray Shoals:

Four towed-diver surveys were conducted over the small summit (~300 m x 500 m) of Stingray Shoals. Continuous reef was the dominant habitat observed. While live coral cover was uniformly high for the entire summit, coral bleaching was common with 73% of the coral appearing pale and 11.1% appearing white. Four fishing nets and four man-made metal objects were observed. Only one giant clam and no COTs were observed.

Uracas:

Eight towed-diver habitat surveys were conducted around Uracas. These surveys completely circled the island at two depths. The dominant habitat observed around the entire island consisted of rock boulders. Averaged over the eight towed-diver habitat surveys, 63.4% of the coral appeared pale and 20.2% appeared white, again suggesting high levels of mild coral bleaching . Only three giant clams were recorded.

Maug:

Sixteen towed-diver habitat surveys were conducted around the three primary islands of Maug. Two or three surveys were conducted at different depths for each of the forereef slopes of the seaward sides of each island. One tow was conducted along the steep inside slopes of each island. The dominant habitats observed going north to east during the outside tow of East Island were continuous reef and spur and groove. Along the outside tow from east to west of the same island, the dominant habitats observed consisted of pavement and continuous reef. Both inside tows conducted along the east shore of East Island observed rock

boulders as the dominant habitat. The dominant habitat along the west shore of East Island was continuous reef. The outside and inside tow conducted along the north shore of North Island observed the dominant habitat to be continuous reef. The dominant habitats observed along the south shore of North Island were continuous reef and bedrock. Along the west shore of the West Island, the outside track observed the dominant habitat to be continuous reef, the middle track observed spur and groove, and the inside track observed rock boulders as the dominant habitat. The outside tow along the southwest shore observed spur and groove as the dominant habitat and the inside track observed rock boulders as the main habitat. The southeast tow observed both continuous reef and bedrock as the dominant habitats. The dominant habitat observed along the east shore of West Island was continuous reef. Averaged over the 16 towed-diver habitat surveys, 26.2% of the coral appeared pale and 5.6% appeared white. Live coral cover along the northwest shore of North Island was predominantly octocorals. Six fishing nets and three lobster traps were observed. We observed 4 COTs and over 1500 giant clams.

Asuncion:

Six towed-diver habitat surveys circumnavigated Asuncion Island at a single depth. Along the north shore, the dominant habitats were observed to be pavement and rock boulders. Along the east shore the dominant habitat observed consisted of rock boulders and sand. Along the south shore, the prevalent habitat was rock boulders. Along the west shore, we observed sections of continuous reef within a dominant pavement and rock boulder habitat. Averaged over the six towed-diver surveys, 25.6% of the coral appeared pale and 10% appeared white. A total of 69 giant clams were recorded.

Fish Observations: (Brian Zgliczynski, Joe Laughlin, and Stephani Holzwarth)

In 8 days of field work, a total of 35 towed-diver surveys were conducted at Stingray Shoals, Supply Reef, Uracas, Maug, and Asuncion. The most notable observations during the towed-diver surveys were three sightings of Giant Groupers (*Epinephelus lanceolatus*) with each being greater than 120 cm TL. Gray Reef sharks (*Carcharhinus amblyrhynchos*) were the most common shark observed at all of the islands. The oceanic bank, Stingray Shoals had the most sharks, with 94 sharks sighted. A dominant feature of the Gray Reef Shark was that most of the sharks were of immature length (less than 100 cm TL). The average size at birth for this species of shark is 60 cm TL and the average size at maturation is 140 cm TL. The benthic feeding sharks, Nurse (*Nebrius feruguineus*) and White Tip Reef sharks were noticeably larger with many over 150 cm TL. With over 530 sightings in 35 tows, the Twinspot Snapper (*Lutjanus bohar*) was the most commonly observed fish over 50 cm TL. Snappers of the genus Macolor (*M. macularis* and *M. niger*) were also commonly observed during the surveys. No observations of the Bumphead Parrotfish (*Bolbometopon muricatum*) or Humphead Wrasse (*Cheilinus undulatus*) were made at any of the remote northern islands.

September 6–13, 2003

Benthic Observations: (Molly Timmers and Rusty Brainard)

Agrihan Island:

A total of 12 towed-diver habitat/fish surveys were conducted around the entire perimeter of the Agrihan Island. The dominant habitat along the east shore consisted of rock boulders. Along the north shore, carbonate pavement was the dominant habitat. Along the west shore, the dominant habitat was observed to be carbonate pavement and rock boulders. The dominant habitats along the south shore were carbonate pavement, sand flats, and continuous reefs. Averaged over the 12 towed-diver surveys, 21.9% of the coral appeared pale and 5.5% appeared white, consistent with the pattern of coral bleaching for each of the Northern Islands. A total of 49 giant clams (*Tridacna sp*.) were observed.

Pagan Island:

A total of 21 towed-diver habitat/fish surveys were conducted around the entire perimeter of Pagan. The north shore benthic habitat consisted predominantly of carbonate pavement. The dominant habitats found in the northwest were rock boulders and carbonate pavement. The dominant habitat observed along the west shore was sand and carbonate pavement. Carbonate pavement was the dominant habitat observed

along both the southwest and southeast shores with occasional areas of continuous reef. Spur and groove habitats dominated the south shore and carbonate pavement and rock boulder habitats dominated the east shore. Averaged over the 21 towed-diver habitat surveys, 21.6 % of the coral appeared pale and 4.6% appeared white indicating ongoing moderate bleaching observed at each of the Northern Islands. Over 5000 urchins were observed along the west to southwest quadrant. Around 5000 sea cucumbers were observed along the south to southeast quadrant. A total of six COTs seastars (*Acanthaster planci*) and 98 giant clams (*Tridacna sp*.) were observed. Two shipwrecks, three anchors, an aircraft landing gear, and other man-made objects were found on the west (leeward) shore.

Anatahan Island:

Because of visibility complications from ash in the water column from the recent volcanic eruption at Anatahan, six towed-diver habitat/fish surveys were conducted only along the east and west shores. Visibility during the towed-diver surveys varied from about 0.5 m along the northeast, northwest, and west shores to 2-5 m along the southeast, east, and southwest shores. Attempts to survey the north shore were aborted as a result of even poorer visibility. The dominant habitats observed along the east shore were sand flats and rock boulders. While the rock boulders along the east shore had a veneer of fine ash cover, most of the corals appeared healthy. Along the west shore, the dominant habitats consisted of carbonate pavement, sand flats, and rock boulders. Unlike the east shore, where ash cover was thin, there appeared to be a deep layer of fine ash covering all habitats along the west shore. While the depth of this ash could not be determined, the surface appeared mostly to be a recently developed sand flat with occasional peaks from coral communities penetrating through the ash. Numerous recently dead coral skeletons were observed, as well as a few dead giant clams (*Tridacna sp*.). While not definitive, some of these areas appeared to have been well developed coral communities completely buried in ash. Interestingly, a few corals (mostly large *Porites sp*. and some soft corals) appeared to have survived the eruption and ash accumulation. Most of these surviving stony corals were partially white from the stress. Averaged over the six towed-diver surveys, 16.7% of the coral appeared pale, 22.9 appeared white, and 13.7 appeared to have recently died. A total of two giant clams (*Tridacna sp*.) were observed.

Guguan Island:

Six towed-diver habitat/fish surveys completely circumnavigated Guguan Island. Surprisingly, the reef communities around most of the island were as well developed as any seen in the Northern Islands, except Maug. Along the northeast and northwest shores, the dominant habitats consisted of carbonate pavement and rock boulders. The dominant habitats observed along the east and west shores consisted of carbonate pavement and spur and groove. The dominant habitats observed along the south shore were rock boulders and spur and groove. Averaged over the six towed-diver surveys, 14% of the coral appeared pale and 1.3% appeared white. One COTs seastar (*Acanthaster planci*) and 90 giant clams (*Tridacna sp*.) were observed. Interestingly, the exposed southeast shore had extensive areas of well developed reef communities, more so than similar shores at the other islands surveyed.

Alamagan Island:

Six towed-diver habitat/fish surveys were conducted around the perimeter of Alamagan Island. Along the northeast, northwest, southeast, and south shores, the dominant habitats observed were rock boulders and carbonate pavement. In addition, the northwest shore had sections of continuous reef. The dominant habitat along the east shore was rock boulders and along the southwest shore we observed primarily sand flats and carbonate pavement. Averaged over the six towed-diver surveys, 13.4% of the coral appeared pale and 3.4% appeared white, consistent with the other Northern Islands. Only seven giant clams (*Tridacna sp*.) and no COT seastars were observed. Interestingly, the reef communities at Alamagan appeared noticeably less developed than those observed at Guguan Island 26 km to the south.

Fish Observations: (Brian Zgliczynski, Joe Laughlin, and Stephani Holzwarth)

During this 7-day period of the cruise, a total of 33 towed-diver fish surveys were conducted at Pagan, Anatahan, Guguan, and Alamagan Islands. The most notable observations during the towed-diver

surveys were the sightings of a Giant Grouper (*Epinephelus lanceolatus*) greater than 175 cm TL at Alamagan and two sightings of >50 cm TL Napoleon Wrasse (*Cheilinus undulatus*) at Guguan and Agrihan. In total, 58 Gray Reef sharks (*Carcharhinus amblyrhynchos*), 29 Nurse sharks (*Nebrius feruguineus*), and 36 White Tip Reef sharks (*Triaenodon obesus*) were sighted during this survey period. One of the observed gray reef sharks at Alamagen was seen with a fishing hook in its mouth. At Guguan, the Bigeye jack (*Caranx sexfasciatus*) was observed in schools of 30 to 60 fish of various sizes. These fish were exhibiting potential spawning behavior with paired swimming of dark and light individuals. This behavior was also observed at Uracas and Maug with larger schools of up to 150 individuals. Limited underwater visibility at the Island of Anatahan greatly reduced the effectiveness of towed-diver fish surveys thus yielding exceptionally low abundance of fishes over 50 cm TL. With over 276 sightings in 33 tows, the Twinspot Snapper (*Lutjanus bohar*) was the most commonly observed fish over 50 cm TL. Snappers of the genus Macolor (*M. macularis and M. niger*), were also commonly observed with 193 individuals sighted during the surveys. No observations of the Bumphead Parrotfish (*Bolbometopon muricatum*) were made during this survey period. The only observation of the Bumphead Parrotfish during the entire survey thus far was made at Pagan on the 26th of August.

September 14–21, 2003

During the period of September 14-20, 34 additional towed-diver habitat/fish surveys were conducted at Pathfinder Bank (4), Arakane Reef (6), Tatsumi Reef (2), Aguijan Island (4), Anatahan Island (6), and Rota Island (12) bringing the total for the CNMI portion of the cruise to 138. In total, towed-diver habitat/fish surveys were conducted around the perimeters of each of the 13 islands of CNMI visited (all except Farallon de Medinilla because of military prohibitions) and across 8 of the oceanic banks and reefs of CNMI. The towed-diver habitat surveys provide an important bridge between the outstanding spatial coverage, but limited resolution (4 m by 4 m resolution pixels) of IKONOS satellite imagery and the outstanding species identification and characterization, but limited spatial coverage, provided during the benthic REA surveys. Likewise, the towed-diver fish surveys greatly expand the spatial coverage of surveys for the ecological and economically important apex predator species of fishes. The following summarizes the towed-diver surveys during the period of September 14-20.

Benthic Observations: (Molly Timmers and Rusty Brainard)

Pathfinder:

Surprisingly, spur and groove was the dominant habitat observed, presumably as a result of significant wave energy at this exposed open ocean bank. Averaged over the four towed-diver surveys over the summit area, 2% of the coral appeared pale and 1.3% appeared white. Compared with others areas surveyed, this indicates a substantially reduced stress of coral bleaching. Soft corals (*Sinularia sp.*) appeared to be one of the dominant corals. Sixty-two giant clams (*Tridacna sp*.) and over 10,000 urchins were observed. Four man-made objects (moorings, anchors, line) were indicative of previous moorings and fishing acitivities.

Arakane:

The dominant habitats observed at Arakane Reef consisted of both carbonate pavement and spur and groove. Even more so than at Pathfinder, soft corals (*Sinularia sp.*) were common over the summit, particularly around the edges. Averaged over the six towed-diver surveys, only 1.4% of the coral appeared pale and .2% appeared white, again indicating that these oceanic banks were not being subjected to the same stressors at the more northerly islands or banks. Ninety-six giant clams (*Tridacna sp*.), over 10,000 urchins, and no COT seastars (*Acanthaster planci*) were observed. Like Pathfinder, there was evidence of prior mooring anchors.

Anatahan:

With improved visibility, we were able to complete towed-diver habitat surveys along the entire south shore and much of the unsurveyed (during first visit) portion of the northwest and north shores. The

dominant habitats observed along the south shore were rock boulders and sand flats. Along the north shore we observed sand flats and continuous reef. Although all surveyed locations contained a layer of ash covering the substrate, the south shore appeared to contain a veneer layer and the north shore appeared to contain a deep layer. Averaged over the six towed-diver surveys, 16.8% of the coral appeared pale, 13.7% appeared white, and 58% of the coral appeared to have died recently in response to the ash caused by the May 6th eruption of the volcano. Most of the recently dead coral was observed along a stretch along the north and northwest shore of what appeared to have been extensive continuous reef prior to the eruption. Six giant clams (*Tridacna sp*.) were observed.

Tatsumi Reef:

The dominant habitat observed along this bank was carbonate pavement. Averaged over the two towed-diver surveys, 11.4% of the coral appeared pale and 4% appeared white. Eleven COT seastars (*Acanthaster planci)* and eight giant clams (*Tridacna sp*.) were observed.

Aguijan:

Along the northeast shore to the south shore, the two dominant habitats observed were carbonate pavement and rock boulders. Continuous reef was observed along the west shore. Averaged over the four towed-diver surveys, 7.4% of the coral appeared pale, 3.6% appeared white, and .5% had recently died. Sixty-three giant clams (*Tridacna sp*.) and 57 COT seastars (*Acanthaster planci)* were observed (31 during one 5-minute section along the west shore). Numerous ordinances were observed between Naftan Rock and Aguijan, apparently they were remains from the former use of this area as a bombing range.

Rota:

The dominant habitat observed on all shores was carbonate pavement. Continuous reef was observed inside Sasanjaya Bay and an area along the west shore. Averaged over the 12 towed-diver surveys, 14.3% of the coral appeared pale and 4.3% appeared white. In this case, the majority of the white corals appeared to have suffered damage by a relatively large abundance of COT seastars (*Acanthaster planci*). Of the total of 225 COTS observed, the highest densities appeared to be at the west and southwest shores, where 40–59 were observed per tow. Interestingly, a total of 76 octopuses were observed, with highest densities along the southeast shore. Seventy giant clams (*Tridacna sp*.) were observed. Densities of both COT seastars and octopuses observed during the tows were the highest for the cruise (for octopus, these were the highest densities observed by CRED towed-diver surveys). Several patches of fire coral and a field of whip coral were observed along the southwest tip of the island. Evidences of three shipwrecks were observed in Sasanjaya Bay.

Fish Observations: (Brian Zgliczynski, Joe Laughlin, and Stephani Holzwarth)

In 7 days of fieldwork, a total of 34 towed-diver surveys were conducted at the Islands of Anatahan, Aguijan, and Rota and the oceanic banks of Tatsumi Reef, Arakane Reef, and Pathfinder Bank. The most notable observations during the towed-diver surveys were multiple sightings of the Napoleon Wrasse (*Cheilinus undulatus*) at the Island of Rota and the oceanic banks Tatsumi and Arakane. Fifteen of these large wrasses were seen at Rota, 5 at Tatsumi, and 3 at Arakane making a total of 23 sightings during this survey period. The Bumphead Parrotfish (*Bolbometopon muricatum*), over 100 cm TL, was observed at Rota Island. This was the second sighting of the Bumphead Parrotfish at any of the islands or banks surveyed during the first leg of this cruise.

The second attempt to survey the island of Anatahan yielded much better underwater visibility, making towed-diver surveys effective. Initial results of surveys at Anatahan showed low densities of fishes over 50 cm TL. These results provide data to be used as a baseline for future surveys.

In general, this survey period yielded noticeably less observations of sharks with a total of 9 Gray Reef sharks (*Carcharhinus amblyrhynchos*), 1 Nurse shark (*Nebrius feruguineus*), and 19 White Tip Reef sharks (*Triaenodon obesus*). With only 112 sightings in 34 tows compared to 273 sightings in 33 tows last survey period, the Twinspot Snapper (*Lutjanus bohar*) was not the most commonly observed fish over 50 cm TL. Snappers of the genus Macolor (*M. macularis* and *M. niger*), were also observed less frequently during

this survey period with only 12 individuals sighted. At Rota several species of Parrotfishes were observed to be noticeably larger and in higher densities than any of the other islands surveyed. These Parrotfishes include Steephead Parrotfish, (*Chlorurus microrhinos*), Longnose Parrotfish, (*Hipposcarus longiceps*), Filament-fin Parrotfish, (*Scarus altipinnis*), and Red Lip Parrotfish, (*Scarus rubroviolaceus*). Parrotfishes proved to be the most commonly observed fishes over 50 cm (TL) for this survey period with 120 sightings, 80 of them being at Rota.

September 23–29, 2003

During the period of September 23-29, 20 additional towed-diver habitat/fish surveys were conducted around the island of Guam (20) and Santa Rosa Reef (3), bringing the total for the cruise to 161. In total, towed-diver habitat/fish surveys were conducted around the perimeters of each of the 14 islands of the Marianas Archipelago visited (all except Farallon de Medinilla because of military prohibitions) and across 9 of the oceanic banks and reefs. The towed-diver habitat surveys provide an important bridge between the outstanding spatial coverage (but limited resolution (4 m by 4 m resolution pixels)) of IKONOS satellite imagery and the outstanding species identification and characterization (but limited spatial coverage) provided during the benthic REA surveys. Likewise, the towed-diver fish surveys greatly expand the spatial coverage of surveys for the ecological and economically important apex predator species of fishes. The following summarizes the towed-diver surveys during the period of September 23-29.

Benthic Observations: (Molly Timmers and Rusty Brainard)

Guam

The two dominant habitats surrounding the entire island were carbonate pavement and spur and groove. In the southwest quadrant, occasional sand flat habitats were also observed. In the northwest, north, and northeast continuous reef habitats were occasionally observed. With the exception of the north part of the island, turbid conditions associated with heavy persistent rains and runoff and moderately large swell conditions were observed. Along the east side, relatively high abundances of macroalgae were observed covering the carbonate pavement. Averaged over the 20 towed-diver surveys, 17.8% of the coral appeared pale and 2.7% appeared white. A total of 215 COT seastars (*Acanthaster planci)* and 30 giant clams (*Tridacna sp*.) were observed around the island. Of the COTS observations, 3 of the 20 towed-diver surveys accounted for 71% of the COTS observed with 81 along Agat Bay in the southwest, 43 in Tumon Bay, and 29 in the northwest between Haputo Pt, and Urune Pt. In most of the other areas surveyed, COTS were sparse. Coral diversity and coral cover were high in the areas of continuous reef on the northwest, north, and northeast sides.

Santa Rosa Reef

The dominant habitats observed over this oceanic bank were both carbonate pavement and spur and groove. Averaged over the three towed-diver surveys, 56.8% of the coral appeared pale and 2.3% appeared white. Twelve giant clams (*Tridacna sp*.) were observed. Most of the dominant spur and groove habitat appeared in depths less than about 15-18 m while areas deeper than this were primarily carbonate pavement and rubble.

Fish Observations: (Brian Zgliczynski, Joe Laughlin, and Stephani Holzwarth)

In the final 5 days of survey, 23 towed-diver fish surveys were conducted around Guam and Santa Rosa Bank. Although surveys were completed, visibility was low during some of the tows because of recent rain. Low visibility affects towed-diver fish surveys if visibility is less than the protocol survey distance of 10 meters. The most commonly observed fishes over 50 cm TL were parrotfishes, with 59 observations almost half of which were Filament-fin Parrotfish (*Scarus altipinis*) (n = 27). Surgeonfishes were the second most abundant family with 43 total sightings. The Humpnose Unicornfish (*Naso tuberosus*) and the Black Tongue Unicornfish (*Naso hexacanthus*) were the most common making up 38 of the total 43 sightings. During 23 towed- diver surveys, 8 sharks were observed. The only shark species sighted were Black Tip Reef Sharks (*Carcharhinus melanopterus*) (n = 3), Whitetip Reef Sharks (*Triaenodon obesus*) (n = 3), and Nurse Sharks (*Nebrius ferrugineus*) (n = 2). One notable observation was that no Gray Reef Sharks

(*Carcharhinus amblyrhynchos*) were sighted during the survey period. Our surveys also showed the absence of large snappers. The most commonly observed snappers species in the islands north of Guam, Twinspot Snapper (*Lutjanus bohar*) and Macolor snappers were not observed over 50 cm TL around Guam or Santa Rosa. The Humphead Wrasse (*Cheilinus undulatus*) was noted on two occasions over 50 cm TL. The oceanic bank of Santa Rosa Reef yielded very low counts of fishes over 50 cm TL. After completing 3 towed-diver surveys, 58 fish were recorded, 50 of which were Rainbow Runner (*Elagatis bipinnulata*). It was noted that no sharks were sited at Santa Rosa Bank.

Appendix F: **Oceanography Team Activity Report** (*Rusty Brainard, Ronald Hoeke, Stephani Holzwarth*)

August 22–28 August, 2003

The volcanic island arc/subduction zone topography and associated extremely steep slopes of the Marianas Archipelago greatly modify the oceanography of the nearshore waters of the islands. Localized upwelling and the associated nutrient enrichment of surface waters, nutrient enrichment, and seawater chemistry changes as a result of volcanic seeps and vents, freshwater inputs, and anthropogenic impacts all have poorly understood effects on the nearshore ecosystems. The effects of seasonal and climatic changes on the islands' marine ecosystems, as well as changes as a result of episodic events such typhoons and volcanic eruptions, are also poorly understood. In order to better understand the linkages between oceanography and ecology, scientists on board are taking a two pronged approach: 1) intensive assessment of oceanographic conditions at each island, simultaneous with ecological assessments, and 2) establishment of long-term oceanographic monitoring.

1. Intensive oceanographic assessments at each island are accomplished by:
    A. Continuous recording of water temperatures as a function of depth during all towing operations, providing a nearly synoptic picture of temperature structure over reef environments,
    B. Shallow water conductivity-temperature-depth (CTDs), including turbidity and chlorophyll measurements, at regular intervals around the islands, which provide indications of water masses and local seawater chemistry changes.
    C. Deep water CTDs and acoustic Doppler current profiler (ADCP) transects around the islands, which provide information on overall oceanographic structure, including dissolved oxygen and chlorophyll, and circulation patterns surrounding the islands.
2. Long-term oceanographic monitoring will be accomplished by deploying a variety of both internally recording and near real-time telemetered instrument platforms and oceanic drifters. These instruments include:
    A. Coral Reef Early Warning System (CREWS) Buoys: Surface buoys measuring the primary meteorological and oceanographic parameters, as well as solar irradiance measurements. These buoys telemeter their data in near real-time.
    B. Sea Surface Temperature (SST) Buoys: Surface buoys measuring high resolution water temperature. These buoys telemeter their data in near real time.
    C. Wave and Tide Recorders (WTRs) measure subsurface temperatures, spectral wave energy, and high precision tidal elevation.
    D. Ocean Data Platforms (ODPs) measure subsurface temperature and salinity, current profiles, directional spectral wave energy, and high precision tides.
    E. Subsurface Temperature Recorders (STRs) measure high resolution subsurface temperatures.
    F. Satellite Drifters, Lagrangian devices providing surface layer circulation information and water temperatures. The drifters telemeter their data in near real time.

Although very preliminary, a number of generalizations have surfaced from the data already collected. All measured surface water temperatures are 0.5 to 0.8 ˚C degrees warmer than NOAA's Pathfinder SST Monthly Climatology for the region. These anomalously warm temperatures are believed to be one of the possible stressors causing low to moderate levels of coral bleaching observed by the benthic and towed-diver teams. Relatively strong cross island chain currents exist, accelerated at the northern and southern tips of the islands, presumably tidally driven. Oxygen concentrations appear to increase at deeper depths towards the northern end of the chain.

A brief log of nearshore data follows. For brevity, temperature data collected during towboard operations have been omitted, but was collected at all sites except Zealandia:

Saipan:

A CREWS Buoy was deployed in Managaha Marine Sanctuary in Saipan Lagoon and 20 shallow water CTDs were performed around the northwest, north, northeast, east, and southeast sides of the island.

Tinian:

Nine shallow water CTDs were performed along the north, northeast, east, southeast, south, and southwest sides of Tinian. A satellite drifter was deployed en route to Sarigan, shortly after passing Saipan.

Sarigan:

Seven shallow water CTDs were performed around the island and an STR was deployed in a small protected rock cove on the northwest tip of the island.

Zealandia:

A WTR was deployed on the northeast side of the northernmost section of the two pinnacles**.**

Pagan:

Five shallow water CTDs were performed and a location for an SST Buoy was determined. The deployment of the buoy will take place on the vessel's return to Pagan Island.

Agrihan:

Eight shallow water CTDs were performed and locations for two STRs were established. The STRs will be deployed on either September 6 or 7, when the vessel returns to the island. A satellite drifter was deployed en route to Stingray Shoals, shortly after leaving Agrihan.

August 29–September 6, 2003

Although very preliminary, a number of generalizations have surfaced from the data already collected. All measured surface water temperatures are 0.5 to 0.8˚C degrees warmer than NOAA's Pathfinder SST Monthly Climatology for the region. Relatively strong cross island chain currents exist, accelerated at the northern and southern tips of the islands, presumably tidally driven. Oxygen concentrations appear to increase at deeper depths towards the northern end of the chain. Several areas of hydrothermal seeps have been noted. CTD measurements of these areas at Maug have shown temperature increases of up to 3˚C from surrounding waters, as well as large salinity and transmissometry anomalies. Depending on their number and distribution, these features may contribute significantly to local circulation and nutrient loading. They warrant further investigation.

A brief log of nearshore data follows. For brevity, temperature versus depth data collected during towboard operations has been omitted.

Stingray Shoals:

Due to the remoteness of this location, no permanent moorings were established. Temperature data were collected on the towboards, however (as at other locations), and a series of deep water CTDs were performed. An exploratory bathymetric survey was also conducted.

Uracas:

Eight shallow water CTDs were performed. A Subsurface Temperature Recorder (STR) was deployed along one of the larger islets off the southeast corner of the island. A satellite-tracked SVP drifter was deployed en route to Supply Reef.

Supply Reef:

Following an exploratory bathymetric survey, a Wave and Tide Recorder (WTR) was deployed in the southeast quadrant of the shoal in 27.1 m of water.

Maug :

Thirty-three shallow water CTDs were performed, including two in a geothermal seep area. An SST Buoy was deployed in the small cove on the north end of East Island. An STR was deployed on the west side of West Island in an area with significant live coral cover.

Acunsion:

Eight shallow water CTDs were performed. An STR was deployed at the mouth of a lava tube on the west side of the island.

Agrihan:

Seven shallow water CTDs were performed, bringing up the number of shallow water CTDs performed at Agrihan to 15. An STR was deployed along the west side of the island. The other planned STR deployment on the east side was abandoned because of extremely poor weather conditions.

Pagan:

Twelve shallow water CTDs were performed, including three in the small lake along the west side of the island. This brings up the number of shallow water CTDs performed at Pagan to 17 thus far. An SST Buoy was deployed in a cove on the west side, near one of two of the island's main landing areas.

Mooring Deployments/Recoveries OES0307

Mooring type	Location	Serial number	Date	Depth (m)	Lat	Long
CREWS	Saipan	261-001	8/19/2003	7.6	15 14.250 N	145 43.371 E
STR	Sarigan	3932718-1065	8/24/2003	0.9	16 42.634'N	145 46.135'E
WTR	Zealandia	2632718-0378	8/25/2003	24.7	16 53.846'N	145 51.204'E
STR	Urucas	3932718-1064	8/31/2003	1.5	20 32.227'N	144 53.860'E
WTR	Supply Reef	2632718-0377	9/1/2003	27.1	20 08.405'N	145 5.915'E
SST	Maug	268-018	9/3/2003	7.3	20 01.752'N	145 13.930'E
STR	Maug	3932718-1050	9/3/2003	2.7	20 01.065'N	145 12.464'E
STR	Asuncion	3932718-1049	9/5/2003	3.7	19 41.605'N	145 23.383'E
STR	Agrihan	3932718-1042	9/6/2003	2.1	18 45.995'N	145 38.296'E
SST	Pagan	268-019	9/7/2003	5.2	18 07.647'N	145 45.437'E

September 6–13, 2003

Although very preliminary, a number of generalizations have surfaced from the data already collected. All measured surface water temperatures are 0.5 to 0.8˚C degrees warmer than NOAA's Pathfinder SST Monthly Climatology for the region. Relatively strong cross island chain currents exist, accelerated at the northern and southern tips of the islands, presumably tidally driven. Oxygen concentrations appear to increase at deeper depths towards the northern end of the chain. Several areas of hydrothermal seeps have been noted. CTD measurements of these areas at Maug have shown temperature increases of up to 3˚C from surrounding waters, as well as large salinity and transmissometry anomalies. Large plumes of extremely turbid water were noted at Anatahan. These plumes may be associated with hydrothermal vents or with

volcanic ash runoff from Anatahan's recent eruption. Transmissometry values within these plumes are several orders of magnitude greater than other locations so far surveyed. Depending on their number and distribution, these features may contribute significantly to local circulation, nutrient loading, and particularly in the case of Anatahan, likely have deleterious effects to the reef ecosystem, such as excessive sedimentation and shading.

A brief log of nearshore data follows. For brevity, the temperature data collected during towboard operations has been omitted, but was collected at all sites except Zealandia.

Pagan (September 7–8):

Twenty-six shallow water CTDs were performed, including three in the small lake along the west side of the island. This brings up the number of shallow water CTDs performed at Pagan to 37 thus far. An SST Buoy was deployed in a cove on the west side, near one of two of the island's main landing areas. An STR was deployed in the shallow rock/coral pools off the beaches of the eastern coast.

Anatahan (September 10):

Twenty-four shallow water CTDs were performed. Plumes of extremely turbid water and what appeared to be hydrothermal seeps were noted at frequent intervals around the island. CTDs were used to assess water types in these areas. An STR was deployed at the southwestern tip of the island.

Guguan (September 11):

Ten shallow water CTDs were performed. An STR was deployed at the western side of the island.

Alamagen (Sepetmeber 12):

Fourteen shallow water CTDs were performed. An STR was deployed near the northern tip of the island.

Pagan (September 13):

Six shallow water CTDs were performed, bringing the total number of CTDs performed at Pagan to 37.

Mooring Deployments/Recoveries OES0307

Mooring type	Location	Serial number	Date	Depth (m)	Lat	Long
CREWS	Saipan	261-001	8/19/2003	7.6	15 14.250 N	145 43.371 E
STR	Sarigan	3932718-1065	8/24/2003	0.9	16 42.634'N	145 46.135'E
WTR	Zealandia	2632718-0378	8/25/2003	24.7	16 53.846'N	145 51.204'E
STR	Urucas	3932718-1064	8/31/2003	1.5	20 32.227'N	144 53.860'E
WTR	Supply Reef	2632718-0377	9/1/2003	27.1	20 08.405'N	145 5.915'E
SST	Maug	268-018	9/3/2003	7.3	20 01.752'N	145 13.930'E
STR	Maug	3932718-1050	9/3/2003	2.7	20 01.065'N	145 12.464'E
STR	Asuncion	3932718-1049	9/5/2003	3.7	19 41.605'N	145 23.383'E
STR	Agrihan	3932718-1042	9/6/2003	2.1	18 45.995'N	145 38.296'E

Mooring type	Location	Serial number	Date	Depth (m)	Lat	Long
SST	Pagan	268-019	9/7/2003	5.2	18 07.647'N	145 45.437'E
STR	Pagan	3932718-1066	9/8/2003	0.6	18 06.179'N	145 46.071'E
STR	Anatahan	3932718-1067	9/10/2003	5.5	16 20.077'N	145 38.719'E
STR	Guguan	3932718-1068	9/11/2003	5.8	17 18.440'N	145 49.884'E
STR	Alamagan	3932718-1110	9/12/2003	3.0	17 37.124'N	145 49.404'E

September 14–21, 2003

Although very preliminary, a number of generalizations have surfaced from the data already collected. All measured surface water temperatures are 0.5 to 0.8˚C degrees warmer than NOAA's Pathfinder SST Monthly Climatology for the region. Relatively strong cross island chain currents exist, accelerated at the northern and southern tips of the islands, presumably tidally driven. Oxygen concentrations appear to increase at deeper depths towards the northern end of the chain. Several areas of hydrothermal seeps have been noted. CTD measurements of these areas at Maug have shown temperature increases of up to 3˚C from surrounding waters, as well as large salinity and transmissometry anomalies. Large plumes of extremely turbid water were noted at Anatahan. These plumes may be associated with hydrothermal vents or with volcanic ash runoff from Anatahan's recent eruption. Transmissometry values within these plumes are several orders of magnitude greater than other locations so far surveyed. Depending on their number and distribution, these features may contribute significantly to local circulation, nutrient loading, and particularly in the case of Anatahan, likely have deleterious effects to the reef ecosystem, such as excessive sedimentation and shading.

A brief log of nearshore data follows. For brevity, the temperature data collected during towboard operations have been omitted, but was collected at all sites except Zealandia.

Aguijan Island and Tatsumi Reef (September 17):

Twelve shallow water CTDs were performed. An STR was deployed at Naftan Rock.

Anatahan (September 18):

An STR was deployed at the southeast corner of the island. A total of two STRs have been deployed at Anatahan and 25 shallow water CTDs have been performed.

Rota (September 19–20):

Twenty-one shallow water CTDs were performed. An SST Buoy was deployed within the boundary of the sanctuary, just off Puňa Point.

Mooring Deployments/Recoveries OES0307

Mooring type	Location	Serial number	Date	Depth (m)	Lat	Long
CREWS	Saipan	261-001	8/19/2003	7.62	15 14.250 N	145 43.371 E
STR	Sarigan	3932718-1065	8/24/2003	0.9144	16 42.634'N	145 46.135'E
WTR	Zealandia	2632718-0378	8/25/2003	24.6888	16 53.846'N	145 51.204'E
STR	Urucas	3932718-1064	8/31/2003	1.524	20 32.227'N	144 53.860'E
WTR	Supply Reef	2632718-0377	9/1/2003	27.1272	20 08.405'N	145 5.915'E

Mooring type	Location	Serial number	Date	Depth (m)	Lat	Long
SST	Maug	268-018	9/3/2003	7.3152	20 01.752'N	145 13.930'E
STR	Maug	3932718-1050	9/3/2003	2.7432	20 01.065'N	145 12.464'E
STR	Asuncion	3932718-1049	9/5/2003	3.6576	19 41.605'N	145 23.383'E
STR	Agrihan	3932718-1042	9/6/2003	2.1336	18 45.995'N	145 38.296'E
SST	Pagan	268-019	9/7/2003	5.1816	18 07.647'N	145 45.437'E
STR	Pagan	3932718-1066	9/8/2003	0.6096	18 06.179'N	145 46.071'E
STR	Anatahan	3932718-1067	9/10/2003	5.4864	16 20.077'N	145 38.719'E
STR	Anatahan	3932718-1113	9/18/2003	3.6576	16 19.975'N	145 42.162 'E
STR	Guguan	3932718-1068	9/11/2003	5.7912	17 18.440'N	145 49.884'E
STR	Alamagan	3932718-1110	9/12/2003	3.048	17 37.124'N	145 49.404'E
STR	Aguijan	3932718-1111	9/17/2003	3.9624	14 50.101'N	145 31.958'E
SST	Rota	268-013	9/20/2003	13.1064	14 06.779'N	145 10.002'E

September 23–29, 2003

A brief log of nearshore data follows. For brevity, temperature data collected during towboard operations have been omitted, but was collected at all sites except Zealandia.

Guam:

An SST Buoy was deployed in Tumon Bay Preserve to provide near real-time temperature measurements to NOAA's Coral Reef Watch to ground-truth satellite observations of sea surface temperature used to provide coral bleaching alerts and warnings. A total of 29 shallow water CTDs were performed around most of the island to examine spatial patterns of oceanographic conditions.

Santa Rosa Reef:

A subsurface Ocean Data Platform (ODP) was moored over the summit of Santa Rosa Reef to monitor ocean current profiles, wave energy, temperature, and salinity over this oceanic bank. The ODP consists of a Sontek Instruments upward looking acoustic Doppler current profiler and a Seabird Instruments Seacat temperature, salinity, and pressure sensor. Observations of coral and algae over most of the oceanic banks suggest harsh wave energy conditions which scour the benthic substrate and limit the species diversity to a limited number of hardy animals. These instruments will allow researchers to quantify these oceanographic conditions for the next year.

Mooring Deployments/Recoveries OES0307

Mooring type	Location	Serial number	Date	Depth (m)	Lat	Long
CREWS	Saipan	261-001	8/19/2003	7.62	15 14.250 N	145 43.371 E
STR	Sarigan	3932718-1065	8/24/2003	0.9144	16 42.634'N	145 46.135'E

Mooring type	Location	Serial number	Date	Depth (m)	Lat	Long
WTR	Zealandia	2632718-0378	8/25/2003	24.6888	16 53.846'N	145 51.204'E
STR	Urucas	3932718-1064	8/31/2003	1.524	20 32.227'N	144 53.860'E
WTR	Supply Reef	2632718-0377	9/1/2003	27.1272	20 08.405'N	145 5.915'E
SST	Maug	268-018	9/3/2003	7.3152	20 01.752'N	145 13.930'E
STR	Maug	3932718-1050	9/3/2003	2.7432	20 01.065'N	145 12.464'E
STR	Asuncion	3932718-1049	9/5/2003	3.6576	19 41.605'N	145 23.383'E
STR	Agrihan	3932718-1042	9/6/2003	2.1336	18 45.995'N	145 38.296'E
SST	Pagan	268-019	9/7/2003	5.1816	18 07.647'N	145 45.437'E
STR	Pagan	3932718-1066	9/8/2003	0.6096	18 06.179'N	145 46.071'E
STR	Anatahan	3932718-1067	9/10/2003	5.4864	16 20.077'N	145 38.719'E
STR	Anatahan	3932718-1113	9/18/2003	3.6576	16 19.975'N	145 42.162 'E
STR	Guguan	3932718-1068	9/11/2003	5.7912	17 18.440'N	145 49.884'E
STR	Alamagan	3932718-1110	9/12/2003	3.048	17 37.124'N	145 49.404'E
STR	Aguijan	3932718-1111	9/17/2003	3.9624	14 50.101'N	145 31.958'E
SST	Rota	268-013	9/20/2003	13.1064	14 06.779'N	145 10.002'E
SST	Guam	268-014?	9/24/2003	12.8016	13 31.141'N	144 47.867'E
SST	Santa Rosa Reef	27-007	9/28/2003	20.4216	12 50.2916'N	144 25.0704'E

Appendix G: **Night Operations Activity Report** (*John Rooney, Phil White, Dennis Tanay, Ken Cochrane, Dave Minkel, Sun He Bak*)

August 22–28 August, 2003

Night operations conducted during OES0307 have included: TOAD camera drop deployments (Tethered Optical Assessment Device), QTC acoustic seabed classification data collection, bioacoustic surveys, ADCP transects, and CTD casts. TOAD deployments have generally been conducted between 1830 and midnight to minimize overhead costs for required shipboard personnel. In most cases this has been followed by bioacoustic surveying along a line several to 5 kilometers long. When the ship's position and schedule has permitted, a bioacoustic survey has been run along the same line as a control during daylight hours. Following bioacoustic surveys, ADCP transects have been run in a box pattern around the islands or bank. A CTD cast to 500 m has been done at each corner of the box, with five water samples collected for chlorophyll analysis at the corner most exposed to the prevailing currents. A table summarizing night operations data collected to date on cruise OES0307 follows:

Location	No. TOAD deployments	No. still photos	No. video segments	QTC files	km of ADCP	CTD casts	km of bioacoustic survey
Saipan Island	2	69	2	7	49	4	5
Tinian Island	0	0	0	1	0	0	0
Sarigan Island	3	0	3	4	10.8	4	10
Zealandia Bank	2	0	2	2	8	4	10
Pagan Island	5	0	5	5	48.3	2	0
Agrihan Island	3	0	3	3	26.2	4	5.5
Totals	15	69	15	22	49	18	20.5

TOAD operations have been successfully conducted in depths from 20 m to as deep as 140 m and have been limited on several deployments by the length of cable available (~190 m). The habitat most often observed consists predominantly of basaltic black sand or low-density, gravel size pumice fragments. These sediments are generally found on more level areas, but have been encountered on surprisingly steep slopes as well. Sediment-covered areas are typically colonized by scattered octacorals, and a variety of fish, echinoderms, and several stingrays have been observed as well. TOAD deployments have also been conducted along vertical and near vertical walls that are common in the CNMI. Hard and soft corals and numerous fish species abound in these high relief areas.

The Captain and Officers of the Deck onboard the *Sette* have gone above and beyond the call of duty in maneuvering the ship to permit TOAD deployments. However, the steep bathymetry and topography of the islands often imposed severe limitations on where TOAD deployments could be safely conducted. A small boat deploying a highly portable ROV would be a much more appropriate tool for assessing benthic habitats in these areas, although the strong currents encountered at times would hamper these operations as well. In particularly steep and rugged terrain, divers equipped with video cameras and closed-circuit rebreathers would be the most effective means for surveying benthic habitats and marine life.

Bioacoustic surveys have been conducted along shore-parallel lines at four of the six islands or banks visited thus far. Ideally, surveys are conducted over depths of 50 m to 200 m, but because of the bathymetric features of these islands, some data were collected at ~500 m depth. Initial observations indicate that echo-reflecting organisms move from small aggregations near the sea floor during daytime (control) surveys into

the top 100 m of the water column during the night. Observations concurrent with TOAD operations suggest that small fish are an important component of the scattering layer at these locations. To more quantitatively evaluate recorded bioacoustic signals, calibration of the echosounder is scheduled during the daylight hour operations at Maug Island.

Only a very preliminary processing of CTD data has been completed at this time. However, it is apparent that the difference between sea temperatures and dissolved oxygen at the surface and at a depth of 500 m have been steadily decreasing as the *Sette* has moved north up the Northern Marianas Islands chain.

August 29–September 6, 2003

Night operations conducted during OES0307 have included TOAD deployments, QTC data collection, bioacoustic surveys, ADCP transects, and CTD casts. A table summarizing night operations data collected since the last progress report (8/28/03) follows:

Location	No. TOAD deployments	No. still Photos	No. video segments	QTC files	km of ADCP	CTD casts	km of bioacoustic survey
Stingray Shoals	5	0	5	5	0	0	12.8
Uracas Island	0	0	0	0	44.4	1	6.3
Pinnacle SW of Uracas	2	0	2	2	8.3	3	10.4
Supply Reef	2	0	2	2	10.0	1	4.8
Maug Island	7	0	7	11	26.6	4	64.8
Asuncion Island	6	0	5	7	23.1	0	0
Agrihan Island	5	0	5	5	48.1	0	9.8
Totals	27	0	26	32	160.6	9	108.8

Bathymetric surveying was conducted during night operations on several occasions:

The reported location and depth of Stingray Shoals vary considerably between different sources. Shipboard bathymetric surveying was conducted during night operations to augment the shallower depths and limited areas surveyed during the day by the towboard team.

Two banks, approximately 6 nmi north of Uracas (Farallon de Parajos), are indicated on NOAA Chart 81004, with depths of 70 and 76 fathoms and the notation "Rep (1951)." Both banks (lat. 20˚ 38.470N, long. 144˚ 51.096 E and lat. 20˚ 39.050 N, long. 144˚ 53.553 E) and the surrounding area were surveyed using both 12 kHz and 38 kHz fathometers. No sign of the reported banks were found. A volcanic spine leading from Uracas does cross the area and is several hundred meters shallower than the neighboring sea floor, but still deeper than 1000 m.

An area approximately 8 nmi southeast of Uracas is indicated on NOAA Chart 81004 as "Discol water" with a 75-fathom bank next to it. Surveys of this area conducted during night operations indicate that depths within the indicated discolored water area are several hundred meters or more. However, a volcanic pinnacle with a minimum depth of 60 m was found and documented within the 75-fathom bank.

Two shoal areas approximately 11 nmi northwest of Maug Island, with depths of 5 fathoms indicated on NOAA Chart 81004, were surveyed using shipboard fathometers. Although areas as shallow as 5 fathoms were documented (by the towboard team), no evidence of the more northwesterly of the two shoals was found during more than 6 hours of surveying.

TOAD deployments during this period have documented several particularly noteworthy benthic habitats:

Stingray Shoals TOAD tows over this little known area show that it is a steep-sided pinnacle topped with luxuriant coral cover. Impressed with what one diver described as this "oasis in the desert," resource management personnel from the CNMI and currently onboard the *Sette* have expressed interested in designating Stingray Shoals as a Marine Protected Area.

A pinnacle, mentioned above and approximately 10 nmi southwest of Farallon de Parajos (Uracas) was found to be a steep-sided, volcanic pinnacle with gas bubbles issuing from what appeared to be a crater. The top of the structure is populated with numerous fish, sharks, and hard and soft corals.

The bathymetry around Maug Islands is characterized by a number of volcanic dikes several meters wide and protruding several tens of meters or more seaward from the rest of the island slope. Forming vertical walls, the dikes support heavy concentrations of large sea fans and other gorgonians, corals, and fish. They also serve as a challenging barrier to towed instruments. The TOAD was snagged on them on a couple of occasions. Skillful shiphandling allowed the safe recovery of the TOAD in both cases.

A wide sand apron off the south end of Asuncion Island features extensive beds of sea pens, particularly between depths of 70 m and 120 m. Despite sandy areas at a range of depths found around many of the islands in the CNMI where research has been conducted on OES0307, large populations of sea pens have not been observed anywhere else.

Bioacoustic Surveys. Although only a very cursory analysis of data from acoustic surveys since the last progress report has been conducted, several preliminary conclusions have been drawn:

Results indicate that acoustic transects over water deeper than about 300 m did not show a significant volume of sonic scattering layer. Future transects will be planned for waters shallower than that depth, rather than for the 0-500-m depth range we have been using.

There is no readily apparent difference between data collected on the windward and leeward sides of islands.

A "permanent" and thick sonic scattering layer exists inside the lagoon at Maug Islands. It does not exhibit diel vertical migration, in contrast with the sonic scattering layer outside the lagoon.

Calibration of the 38 kHz transducer, planned for Maug Islands, was cancelled as a result of bottom conditions that were not conducive to anchoring. Calibration of the 38 kHz and 120 kHz transducers is strongly recommended to enable quantitative estimates of sonic scattering layer density.

Deepwater CTDs. The CTD being deployed from the *Sette* was damaged when the winch being used failed in the up position causing the CTD to two-block on the block on the J-frame. This caused the cable to part and allowed the CTD to freefall to the deck below. Fortunately there were no injuries to personnel. However, at this time, both the CTD and the spare carried onboard are nonfunctional. Efforts are being made to address that problem. In the interim, a smaller CTD, operable to a depth of 350 m rather that the 500 m depth we have been deploying to, may be used.

September 6–13, 2003

Night operations conducted during OES0307 have included TOAD deployments, QTC data collection, bioacoustic surveys, ADCP transects, and CTD casts. A table summarizing night operations data collected since the last progress report (9/07/03) follows:

Location	No. TOAD deployments	No. still photos	No. video segments	QTC files	km of ADCP	CTD casts	km of bioacoustic survey
Pagan Island	3	0	3	3	119.1	1	13.9
Saipan Island	7	0	7	7	0	0	0

Location	No. TOAD deployments	No. still photos	No. video segments	QTC files	km of ADCP	CTD casts	km of bioacoustic survey
Anatahan Island	5	0	5	6	6.7	1	20.4
Guguan Island	3	0	3	4	20.4	2	13.7
Alamagen Island	6	0	6	6	27.8	3	13.0
Totals	24	0	24	26	173.9	5	60.9

September 14–21, 2003

The *Oscar Elton Sette*'s schedule during this period was interrupted by a trip back to Saipan for a personnel transfer. We took advantage of this unscheduled visit to conduct additional surveys of Garapan Anchorage outside of Saipan Harbor. The CNMI Department of Fish and Wildlife (DFW) has identified important coral reef systems within the central portion of the anchorage that are being damaged by repeated anchoring of large vessels. They are interested in documenting evidence of anchor damage to bolster their request for the establishment of permanent moorings to protect the resource. Although within the depth range of conventional scuba diving, most of this approximately 30-square kilometer area is at depths in excess of 25 m, making effective surveying of the area difficult with the resources available to the CNMI DFW. Accordingly, they requested CRED's assistance with surveying this area during OES0307. Seven specific sites identified by the CNMI DFW, in addition to the four surveyed during our previous visit, have been surveyed. Copies of TOAD video tapes and files with ship's track and time stamp information in text and ArcView shape file format were provided to Michael Trianni, Fisheries Supervisor for the CNMI DFW, who embarked onboard the *Oscar Elton Sette*.

Most of the other TOAD tows conducted during this period documented low-relief slopes in the 50-m to 140-m depth range. Generally these are covered with pumice fragments ranging in size from coarse sand to small gravel. Also visible are calcareous fragments of *Halimeda* sp. algae, echinoderm tests, and mollusks. A variety of fish species have been seen, as well as several stingrays. The latter are hypothesized to be responsible for many of the shallow round pits 0.5 m to 2.0 m in diameter that are very common features of these shelves.

Also often encountered at this depth range are jagged vertical walls, typically heavily colonized by a wide variety of colorful sea fans, whip corals, and other soft corals and frequented by a variety of fish species. Often extending over a meter out from solid substrate, the profusion of life found on these vertical and near vertical surfaces provide fantastic scenery and suggests that these habitats should be investigated further.

The Island of Anatahan experienced significant volcanic eruptions in June 2003. Scuba diver surveys during this period encountered very poor visibility (2 m or less) in many areas. Although visibility was better than that at the deeper depths investigated via TOAD surveys, visibility was much less here than at other islands in the CNMI. Almost the entire substrate was covered with a heavy layer of mostly silt size sediment. In a few places where the topography was steep enough, living corals and other fauna could be seen, but very little benthic life appears to have survived the heavy and persistent infusion of volcanic ash. Even wire corals extending a meter or so above the substrate had a thick layer of ash, suggesting that deeper benthic habitats here will be impacted for some time as sediment from shallower areas is gradually washed into deeper water. Although typically considered detrimental to benthic habitats, a large typhoon would probably be very helpful to the reestablishment of marine ecosystems around Anatahan, by washing away much of the silt. Despite the silt, a fair number of fish were observed, including a dogtooth tuna, which was encountered in the water column as the TOAD descended.

As indicated in the preceding progress report, the CTD that was originally used on the cruise was damaged when the winch deploying it failed. However, extended efforts by the Lead Electronics Technician and Senior Survey Technician, Jeff Hill and Philip White respectively, managed to get an old CTD onboard

repaired and returned to service. In the interim, one cast was completed with a Seacat 19+ CTD which is normally deployed from a small boat by the mooring team. Unfortunately, a lack of available ports on the current CTD means that we are no longer able to collect chlorophyll data.

All islands, banks, and reefs in the CNMI which have been acoustically surveyed during OES0307 (13 so far) exhibit almost the same sonic scattering layer (SSL) characteristics. Survey results show SSL aggregates at depths between 300 m and 500 m along the sides of the islands that move to the surface (100 meters and shallower) at night. More detailed analyses beyond the initial observations reported here will be done back in Honolulu on data from these islands, banks, and reefs, and on acoustic data collected during the transit from Pagan Island to Pathfinder Reef.

Night operations conducted during OES0307 have included TOAD deployments, QTC data collection, bioacoustic surveys, ADCP transects, and CTD casts. A table summarizing night operations data collected since the last progress report (9/13/03) follows:

Location	No. TOAD deployments	No. still photos	No. video segments	QTC files	km of ADCP	CTD casts	km of bioacoustic survey
Pathfinder Bank	2	0	2	3	0	1	1.7
Arakane Bank	4	0	4	4	4.4	2	8.9
Esmeralda Bank	3	0	3	4	15.5	1	0
Aguijan Island	3	0	3	3	0	0	0
Rota Island	11	0	10	12	46.3	2	28.9
Totals	23	0	22	26	66.2	6	39.5

The *Oscar Elton Sette*'s schedule during this period was divided between shallow (minimum depths < 100 m) banks and two islands, all in the southern portions of the Marianas or Western Marianas Archipelagos. As with banks encountered earlier in the cruise, those visited during this period were found to be offset from their charted position, or at least be poorly represented on the NOAA Chart (81004). Pathfinder Bank is 1.7 nautical miles southeast of its plotted position and includes areas shallower than 10 m, rather than the 8 fathoms shown on the chart. Arakane Bank is smaller than indicated on the chart and its true center is approximately 0.5 nautical miles southeast of the center of the charted bank. There are two other shallow banks plotted near Esmeralda Bank. One of them is a kidney-shaped area labeled "Active Sulphur Boil (1945)," and with a depth of 30 fathoms indicated. This bank does not exist, while the other, Esmeralda Bank, is smaller than indicated on the chart. Extensive bathymetric "surveying" was done around all of these banks during night operations.

In general, the substrate in areas visited during this portion of OES0307 was dominated by calcareous sediment and fossil reef pavement. Most other locations visited were found to have predominantly basalt rock or sand and gravel-sized pumice. The exception to this general observation is Esmeralda Bank, which appears to have experienced recent volcanic activity and shows signs of current hydrothermal circulation.

Bioacoustic surveys indicate that the sonic scattering layer (SSL) off Rota Island is present during both daylight and night time hours, at depths between approximately 50 m and 100 m. Aside from Maug Island, which features a persistent SSL inside the crater, all of the islands surveyed in CNMI presented an active mesopelagic community which exhibited diel migration. At present, identification of the echo source is not possible since no trawl sampling was conducted. However, based on the difference of the echograms from the 38 KHz and 120 KHZ channels, one possible echo source could be thick patches of planktonic communities. It appears from a quick review of the acoustic data collected during this period, that parallel

transects perpendicular to the coastline at 0.25 to 0.5 nautical mile intervals would yield a good distribution map of both nekton and plankton communities. Finally, as indicated in previous progress reports, it is strongly recommended that calibration of the EK60 transducer be performed in order to obtain density estimates from the echo integration values.

September 23–29, 2003

Night operations conducted during OES0308 have included TOAD deployments, QTC data collection, bioacoustic surveys, ADCP transects, and CTD casts. A table summarizing night operations data collected during the cruise follows:

Location	No. TOAD deployments	No. still photos	No. video segments	QTC files	km of ADCP	CTD casts	km of bioacoustic survey
Guam	8	0	8	10	5.00	2	37.4
11-Mile Bank	3	0	3	3	0	0	0
Galvez Bank	10	0	10	11	32.7	0	0
Santa Rosa Reef	5	0	5	6	31.1	1	11.1
Totals	26	0	26	30	113.8	6	48.5

The *Oscar Elton Sette* conducted research around the main Island of Guam and several reefs and shallow banks in nearby waters during this cruise. In general, observations from TOAD deployments suggest that the bathymetry in these areas features fewer vertical walls and more sediment compared to CNMI, at least in the 10 m to 150 m depth range accessible by the TOAD. Sediments observed on this cruise appear to have a higher percentage of calcareous components on average than do sediments in the waters around CNMI. Although the TOAD seems to scare many fish making it a less than perfect tool for assessing those communities, Guam appeared to have lower fish population densities than were found in CNMI. However, the offshore banks appeared to support larger communities than those observed around the Island of Guam itself. Contrary to expectations, coral and fish communities at Galvez Bank appeared to be flourishing more than at Santa Rosa Bank. We speculate that the deeper depths around Galvez Bank may offer greater protection from high wave energy events to benthic communities there.

In addition to the data collection indicated in the above table, bathymetric surveying was conducted during night operations at several locations. At the request of a Department of Aquatic and Wildlife Resources representative onboard the *Oscar Elton Sette*, we surveyed around two GPS positions we had been given for a bank referred to locally as "Icebox." The bathymetry around both locations, however, was much deeper than the ~100 ft reported for that bank, precluding diving and TOAD deployments. Surveying was conducted for several hours around the 11-mile Bank as well to refine and check charted bathymetry. Finally, it is worth noting that conditions at Galvez Bank were too rough to launch small boats. TOAD deployments, however, were possible and conducted almost continuously for 15 hours, generating a very comprehensive picture of the benthic habitats there.

It was noted that a CTD cast off the northeast corner of Guam showed profiles that differed significantly from the open ocean type profile we had expected there. Rather than showing a pronounced chlorophyll maximum only around the thermocline, chlorophyll values near the surface approached those at the thermocline, and there was a spike in chlorophyll values between depths of roughly 30 m and 50 m as well. That type of pattern is typical of those found on leeward sides of islands and may be a result of the strong southerly winds in the area over the preceding several days.

Bioacoustic surveys along Guam and outlying banks and reefs show mesopelagic activities similar to those in CNMI. In both areas, the sonic scattering layer (SSL) appears as a 50-m to 100-m thick band during nighttime echo sampling, but is not observed during control sampling in daylight periods. A control transect

collected at around 8:00 AM local time along eastern Guam depicted an active SSL typical of those observed at midnight. Unfortunately, other ship operations precluded resurveying this transect at night. The SSL could be a permanent characteristic of this part of the coast, as was observed in the lagoon in Maug Island in CNMI or a more typical SSL sampled at the start of its diel migration towards the bottom. Further surveying at a higher temporal resolution would enable better characterization of the SSL in this area.

Appendix H: **Turtle Team Activity Report** (*Steve Kolinski, Stephani Holzwarth, Ronald Hoeke*)

August 22-28, 2003

Saipan:

Turtle survey orientation and training were conducted on August 22, 2003 along selected east coast sites of Saipan using surface snorkel tows with two observers trailing behind a single boat. The Forbidden Island area and east Naftan were selected in consultation with the DFW turtle biologist as high green turtle densities had been observed in these areas during cliff-line surveys in 1999, and in-water surveys would allow for assessment of submersible habitat along with the feasibility for potential tag and release efforts. A total of 12 green turtles were observed in the Forbidden Island area and 9 were observed along east Naftan. Sixteen of the turtles (76%) were juveniles, two (10 %) appeared to be adult females, and the maturity status of the three turtles (14 %) could not be determined (between 71 and 90 SCL cm; categorized as juvenile/adult). A variety of habitat types existed in each area, including hardpan, steep ledges and slopes, ridges, large boulders, spur and groove, and complex reef habitat. A brief snorkel at a collection of emerged rock ridges where an estimated 15 turtles had been observed at Forbidden Island in 1999 found no turtles, but instead discovered extremely complex exposed ridge structure with nearly vertical and or undercut sides leading to canyon-like depths of roughly 20 meters. Although such habitat may be adequate for turtle sleeping, it is more likely that the turtles seen in 1999 were feeding on algae along the ridges. Preliminary findings support previous reports (Kolinski et al., 1999; 2001) of relatively high turtle densities in these areas; however, neither area appeared particularly amenable to efficient tag and release efforts.

Tinian:

Towed-diver (SCUBA) survey methods were assessed at Tinian in three transects along the northwest, northeast, and east sides of the island. Two divers were towed behind a boat and maintained depths consistent with being able to adequately survey maximum visible vertical and horizontal distances. The methods worked extremely well and proved essential for surveying the northern-arc islands where visibility from the surface is reduced because of surface turbidity and limited benthic backscatter. No turtles were observed along the northwest transect. A total of 26 green turtles were observed along the east coast transects. Twenty (77 %) were juveniles, three (12 %) were adults, and three (12 %) were classified as juvenile/adult. Tinian was previously surveyed in 2001 (Kolinski et al., In Press).

Northern-arc Islands:

Other than Anatahan (Ilo and Manglona, 2002), turtles have not been surveyed in the northern-arc islands of the CNMI. The following information on turtle numbers, distributions, and habitats is limited as information is still being processed.

Sarigan:

A total of five juvenile (83 %) and one juvenile/adult (17 %) green turtles were observed along three towed-diver transects covering roughly 80% of the island perimeter.

***Zealandia Bank*:**

One juvenile green turtle was observed by survey teams during SCUBA dive surveys at two Zealandia Bank pinnacles.

Pagan Island:

Nine green turtles and one hawksbill turtle were observed in a combination of reef tow team and turtle tow team transects along the northeast side of Pagan Island. Seven of the eight (88 %) green turtles were juveniles and one (12 %) was classified as a juvenile/adult. The hawksbill was classified as a juvenile/adult.

***Agrihan Island*:**

Eight green and one hawksbill turtles were observed along three east coast towed-diver transects. Six of the eight green turtles (75 %) were juveniles, one (13 %) was an adult female, and one green turtle (13 %) was classified as a juvenile/adult. The hawksbill was classified as a juvenile.

Similar to CNMI southern-arc islands (Kolinski et al., In Press), limited numbers of green and, to a much lesser extent, hawksbill turtles appear to utilize surveyed northern-arc islands.

August 29–September 6, 2003

Reef areas were surveyed for turtles at Stingray Shoals, Uracas Island, Supply Reef, Maug Island, Asuncion Island, Agrihan Island, and Pagan Island. Observations of subsurface and/or surfaced turtles were collected from all personnel of the towed-diver turtle surveys, towed- diver habitat/fish surveys, and fish and benthic rapid assessment teams. A general summary of observations is presented below. Only a limited analysis of the data has been completed. Corrections for likely multiple sightings of individual turtles have not yet been made.

Stingray Shoals:

No turtles were observed during combined benthic tow/turtle surveys, or by fish and benthic rapid assessment teams.

Uracas Island:

Eight observations of green turtles were made by turtle survey and benthic tow teams in multiple tows around the island. Turtles classified as juveniles (SCL ≤ 70 cm) accounted for six (75 %) of the observations, and the remaining two observations (25 %) were of juvenile/adults (70 cm < SCL ≥ 90 cm).

Supply Reef:

Tidal and technical conditions did not allow for completion of planned surveys at Supply Reef. However, an individual juvenile green turtle was observed during deployment of a wave and tide recorder.

Maug Island:

Thirty-two observations of turtles were made during multiple tows and dives around the ocean and lagoon sides of the west, north, and east islands of Maug. One of the turtles (3 %) was listed as a possible juvenile hawksbill turtle. Juvenile greens accounted for 26 (81 %), and juvenile/adult greens for the remaining 5 (16 %) of the observations.

Asuncion Island:

Five juvenile greens (83 %) and one juvenile/adult (17 %) green/hawksbill turtle were observed during a double tow around the island.

Agrihan Island:

Five juvenile (83 %) and one (17 %) juvenile/adult green turtles were observed during eight SCUBA tow surveys along the north and west sides of Agrihan Island.

Pagan Island:

Six juvenile (75 %) and two juvenile/adult (25 %) green turtles were observed during eight SCUBA tow transects along the north and west shores of Pagan Island.

Preliminary conclusions: Green turtles appear to recruit to and utilize islands and reefs in limited numbers in the northernmost regions of the Marianas Archipelago. Hawksbill turtles may also be present, but would appear to be extremely rare. Only Stingray Shoals lacked evidence of turtle presence. The apparent absence of adult turtles at the above surveyed areas leaves open the question of where adult greens of the archipelago, if at all, may be concentrated (Kolinski et al., In Press).

September 6–13, 2003

During this reporting period, reef areas were surveyed for turtles at Anatahan, Guguan, Alamagan, and Pagan Islands. Observations of subsurface and/or surfaced turtles were collected from all personnel of the turtle survey, benthic tow survey, and fish and benthic rapid assessment teams. A general summary of observations is presented below. Only a limited analysis of the data has been completed. Corrections for likely multiple sightings of individual turtles have not yet been made.

Anatahan Island (9-10-03):

Extremely poor, presumably ash related, visibility around most of the island greatly limited the ability of submerged observers in sighting turtles. Only portions of the island were transected. Along the eastern shores, where visibility approached 4 m, eight green turtles were observed in a single 50-min tow survey. Turtle numbers did not exceed two along remaining transects where visibility averaged 1 to 2 meters. No turtles were sighted during a 1.25-hour anchored boat site survey along the north coast. Green turtles were encountered a total of 15 times by all teams at various locations. Twelve of the turtles (80 %) were classified as juveniles (SCL ≤ 70 cm) and three (20 %) as juvenile/adults (70 cm < SCL ≥ 90 cm). Unlike previous surveys (Ilo and Manglona, 2003), large green turtles were not commonly encountered (although one 90-cm SCL turtle was observed) and hawksbill turtles were not seen.

Guguan Island (9-11-03):

Tow transects twice encircled the island perimeter. One hawksbill and 18 green turtle observations were made by all teams. The hawksbill was an adult male. Observations of green turtles included 14 juvenile (74 %), 3 juvenile/adult (16 %) and 1 adult (5 %) sightings.

Alamagan (9-12-03):

Nineteen observations of green turtles were made by all teams. Juveniles accounted for 14 (74 %), juvenile/adult for 3 (16 %), and adults for 2 (11 %) of the observations.

Pagan Island (9-13-03):

East and southeast reef areas were tow-surveyed for turtles. Visibility was limited along much of the transected region, reaching 1 m in some areas, but averaging 6 to 9 m. Three juvenile (25 %) and one juvenile/adult (25 %) green turtles were observed.

Preliminary conclusions: Green turtles appear to recruit to and utilize the above surveyed island reefs in limited numbers. One hawksbill turtle was also observed at Guguan Island. Green turtles have been encountered at all northern-arc islands of the Marianas Archipelago, as well as at Zealandia Bank and Supply Reef. Hawksbill sightings have been made at Pagan, Agrihan, and Guguan Islands, with possible sightings at Maug and Asuncion Islands. Stingray Shoals lacked evidence of turtle presence.

September 14–21, 2003

Reef areas were surveyed for turtles at Pathfinder, Arakane, and Tatsumi Reefs and Aguijan, Anatahan, and Rota Islands. Observations of subsurface and/or surfaced turtles were collected from all personnel of the turtle survey, benthic tow survey, and fish and benthic rapid assessment teams. A general summary of observations is presented below. Only a limited analysis of the data has been completed. Corrections for likely multiple sightings of individual turtles have not yet been made.

Pathfinder Reef (9-14-03):

No turtles observed in four 50-minute tows.

Arakane Reef (9-15-03):

One 80-cm SCL green turtle was observed in six 50-minute tows.

Tatsumi Reef (9-17-03):

No turtles were observed in three approximately 40-minute tows.

Aguijan Island (9-17-03):

Tows were conducted along the entire island perimeter including Naftan Rock. A total of seven juvenile (SCL ≤ 70 cm) green and one juvenile hawksbill turtles were sighted.

Anatahan Island (9-18-03):

Tow surveys were conducted along the southeast, south, southwest, and north sides of the island. A total of 20 observations of green turtles were reported. Fourteen occurred along southeast transects, five along south island transects, one on the southwest side, and no turtles were observed along the north coast. Eighty-five percent of turtles observed were juveniles and 15% were classified as juvenile/adults (70 cm < SCL ≥ 90 cm).

Rota Island (9-19/20 –03):

Tow transects were conducted in various areas on all sides of Rota Island. Eighty-two observations of green turtles were made. Fifty of these (61 %) were juveniles, twenty-five (30 %) were classified as juvenile/adults, and seven (9 %) were classified as adults (SCL < 90 cm).

September 23−29, 2003

Reef areas were surveyed for turtles along various transects at Guam from September 23 through September 26, 2003. The island is large, and limited time constraints prohibited a complete survey coverage of the island perimeter. The Guam Division of Aquatic and Wildlife Resources collects turtle abundance and distribution data during biweekly aerial surveys, which they have conducted for nearly 10 years. The focus of these turtle surveys were thus on size distributions of turtles in the water. Heavy rains limited visibility at all but the northern sections of the island. Observations of subsurface and/or surfaced turtles were collected from all personnel involved in the turtle survey, benthic towed-diver survey, and fish and benthic REA teams. Only a limited analysis of the data has been completed, and corrections for likely multiple sightings of individual turtles have not yet been made.

A total of 34 green and one hawksbill turtle observations were made. Twenty-five (71%) observations were of juvenile (SCL ≤ 70 cm) greens, six (17%) of juvenile/adult (70 cm < SCL ≥ 90 cm) greens, three (9%) of adult (SCL < 90 cm) greens, and the single hawksbill (3%) was estimated at 75 cm SCL.

Galvez Bank (9-27-03):

Water assessments were not conducted because of weather conditions.

Santa Rosa Reef (9-28-03):

No turtles were observed during three towed-diver surveys across Santa Rosa Reef or by fish, benthic, and mooring teams during separate dives.

Appendix I: **Geodetic Team Activities Summary** (*Dave Minkel, Ken Cochrane, and John Rooney*)

August 22–28, 2003

Sarigan Island:

Recovered Sarigan AZ Mark 1964; occupied station with survey-grade Ashtech GPS for 5 hrs. Station was established by U.S. Army Corps of Engineers on Guam 63 datum, hence occupation and resultant high-accuracy position will assist in determination of a Guam 63 - NAD 83 datum transformation for the northern islands of the CNMI. Performed ~4 hrs of photo-ID of man-made and natural features visible on the IKONOS imagery with Trimble Pro XRS. Because of time and logistical constraints only a small (~ 400–500 m) area of the island was mapped. Field work is probably not sufficient to determine scale and rotations parameters of the imagery, but should be sufficient to shift nautical charts to a reasonably accurate NAD 83 position.

Pagan Island:

Attempted landing on eastern side of island, but unable to land because of rocky beach characteristics. Landing will be accomplished later in cruise when we return to island.

Agrihan Island:

Unable to recover Agrihan AZ Mark (US CoE 1964) because of location of mark and time constraints, hence no assistance, from this field work, in determining Guam 63 / NAD 83 datum transformation. Agrihan 1992, established by Lamont - Doherty Geological Observatory, occupied for approximately 4.5 hours with survey-grade GPS in lieu of U.S. CoE station. Observations may assist tectonic studies of the CNMI.

Performed approximately 3 hours of photo-identification of man-made and natural features. Positioning of highly visible man-made structures (buildings, sheds, cisterns, etc.) located in village should assure accurate relocation of area chart(s). Effects of 2002 typhoon, as reported by island inhabitants and date of imagery may cause positioning of natural features to be of no use.

Pending logistical considerations, a landing and mapping effort on the northwest portion of the island is planned for later in the cruise to assist in determination of imagery scale and rotation parameters.

August 29–September 6, 2003

Uracas Island (a.k.a. Farallon de Pajaros):

Unable to land sufficiently near stations JUDY YEAGER (National Ocean Service), URACAS and URACAS AZ MARK (U.S. Corps of Engineers), and URACAS (Lamont-Dougherty Geological Observatory) to accomplish station searches. Non-monumented point established on northwest point of Uracas with 5 hours of dual-frequency GPS observations. This point was used as the base station for photo-identification activities. Photo-ID was performed on numerous, large free-standing boulders on the northwest portion of the island.

Maug Islands:

Search performed for BM #3 (a.k.a. MAUG ASTRO RESET 1); station believed destroyed because of beach erosion. MAUG 1964 (USCoE) recovered and occupied for 16 hours with dual-frequency GPS unit. Because of hazards to personnel in reaching this station a second non-monumented point was established on the south point of Nishi (west island) as a base for photo-ID activities. The following day Photo-ID operations were accomplished from small boat on Nishi and Higoshi (east island) on the "lagoon" side of the islands. Poor satellite coverage prevented ID work on Kila (north island). Recovery of MAUG and long observation period should provide excellent constraint of USCoE traverse and determination of Guam 63 parameters. Photo-ID work should be equally successful as solitary, offshore boulders were positioned; the high visibility and distinct image of offshore boulders coupled with the large area covered by a small boat-based operation were felt to be extremely successful.

Asuncion Island:

Recovered ASUNCION AZ MARK (USCoE) and occupied with dual-frequency GPS unit for 5 hours. Photo-ID work was performed simultaneously with observations on ASUNCION AZ MARK. Photo-ID was again performed from small boat and was extremely successful; the entire island was circumnavigated and distinct offshore boulders were positioned.

Agrihan Island:

AGRIAHN AZ MARK (USCoE) Based on information provided by inhabitants of the island on our previous visit, we landed to the north of AGRIHAN AZ MARK and were successful in locating said survey station. Station was occupied for 5 hours with a dual-frequency GPS unit while simultaneously performing Photo-ID work. Again, Photo-ID was accomplished by small boat, but due to sea state only the western side of the island was surveyed. However, due to the distinct and discreet images of the offshore boulders the ID work should be quite sufficient for rectification of imagery.

September 6–13, 2003

Pagan Island

Conducted search for USCoE station WEST BASE 1951; station not found due to poor description and lack of metal detector. Condition of station location indicates station still exists, but has been covered by soil and grass. Station PAGAN 1 (PID AA5095) recovered and occupied with dual-frequency GPS for approximately 29 hours. Photo-ID work performed on island and along shore over the three days field unit was at Pagan; Japanese infrastructure (bunkers, runway, roads, etc.) from World War II and natural shoreline features used as objects.

Anatahan Island

USCoE station ANATAHAN 1964 not searched for due to location on southwest rim of volcano crater (Anatahan is an active volcano); station believed destroyed because of recent volcanic activity. Search for Lamont-Dougherty station ANAT LANDING unsuccessful; station believed to be buried under volcanic ash from February 2003 eruption. Un-monumented station established as base for Photo-ID; Photo-ID of natural shoreline features performed from small boat on northern and western shores; sea state precluded operations on remaining shoreline.

Guguan Island

Westerly swell precluded safe landing on western shore of island and search for USCoE station GUGUAN, GUGUAN AZ MARK, and Lamont-Dougherty station GUGUAN and GUGUAN RM3. Un-monumented station established on north shore of island for Photo-ID work. Photo-ID of natural shoreline features accomplished from small boat; sea state prevented operations on eastern and southern shores.

Alamagan Island

USCoE stations ALAMAGAN and ALAMAGAN AZ MARK not searched for because of location and poor description. Lamont-Dougherty station ALAMAGAN RM3 recovered and occupied with dual-frequency GPS as base station for Photo-ID operations. Due to GPS equipment failure, 2.5 hours of data for the 5.5 hour session was lost. Fortunately, the failure occurred after Photo-ID operations had been completed. While the original 1992 Lamont-Dougherty report does not include a precise position for this station, subsequent tectonic studies may provide a more accurate solution than the 3 hours of data collected in this effort.

September 14–21, 2003

Aguijan Island (a.k.a. Goat Island)

Photo-ID was performed on Aguijan to assist CNMI agencies; a NOAA interest in this island was not expressed during discussions of project goals and priorities. A base station was not established on the island because of island topography (a shoreline of sheer cliffs) and the close proximity of the Saipan

Continuously Operating Reference Station (CORS). Because of sea conditions, only the northern and eastern shores of the island were investigated.

Geodetic Operations Concluded

Geodetic field operations concluded on the evening of September 17 with the departure of Mr. Ken Cochrane, Coastal Resources Management Office, CNMI and the GPS equipment from *Oscar Elton Sette*. Mr. Cochrane returned the GPS equipment used to accomplish this project to the Office of Lands Registration, CNMI; their support is gratefully acknowledged.

All indications are that the field work was completely successful; photo-identification of features was performed on all islands visited, and recovery and occupation of sufficient U.S. Corps of Engineers survey stations to determine an accurate datum transformation for Guam 1963 were accomplished.

The Geodetic Team greatly appreciates the support and assistance provided by the officers, crew, and scientific compliment of the *Oscar Elton Sette*.

Appendix J: **Multibeam Habitat Mapping Team Activities (Aboard CREI Survey Launch AHI)** (*Scott Ferguson, Joyce Miller, Bruce Appelgate, Paul Johnson*)

September **14–21, 2003**

A new CREI survey launch, R/V *AHI* (Acoustic Habitat Investigator), was deployed in the Southern Islands of CNMI and Guam in August and September 2003. The 25-ft launch is equipped with a RESON multibeam echosounder and a POS/MV motion sensor, which produce high resolution depth and backscatter data across a 150 degree swath of the seafloor. These data will be used to begin developing high resolution benthic habitat maps for the coral reef ecosystems in all areas surveyed.

Transported to the Marianas aboard the *Oscar Elton Sette*; the *AHI* was launched in Saipan on August 18, 2003 for independent survey work in around Saipan and Tinian Islands and the surrounding areas. During 28 days of operations based in Saipan, the Multibeam Mapping Team completed extensive surveys around Saipan, Tinian, Marpi Bank, and Tatsumi Reefs. With excellent support from colleagues at the CNMI Division of Fish and Wildlife(DFW) and use of the DFW 27-ft research vessel as a support vessel when needed, high quality surveys were completed in water depths ranging from 20 meters to greater than 250 meters in almost all areas visited. In addition, the CREI surveyors were requested by the Commonwealth Port Authority (Saipan harbormaster) to conduct reconnaissance surveys of areas of concern to navigation. Working with NOAA's National Ocean Service (NOS), the *AHI* surveyors were able to provide reconnaissance data needed to evaluate charting needs in Saipan. A report of findings was provided to the harbormaster and to NOS, and pertinent data were sent to NOS for detailed analysis. Preliminary processing of almost all survey data was done while in Saipan to assure data quality.

Escorted by the DFW vessel, the *AHI* transited to Rota Island on September 16, where one day of survey was conducted around Rota. A vessel provided by the Guam Fisherman's Coop met the *AHI* in Rota for transit to Guam on September 18. The Habitat Mapping Team, in collaboration with the Division of Aquatic and Wildlife Resources, the Fisherman's Co-op, and other interested stakeholder are working together to determine highest priority areas to conduct multibeam surveys around Guam for 7 days before being loaded aboard the *Oscar Elton Sette* on September 30 for transit back to Honolulu.