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National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE/NOAA FISHERIES

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CRUISE REPORT[1]

VESSEL: *Townsend Cromwell*, Cruise 02-07 (TC-281)

CRUISE PERIOD: September 8 - October 7, 2002

AREA OF OPERATION: Northwestern Hawaiian Islands (NWHI) (Fig. 1)

ITINERARY:

8 Sept — Embarked Russell Brainard, Edward DeMartini, Stephani Holzwarth, Jean Kenyon, Robert Schroeder, Brian Zgliczynski, Steve Cotton, Joseph Chojnacki, Jon Winsley, Peter Vroom, Scott Godwin, and Kimberly Page. Departed Snug Harbor at 1100 en route to NWHI.

9 Sept — At 0700, the *Townsend Cromwell* diverted from its cruise track to assist the U.S. Coast Guard (USCG) Rescue Coordination Center in searching for an apparent distress signal from EPIRB. At 1215, the *Townsend Cromwell* received word from the USCG that the distress signal was a false alarm. *Townsend Cromwell* resumed transit to Necker Island. Conducted Dive Safety Management Drill for all divers and coxswains. Deployed Surface Velocity Program (SVP) satellite-tracked drifter (Argos ID# 30147) off Nihoa Island in 60 m of water at lat. 23˚05.157'N, long. 161˚58.486'W with two archival fish pop-up tags, A258 and 02P0189.

10 Sept — Arrived at Necker Island at 1430 to commence operations. Conducted one fish and benthic rapid ecological assessment (REA) station along the south shore of Necker Island. Deployed Ocean Data Platform (acoustic Doppler current profiler and conductivity-temperature-depth recorder) in 25 m of water at lat. 23˚34.080'N, long. 164˚42.738'W at 1555 HST. Deployed a sea surface temperature buoy (SOSI #268-011, Argos ID# 28830) in 15.5 m of water at lat. 23˚34.291'N, long. 164˚41.865'W at 1640 HST. Conducted TOAD towed camera and of QTC acoustic habitat mapping operations (7.4 km). Deployed SVP satellite tracked drifter (Argos ID# 30288) in 34 m of water at lat. 23˚33.94'N, long. 164˚49.09'W. Departed for French Frigate Shoals (FFS).

[1] PIFSC Cruise Report CR-05-012
Issued 16 December 2005

11 Sept — Arrived FFS. Conducted two fish and three benthic REA surveys at the northern portion of FFS near Shark Island. Conducted fish collection dive to collect specimens of *Dascyllus sp.* Retrieved Coral Reef Early Warning System (CREWS) oceanographic buoy (SOSI 261-001, Argos ID# 27267) deployed in September 2001 and deployed replacement buoy (SOSI 279-001, Argos ID# 21392) at same site, lat. 23˚51.407'N, long. 166˚16.310'W in 8 m of water. Deployed SBE39 subsurface temperature recorder (#00905) in 2 m of water in patch reef of lagoon pools at lat. 23˚51.967'N, long. 166˚13.180'W. Conducted towed-diver habitat/fish survey in backreef lagoon pools. Conducted tethered optical assessment device (TOAD) towed camera and 161 km of QTC acoustic seabed classification surveys over the western portion of FFS.

12 Sept — Conducted three fish and benthic REA surveys and five towed-diver habitat/fish surveys along the east and southeast forereef slopes of the windward barrier reef. Conducted TOAD towed camera surveys over the southeastern reef slope and 142 km of QTC acoustic seabed classification surveys around entire atoll perimeter. Conducted shipboard CTD to a depth of 500 m at permanent CTD station at the south end of FFS.

13 Sept — Conducted three fish and benthic REA surveys and five towed-diver habitat/fish surveys along northeast and north forereef slopes of windward barrier reef. Departed FFS en route to Laysan Island. Conducted QTC acoustic seabed classification surveys over Brooks Bank (21.3 km) and St. Rogatien Bank (6.8 km).

14 Sept — Conducted shipboard CTD to a depth of 500 m at permanent CTD station south of Gardner Pinnacles. Deployed SVP satellite tracked drifter (Argos ID #30114) with pop-up satellite fish tags PSAT A217 and Wildlife Computers 02P0187 in 3050 m of water at lat. 24˚08.906'N, long. 167˚41.159'W.

15 Sept — Arrived and anchored at Laysan Island at 0945. Deployed SST buoy (SOSI #268-010, Argos ID# 28829) at lat. 25˚46.374'N, long. 171˚44.551'W in 2.5 m of water. Conducted four towed-diver habitat/fish surveys, three fish and benthic REA surveys, eight shallow water CTDs, and one TOAD camera survey around Laysan Island. Conducted QTC acoustic seabed classification surveys over Laysan Bank until sea conditions caused too much rolling for adequate data quality (54.1 km). Departed Laysan Island en route to Lisianski Island. Deployed SVP satellite tracked drifter (Argos ID# 30350 at lat. 25˚44.265'N, long. 171˚49.771'W in 40 m of water.

16 Sept — Arrived at Lisianski Island/Neva Shoals at 1300. Deployed SST buoy (SOSI #268-008, Argos ID# 12195) at former CREWS buoy site at position 25˚58.061'N, 173˚54.965'W in 8 m of water. Conducted two towed-diver habitat/fish surveys of reefs on east side of Neva Shoals. Conducted two fish and benthic REA surveys along southeast side of Neva Shoals. Conducted QTC acoustic seabed classification surveys over Lisianski Bank (21.7 km) and Bank #8 (10.7 km) en route to Pearl and Hermes Atoll. Deployed SVP satellite

tracked drifter (Argos ID# 30225) with pop-up satellite tags PSAT A252 and Wildlife Computers 01P0289 at lat. 26˚18.216'N, long. 174˚32.247'W in 63 m of water over Bank #8.

17 Sept — Arrived at Pearl and Hermes Atoll at 1145. Retrieved CREWS buoy (SOSI 262-004, Argos ID #26105) and settlement/recruitment plates. Deployed three invertebrates traps. Deployed replacement CREWS buoy (SOSI 280-003, Argos ID #21376) at temporary site for the night. Conducted two fish and benthic REA surveys on southeast forereef slope. Conducted 11 shallow water CTDs along entire east side of atoll. Conducted TOAD drift dive along southeast reef slope. Conducted QTC acoustic seabed classification surveys along east side of atoll (5.7 km). Conducted two shipboard CTDs to a depth of 500 m.

18 Sept — Completed deployment of CREWS buoy (SOSI 280-003, Argos ID #21376) at original site, lat. 27˚51.245'N, long. 175˚48.954'W. Retrieved invertebrate traps. Conducted two towed-diver habitat/fish surveys in the coral maze in the central lagoon and two surveys along the northern backreef just inside the barrier. Conducted three fish and benthic REA surveys along the northeast and north forereef slopes. Conducted 13 shallow water CTDs along northwest side and interior of atoll. Conducted TOAD drift dive over northwest reef slope. Conducted QTC acoustic seabed classification surveys along northwest reef slope (3.7 km). Conducted two shipboard CTDs to a depth of 500 m on northeast and northwest sides of Pearl and Hermes Atoll.

19 Sept — Conducted five towed-diver habitat/fish surveys along south and southwest back reef and shallow forereef slope and southeast backreef. Conducted three fish and benthic REAs in lagoon. Conducted seven shallow water CTDs to complete survey around entire atoll. Conducted TOAD drift dive along reef slope south of anchorage area on south side of atoll. Conducted QTC acoustic seabed classification surveys along southern reef slope (9.0 km). Departed Pearl and Hermes Atoll en route to Midway Atoll.

20 Sept — Deployed SVP satellite tracked drifter (Argos ID# 30291) to the west of Pearl and Hermes Atoll at position 27˚51.347'N, 176˚21.191'W. Arrived Midway Atoll at 0730. Retrieved Midway CREWS buoy and settlement/ recruitment plates. Deployed SST buoy (SOSI #268-009, Argos ID# 28831) at former CREWS buoy site at position 28˚13.073'N, 177˚20.641'W. Conducted four towed-diver habitat surveys along southeast, south, and southwest forereef slopes. Conducted five fish REA surveys and three benthic REA surveys in Welles Harbor.

21 Sept — Conducted six towed-diver habitat/fish surveys along northeast, north, and northwest forereef slopes and northwest backreefs. Conducted three benthic and four fish REA surveys along northwest reef slope and backreef. Ship departed Midway Harbor. Conducted TOAD towed camera and QTC acoustic seabed classification surveys (18.9 km) around northwest side of Midway.

Conducted shipboard CTD to 500 m at permanent station. Departed Midway en route to Kure Atoll.

22 Sept — Arrived Kure Atoll at 0730. Deployed replacement CREWS buoy (SOSI #280-002, Argos ID# 21531) at same site, lat. 28˚25.118'N, long. 178˚20.673'W. Conducted three fish and benthic REA surveys along southeast and south forereef slopes. Conducted two towed-diver habitat/fish surveys along the southeast and east forereef slopes. Deployed subsurface temperature recorder SBE#0903 at shipwreck on north end of lagoon at position 28˚26.844'N, 178˚18.365'W. Conducted 14 shallow water CTDs around atoll perimeter. Conducted TOAD towed camera dive along northwest side of Kure Atoll. Conducted QTC acoustic seabed classification surveys around western half of Kure reef slope (24.3 km). Conducted shipboard CTD to 500 m at permanent station.

23 Sept — Deployed Ocean Data Platform (SOSI #267-005) on west side of Kure Atoll at position 28˚25.782'N, 178˚22.668'W. Conducted four towed-diver habitat/fish surveys of western back reef, eastern backreef, and coral gardens near CREWS buoy. Conducted five fish and three benthic REA dives along northwest backreef. Conducted 14 shallow water CTDs in lagoon. Conducted TOAD drift dive over southwest reef slope. Conducted QTC acoustic seabed classification surveys around atoll (130.7 km). Conducted shipboard CTD to a depth of 500 m.

24 Sept — Conducted five towed-diver habitat/fish surveys along south and west reef slopes and northwest and north backreefs. Conducted four fish and benthic REA surveys in Kure Lagoon. Deployed subsurface temperature recorder (SBE39 #0907) at position 28˚25.756'N, 178˚22.105'W. Conducted TOAD drift dive along east reef slope. Conducted QTC acoustic seabed classification surveys around atoll (143.6 km). Departed Kure Atoll en route to Midway Atoll. Deployed SVP satellite tracked drifter (Argos ID# 29938) at position 28˚25.187'N, 178˚29.517'W.

25 Sept — Arrived at Midway Atoll at 0700. Conducted five towed-diver habitat/fish surveys along west forereef slopes and southwest and north backreefs. Conducted four fish and benthic REA surveys of southwest forereef slope, two backreef sites, and the SST buoy location. Deployed subsurface temperature recorder (SBE39 #0904) in 1 m of water at position 28˚16.664'N, 177˚22.070'W. Conducted 17 shallow water CTDs around Midway Atoll. Conducted TOAD drift dive and QTC acoustic seabed classification surveys along northwest reef slope (58.4 km). Departed Midway Atoll en route to Pearl and Hermes Atoll.

26 Sept — Arrived at Pearl and Hermes Atoll at 0700. Conducted five towed-diver habitat/fish surveys along northwest back reefs. Conducted four fish and three benthic REA surveys of northwest backreef. Deployed subsurface temperature recorder (SBE39 #0900) in 2.5 m of water at position 27˚54.710'N, 175˚53.657'W. Deployed subsurface temperature recorder (SBE39 #0906) in 1

m of water at position 27˚57.450'N, 175˚46.850'W in the middle of the Three Sisters Mokus. Conducted QTC acoustic seabed classification surveys along northwest reef slope (30.5 km). Conducted shipboard CTD to a depth of 500 m in southwest corner of Pearl and Hermes Atoll.

27 Sept — Conducted five towed-diver habitat/fish surveys along northeast and east backreefs and in central lagoon coral maze near CREWS buoy site. Conducted three fish and one benthic REA surveys of northeast backreef and south lagoon. Anchored ship for the night.

28 Sept — Embarked three media personnel from the *M/V Rapture* conducting interviews of scientists and crew to celebrate the last cruise of the *Townsend Cromwell.* Weighed anchor at 0630 to transit to the southwest corner of Pearl and Hermes Atoll. Conducted three towed-diver habitat/fish surveys along the southwest entrance channel and backreefs. Conducted two fish and benthic REA surveys of southwest backreef and lagoon. Deployed subsurface temperature recorder (SBE39 #0899) in 2 m of water at position 27˚46.489'N, 175˚58.720'W in 2 m of water on the right side of the small boat channel on the southwest side of the atoll. Disembarked media personnel. Departed Pearl and Hermes Atoll en route to Lisianski Island.

29 Sept — Arrived at Lisianski Island at 0700. Conducted six towed-diver habitat/fish surveys around northeast, northwest outer reef slopes, east and northwest nearshore reefs and lagoonal waters on southwest side of island. Conducted three fish and benthic REA surveys of northeast, north and northwest sides of island. Deployed subsurface temperature recorder (SBE39 #0902) in 2 m of water at position 26˚03.142'N, 173˚58.091'W. Conducted TOAD towed camera dive over northwest bank. Conducted QTC acoustic seabed classification surveys along northwest and west banks (181.9 km).

30 Sept — Redeployed subsurface temperature recorder (SBE39 #0902) to the east side of Lisianski Island in 0.5 m of water at position 26˚03.801'N, 173˚57.660'W. Conducted two towed-diver habitat/fish surveys of east side of Neva Shoals. Conducted two fish and benthic REA surveys of east side of Neva Shoals. Departed Lisianski Island/Neva Shoals at 1130 en route to Maro Reef.

01 Oct — Conducted shipboard CTD to 500 m at Laysan Island permanent station. Arrived at Maro Reef at 0945. Deployed replacement CREWS buoy (#280-001, Argos ID# 21529) at former CREWS buoy site at position 25˚26.791'N, 170˚38.029'W in 8 m of water. Conducted two towed-diver habitat/fish surveys of deep pinnacle area on north side of Maro Reef. Conducted two fish and benthic REA surveys of southwest, west, and northwest reef spurs. Conducted TOAD towed camera dive and QTC acoustic seabed classification surveys over east bank of Maro Reef (230.2 km).

02 Oct — Conducted four towed-diver habitat/fish surveys in deeper waters along the northeast, east, and southeast sides. Conducted three fish and benthic REA surveys on the northeast and east sides. Deployed subsurface temperature

recorder (SBE39 #00901) at position 25˚23.050'N, 170˚32.383'W in 1.5 m of water. Conducted 14 shallow water CTDs around perimeter of shallow reef habitats at Maro Reef. Conducted TOAD drift dive and QTC acoustic seabed classification surveys over northeast bank of Maro Reef (56.0 km). Departed Maro Reef at 2400 en route to FFS.

03 Oct — Deployed SVP satellite tracked drifter (Argos ID# 30111) at position 25˚04.402'N, 170˚03.961'W in 2048 m of water. Conducted shipboard CTD to 500 m at permanent Maro Reef CTD site.

04 Oct — Arrived at FFS at 0800. Refurbished mooring hardware on CREWS buoy (#279-001). Conducted four towed-diver habitat/fish surveys of reefs between Tern and Shark Islands, the northwest reef spurs near East Island and Round Island. Conducted three fish and benthic REA surveys of the northern interior portion of the open atoll. Deployed subsurface temperature recorder (SBE39 #00898) on the south side of La Perouse Pinnacle position 23˚47.558'N, 166˚14.009'W in 4 m of water. Conducted QTC acoustic seabed classification surveys over west bank of FFS (230.2 km). Departed FFS en route to Honolulu.

05 Oct — Conducted shipboard CTD to 500 m at permanent station off Necker Island.

06 Oct — Deployed SVP satellite-tracked drifter (Argos ID# 30311) at position 22˚20.947'N, 161˚14.248'W in 4800 m of water. Conducted post-cruise meeting on board to discuss cruise operations and identify potential areas for improvement.

07 Oct — Arrived Snug Harbor, Pier 45, Honolulu, Hawaii to complete final research cruise of the *Townsend Cromwell* at 1300. Disembarked Brainard, DeMartini, Holzwarth, Kenyon, Zgliczynski, Schroeder, Vroom Godwin, Cotton, Page, Chojnacki, and Winsley.

MISSIONS AND RESULTS:

A. FISH SURVEYS

From 10 September to 4 October, the CREI Fish REA team (Edward DeMartini, Robert Schroeder, and Steve Cotton) conducted quantitative transects around eight islands/atolls of the NWHI according to NWHI Coral Reef Assessment and Monitoring Program (NOWRAMP) survey protocols. This included (with number of stations surveyed) various representative reef habitats around: Necker Island (1), French Frigate Shoals (FFS; 12), Lisianski-Neva Shoals (7), Laysan Island (3), Pearl and Hermes Atoll (17), Midway Atoll (12), Kure Atoll (12) and Maro Reef (5), for a total 69 stations. Some of these stations were surveyed in previous years, notably the historical stations established in 1980-1983 at Midway Atoll. The cumulative total of fish REA stations conducted by the Honolulu Laboratory in the NWHI during 2000-02 is 152. Surveys were conducted at depths of 1-15 m. Habitat types included fringing reef, outer barrier reef slope (forereef), inner reef flat (backreef), and lagoonal and oceanic patch reefs. Sea and swell conditions were generally

mild, with swells occasionally high (3 m); underwater visibility was generally moderate (10-20 m) but sometimes low (5-10 m) at FFS, Maro Reef, and Lisianski-Neva Shoals. The benthic team conducted coral and macroinvertebrate surveys within half-an-hour of the fish team at most stations. Water temperatures ranged from the high 26˚C to 28˚C.

As on the 2000 and 2001 NOWRAMP surveys, fish belt-transect stations consisted of three consecutive 25-m lines, separated by about 5 m, set along a single depth at 1.5-14 m. Each diver first tallied all fishes ≥20 cm total length (TL) within a 4-m wide strip (100 m^2 area) on the initial swim-out of each transect line. Each diver then tallied all fishes <20 cm TL within a 2-m wide strip (50-m^2 area) on the return swim of each line. Stationary Point Counts (SPCs) were conduced by a third diver recording species, with size class estimates, for all fish >25 cm TL within a 10-m radius at four points separated from the belt transect lines. REA surveys for additional species presence were conducted during the same dive following the quantitative surveys. Photos documenting fish and their habitat were taken at many stations.

The 2002 survey represents the third consecutive year that NOAA Fisheries, Honolulu Laboratory, has surveyed reef fish throughout the NWHI. Conclusions regarding the overall current status of NWHI fish assemblages must await pending statistical analyses. However, some initial impressions are worth mentioning. Findings were generally consistent with those of the 2 prior years. Coral reef fish assemblages in the NWHI appear to remain healthy and intact. Apex predators, dominated by large jacks (*Caranx* spp.) continue to be abundant in absolute terms (and relative to the MHI) at all sites surveyed, with the possible exception of Midway Atoll. Standing stocks of lower trophic level carnivores and herbivores remain high and of large average individual body size. These observations were not unexpected; shallow (<20 m) reefs of the NWHI remain de facto refuges because of their remoteness and are now officially protected from fishing within the NWHI Coral Reef Ecosystem Reserve. Labroids (wrasses and parrotfishes) such as the Hawaiian hogfish *Bodianus bilunulatus* and the spectacled parrotfish *Chlorurus perspicillatus* continue to exhibit smaller average body sizes at sex change from initial (female) to terminal (male) phases at Kure and Pearl and Hermes Atolls where apex predatory jacks appear to be more abundant (relative to Midway Atoll). Recruitment of 2002 year-classes was generally strong, perhaps better than observed in 2000 and 2001, which were also healthy. As in 2001, epidermal lesions (of unknown cause) were noted on a small percentage of goldring surgeonfish *Ctenochaetus strigosus* at FFS and Lisianski-Neva Shoals; the incidence of lesions had been much higher and geographically widespread in 2000. Marine debris is still being encountered occasionally, most commonly on the backreef at Midway Atoll and on reefs within the lagoon at Pearl and Hermes Atoll.

There were a few exceptional observations, however. Two fish species (the finescale triggerfish *Balistes polylepis* and the goldrim surgeonfish *Acanthurus nigricans*) were newly observed in the NWHI by the Honolulu Laboratory Fish Team. Whitetip reef sharks were consistently encountered, but grey reef and Galapagos sharks were seen less frequently this year than on previous NWHI assessments. The observed coral bleaching at the northern end of the archipelago has had no obvious effect on overall reef fish standing stock biomass or herbivore-to-carnivore ratios. However, several species of corallivorous fishes (the blue-eye damselfish *Plectroglyphidodon johnstonianus* and the leopard blenny *Exallias brevis*) appeared less and more abundant (or conspicuous), respectively, than on

previous surveys at the three northernmost atolls affected by the summer 2002 bleaching event. Definitive statements regarding corallivore densities remain pending statistical data analyses.

B. CORAL SURVEYS

Jean Kenyon, CREI marine ecologist, conducted coral surveys in conjunction with survey activities undertaken by other members of the benthic team (Peter Vroom, phycologist; Kim Page, phycological assistant; Scott Godwin, invertebrate biologist) and the CREI fish team (above). In accordance with Northwestern Hawaiian Islands Research and Monitoring Program (NOWRAMP) 2002 protocols agreed upon by coral scientists onboard the *Townsend Cromwell* and the collaborative charter vessel *Rapture*, video documentation of the benthic habitat as well as quantitative assessments of corals occurring within 2, 25-m-long transect lines were conducted around eight islands/atolls of the NWHI. This included (with number of stations surveyed) various representative reef habitats around: Necker Island (1), French Frigate Shoals (FFS; 11), Lisianski-Neva Shoals (7), Laysan Island (3), Pearl and Hermes Atoll (14), Midway Atoll (9), Kure Atoll (9) and Maro Reef (5), for a total 59 stations. Exclusive of coral REAs conducted by Rapture scientists in 2002 [the number of which remains to be reported as of this writing], the cumulative total of coral REA stations surveyed by Jim Maragos and Jean Kenyon working from the *Townsend Cromwell* and *Rapture* in the NWHI during 2000-02 is 155. Surveys in 2002 were conducted at depths of 0.5-14 m. Habitat types included fringing reef, outer barrier reef slope (forereef), inner reef flat (backreef), and lagoonal and oceanic patch reefs. Sea and swell conditions were generally mild, with swells occasionally high (3 m); underwater visibility was generally moderate (15-20 m) but sometimes low (5-10 m) at FFS, Maro Reef, and Lisianski-Neva Shoals. Water temperatures ranged from 26˚C to 28˚C. Although most benthic REA stations were surveyed by both the benthic team and fish team, a few sites were surveyed only by the benthic team; conversely, a few sites were surveyed only by the fish team.

Previous coral REAs in 2000 and 2001 were largely qualitative in nature, focusing on compiling species lists for the various islands and atolls of the NWHI as well as making subjective assessments of the relative abundance of each species at each site using the DACOR system (D = Dominant, A = Abundant, C = Common, O = Occasional, R = Rare). Surveys in 2002 were designed to be more quantitative in nature, and to include dedicated observations regarding coral bleaching and disease. Coral surveys in 2002 began by videotaping along the first 2 of 3, 25-m transect lines (each separated by about 5 m and set along a single depth at 5-45 feet) laid out by the fish team some 20-25 minutes prior to the benthic team's water entry. The coral biologist attempted to swim about 1 m above the transect line while videotaping, and additionally recorded 360˚ views of the surrounding area at the beginning, middle, and end of the transects' overall length. Then, on the swim-back along the two consecutive 25-m lines, each coral colony whose center fell within a 1-m-wide strip on either side of the line was categorized as having a maximum diameter belonging to one of 7 size classes (0-5 cm, 5-10 cm, 10-20 cm, 20-40 cm, 40-80 cm, 80-160 cm, or >160 cm). For species in which clonal propagation (e.g., *Porites compressa*) or fissioning (e.g., *Porites lobata*) is an important part of the life history strategy, judgments had to be made regarding the boundaries of individual colonies in order to assess the number of colonies present and their maximum diameter. In making such judgments, consideration was given to tissue color, interfaces with neighboring colonies of the same

species, and variations in growth form. When determinations of individual colonies could not be made on these criteria alone, conspecific areas of live tissue separated by more than 10 cm were considered to be separate colonies. In this manner, a total of 100 m^2 was surveyed at most sites; at two sites, strong current or an unusually large number of small colonies only allowed a portion of one transect line to be surveyed within the allotted dive time.

During the videotaping and subsequent swim-back/quantitative survey, assessments were made regarding the incidence and severity of bleaching as well as of disease or other tissue anomalies. Depending on remaining dive time and coordination with other members of the benthic team, the precision of bleaching assessments ranged from estimates of the percentage of the surface area of each species impacted by bleaching within the range of visibility and the degree of severity (i.e., the estimated percentage decrease in loss of normal pigmentation) to direct counts of bleached colonies within the transect belt. Observations included whether bleaching was accompanied by tissue mortality or if bleached tissue was still alive, as assessed by whether polyps in bleached tissue were visible and, if so, reacted to touch by retracting into their calices. Observations were also recorded for each station regarding species for which bleached tissue was not observed. At two sites, the central "coral gardens" at Kure (site TC-18-shallow) and a northern lagoon backreef at Midway (TC-20), additional digital videos were taken while randomly swimming, for several minutes, about the site to record the general nature and extent of bleaching. At most sites where bleaching was evident, digital still photos of the habitat and representative affected colonies were also taken.

Following the surveys conducted along the transect lines, a larger area at the site was examined to search for additional species of corals that did not fall within the belt transect and to make a subjective assessment, using the DACOR system, of the relative abundance of all coral species observed at the site. At most sites, digital still photos were taken of the general habitat and of selected corals. Digital still photos were taken of two corals that could not be identified in the field, one an unknown zoanthid and the other an unknown faviid.

The 2002 survey represents the third consecutive year that NOAA Fisheries, Honolulu Laboratory, in collaboration with its partners (most notably U.S. Fish and Wildlife Service) has surveyed corals throughout the NWHI. Conclusions regarding the overall current status of coral assemblages must wait pending further analyses. However, some salient observations can be stated even in the absence of more detailed analysis of written or videographic records.

For the first time, widespread, severe bleaching was observed and recorded in the Hawaiian Islands. The first observations of bleaching during coral REAs were made on September 17 at Pearl and Hermes Atoll (site TC-16, east outer barrier), at which an estimated 2% of the pocilloporids within the range of visibility were noticeably bleached. Observations conducted throughout the following 11 days in a variety of habitats at Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll revealed bleaching to have heavily impacted the coral populations of several species at all three atolls. A relatively low level of bleaching, as assessed by the number of colonies affected, was evidenced at sites along the outer barrier forereef at all three atolls. Given the low percentage of coral coverage

along these outer barrier forereefs, as well as the lack of coral species diversity (as revealed by both coral REAs and analysis of towboard surveys in 2000), the observation that bleaching was primarily witnessed in pocilloporids might well have been confounded with crown-of-thorns predation, as well as obscured the greater diversity of genera that were bleached and/or in the process of bleaching elsewhere within the atolls. Bleaching was most pronounced with the lagoon system of each atoll, at both patch reef habitats and, most markedly, at shallow backreef habitats. Written data from a 100-m^2 belt transect conducted at a north lagoon backreef REA site at Pearl and Hermes Atoll (site TC-26) exemplifies the nature of the phenomenon observed at virtually every backreef site visited at the three northern atolls: Of 40 colonies of *Montipora capitata* colonies counted, an estimated 50-80% of the surface area of all colonies were bleached, accompanied by gross tissue mortality; of 46 *Montipora turgescens* colonies counted, 27 were bleached such that pigmentation intensity was reduced an estimated 50-80%; of 17 *Pocillopora damicornis* and *P. meandrina* colonies counted, all 17 were completely bleached and dead; of 12 *Leptastrea purpurea* colonies counted, all 12 were bleached such that pigmentation intensity was reduced an estimated 80%. In contrast, colonies of *Pavona duerdeni* and *Fungia scutaria*, though rare at the site, did not appear to be bleached.

Differences in the incidence (i.e., counted number or estimated percentage) and severity (i.e., degree of loss of pigmentation and bleached tissue mortality/vitality) of bleaching among genera and species quickly emerged with continued observations. Members of the genus *Pocillopora*, along with the species *Montipora capitata*, were the most impacted by bleaching, both in terms of percentage of total individuals affected (incidence) and the degree to which bleaching had resulted in mortality of all or part of the colony (severity). Pocilloporids occur as discrete colonies that rarely exceed 50 cm in diameter in the NWHI; the majority of bleached pocilloporids were entirely dead, and the subsequent process of algal overgrowth was already in progress at many sites. In contrast, many montiporids, including *Montipora capitata*, form large colonies measuring more than 80 cm in diameter in backreef habitats; the boundaries of individual colonies can be difficult to determine as they spread through clonal propagation. Nearly all such large colonies had extensive areas of bleached, dead tissue, along with smaller patches of still-living tissue that showed a range of partial bleaching of pigments. The initiation of algal growth could be observed on the dead portions of such colonies. Whether the remnant patches of living tissue can maintain their vitality, extend growth onto portions of the bleached skeleton, or succumb to algal overgrowth remains to be observed in future monitoring efforts. *Montipora turgescens*, the second most prevalent montiporid at lagoon backreef sites, showed the next greatest incidence and severity of bleaching. Though most colonies observed at backreef sites at the three northern atolls showed partial fading of the populations' usual vivid blue coloration, the tissue was still alive and might potentially recover if not subjected to further stress.

Several species in the genus *Porites* (*P. lobata*, *P. evermanni*, and *P. compressa*) typically account for a large percentage of the overall live coral cover in a variety of habitats, including the outer barrier forereef and lagoon patch reefs, and are also well represented in the backreef habitat. At the three northern atolls, *Porites* colonies, although occasionally observed to contain patches of partially bleached, living tissue, were less impacted by the bleaching phenomenon, particularly when considered in relation to their numerical abundance and substantial contribution to overall coral cover. Written data from a 100-m^2

belt transect conducted at a shallow (2-m depth) site within a central area of lagoon patch reefs at Kure atoll ("coral gardens," site #TC18-shallow) exemplifies this disparity in the degree to which resident genera were affected: Of 151 pocilloporids counted within the belt transect, all were 100% bleached, dead, and partially overgrown with turf algae; of 15 colonies of *Montipora turgescens*, all were bleached white and dead; of 44 colonies of *Porites lobata* within the belt transect, none appeared bleached or otherwise anomalous in colony surface appearance. Moreover, *Porites compressa*, a species that readily spreads through asexual, clonal reproduction and whose colony boundaries can be difficult, if not impossible, to detect in the field, was the dominant species at the site; nonetheless, only an estimated 5 to 10% of the surface area was bleached, though not to any degree that resulted in tissue mortality. Other coral species that occasionally occurred in the high-bleaching-risk areas of the patch reefs and backreefs at the three northern atolls were only rarely observed to show a low level of bleaching, which was not accompanied by tissue mortality. These species include *Pavona duerdeni*, *Pavona varians*, *Cyphastrea ocellina*, *Fungia scutaria*, and *Psammacora stellata*. These species, however, typically form only small colonies that contribute but a very small percentage of overall coral cover.

In light of this hierarchy of coral susceptibility to bleaching at the three northern atolls, it is interesting to note a divergence from this ranking at both Lisianki-Neva Shoals and Maro Reef, both of which (with the exception of two dives at Lisianki-Neva Shoals) were surveyed after the three northern atolls. At both of these reef complexes, the incidence and severity of bleaching were considerably less than at the three northern atolls. Moreover, at these reef complexes, in both of which the pocillloporids, montiporids, and Porites comprise an estimated 90% of the coral cover, members of the genus *Porites* were relatively more impacted than were the pocilloporids and montiporids. Written data from a site north of Lisianski Island (TC-11) surveyed on 29 September exemplify this generalization: Of 120 colonies of *Montipora tuberculosa* and *M. turgescens* counted within the belt transect, an estimated 15% of the colonies had partially bleached tissue unaccompanied by tissue mortality, whereas a counted 5 (20%) of the 25 *Porites* colonies had partially bleached tissue unaccompanied by tissue mortality. This trend towards heightened susceptibility of *Porites* relative to other genera was further manifested at Maro Reef where the few corals observed with bleaching stress were almost invariably members of the genus *Porites*, even though montiporids and pocilloporids were well represented at Maro Reef. Members of the genus *Acropora*, which are typically among the first species to suffer bleaching in other regions where they are important members of the coral assemblage (e.g., western Pacific), were not observed to have experienced bleaching at either Maro Reef or French Frigate Shoals (where they are numerically most abundant in the NWHI), although dense populations of *Acropora valida* and *Acropora cytherea* were observed at Maro Reef and French Frigate Shoals, respectively (Maro site TC-28 and FFS sites TC-21 and TC-30).

At most sites where bleaching was observed, algal growth on the dead coral skeletons was also noted. The degree to which overgrowth had progressed was quite consistent within each site but demonstrated a range of variation among sites. It would be instructive, in terms of our understanding of reef dynamics on ecological time scales, to know how quickly the process of coral skeleton overgrowth by turf, fleshy, and coralline algae occurs, as such information could be useful in inferring past events from recent observations. For example, at two sites at Pearl and Hermes Atoll within two different habitats (site TC-17,

outer barrier, and site TC-30, SW backreef), there was a striking number of large, dead *Pocillopora* heads, all of which were coated with a similar assemblage and density of algae. At site TC-30, 124 dead *Pocillopora* colonies were counted within the 100-m^2 belt transect, 95% of which were larger than 20 cm in diameter, and all of which were heavily encrusted with a similar density and assemblage of turf, fleshy, and coralline algae. Only 26 live pocilloporids were counted within the belt transect, of which only 38% were larger than 20 cm in diameter. At TC-17, 76 dead *Pocillopora* colonies were counted within the 100-m^2 belt transect, all heavily encrusted with turf and coralline algae, whereas only 1 living *Pocillopora meandrina* colony was counted, which measured less than 5 cm in diameter. At both sites, the abundance of large, dead coral *Pocillopora* heads with similar levels of algal encrustation, coupled with the relative paucity of living pocilloporids largely representing small size classes, suggests that some event led to the death of the larger, older colonies within a narrow window of time. Judging from sea surface temperature data telemetered from CREWS buoys at Pearl and Hermes, Midway, and Kure Atolls (Rusty Brainard, pers. comm.), coupled with anecdotal observations by CREI Marine Debris Specialists working at Pearl and Hermes Atoll in July 2002 (Joe Chojnacki, Kim Page), the present bleaching event appears to have developed to its present state within a period of less than 3 months. It is hypothesized, based upon the observations summarized above, that bleaching episodes have occurred in the northern atolls of the NWHI in the recent past as well, resulting in concentrated, species-specific mortality, the species range of which is determined by the intensity and duration of physical factors implicated in causing bleaching (e.g., heightened sea surface temperatures coupled with periods of intense UV radiation). Future observations of the ecological fate of recently bleached reefs will be instructive in better understanding both the short-term and longer-term dynamics that have sculpted, and continue to sculpt, these reefs.

C. ALGAL SURVEYS

Algae are among the fastest growing organisms in coral reef ecosystems, and changes in algal species composition and abundance can serve as early warning indicators of change in the overall reef environment. Increases or decreases of algal abundance on marine reefs do not necessarily indicate the declining health of the ecosystem; however, they inform scientists of potential problems that may need to be monitored. For instance, increases in algal abundance may be the result of overfishing, sewage contaminants, or coral bleaching. Decreases in algal abundance may be the result of increased herbivore populations.

The Northwestern Hawaiian Islands contain some of the most pristine coral reef ecosystems in the world. Because of their isolation and the relatively few human activities in the area, algal species composition and abundance on Northwestern Hawaiian reefs are natural (i.e., no alien species are known, and pollution is not a factor affecting abundance). This gives scientists the opportunity to monitor fluctuations and population dynamics in algal communities without the confounding effects present in many other reef systems around the world.

Previous expeditions from the Coral Reef Ecosystem Investigation (CREI) have brought back copious amounts of algal material that are currently being examined. Close to 150 species have been reported from the Northwestern Hawaiian Islands so far, and more species are being found as samples are processed. The majority of these species are turf algae (small plants less than 1 cm tall that grow in dense, often multispecies, mats) and

epiphytes (tiny plants that grow on larger plants). Although the diversity of these small organisms is of great importance to the ecosystem as a whole, the plants themselves are too small to monitor in field settings, and identification of species is extremely time intensive. In order to quickly monitor and assess change in algal species composition and abundance in the field, macroalgae (plants large enough to be noticed and recognized by divers) are the organisms that have to be assessed.

Starting in September 2002, the CREI program has started monitoring the types of macroalgae present in the Northwestern Hawaiian Islands and their percent cover in various reef settings. Photoquadrats taken along fish transect lines tie algal population structure to fish communities in the same area and provide permanent historical records where percent cover can be objectively analyzed with various computer software packages. Algal samples taken from the photoquadrats will allow scientists to identify species that occur in photographs at a microscopic level and allow for the creation of permanent herbarium records that may eventually be deposited at national research institutions.

When possible, turf algae (which grows on essentially every hard surface present in a reef community) were collected for future analysis. However, to expedite photoquadrat image processing, these genera will be lumped into the category "turf" during photoquadrat analysis. Additionally, epiphytes found growing on macroalgae will also be kept for future processing.

Abundance of macroalgae within photoquadrats was recorded as algae were collected in the field. A "1" was given to the most abundant alga, "2" to the next most common, etc. This set of data is useful when analyzing photoquadrats and gives a rough estimate of which algae are most common in the environment. However, it is important to realize that these numbers are subjective, and different recorders may view the abundance of algal genera within a single quadrat differently. Additionally, using this method, a quadrat that contains 100 individuals of *Halimeda* and 3 of *Microdictyon* will receive the exact same ranking as a quadrat that contains 30 plants of *Halimeda* and 29 of *Microdictyon*. Therefore, the data these numbers represent must be regarded with a wary eye. Finally, these numbers imply nothing about percent cover.

Future visits to the same reef regions in the Northwestern Hawaiian Islands over time will allow us to document natural fluctuations in algal diversity and percent cover. Once identification of macroalgal species is complete and percent cover determined through photoquadrat analysis, diversity indices will be used to determine the areas within and between islands that are most similar. This type of information will prove important for reef management schemes. For instance, if algal communities in specific areas in the Northwestern Hawaiian Islands begin to change dramatically, similar sites that group together when analyzed with diversity indices will alert reef managers of other sites that might be subject to similar change.

Summary Statistics:

Towed Diver Habitat/fish Surveys - 83

FFS - 15	Maro - 6
Laysan - 4	Lisianski/Neva - 10

Pearl & Hermes - 22 Midway - 15
Kure - 11

Fish Rapid Ecological Assessment Surveys - 68
Necker - 1 FFS - 11
Maro - 5 Laysan - 3
Lisianski/Neva - 7 Pearl & Hermes - 17
Midway - 13 Kure - 12

Benthic Rapid Ecological Assessment Surveys - 62
Necker - 1 FFS - 12
Maro - 5 Laysan - 3
Lisianski/Neva - 7 Pearl & Hermes - 14
Midway - 10 Kure - 10

CREWS buoy deployments - 4
FFS - 1 Maro - 1
Pearl & Hermes - 1 Kure -1

Ocean Data Platform deployments - 2
Necker - 1 Kure - 1

SST buoy deployments - 4
Necker -1 Laysan - 1
Lisianski/Neva - 1 Midway - 1

Subsurface Temperature Recorder deployments - 10
FFS - 2 Maro - 1
Lisianski - 1 Pearl & Hermes - 3
Midway - 1 Kure - 2

SVP satellite tracked drifter deployments - 10
Settlement/recruitment plate deployments - 10 arrays
Shipboard CTDs to 500 m - 13
Shallow water CTDs - 111
TOAD towed camera dives - 13
QTC acoustic habitat classification surveys - 1332 km
Shipboard ADCP/TSG transects - 4500 km

RECORDS:

The following forms, logs, charts, and data records were kept and given to the Honolulu Laboratory upon termination of the cruise. These include all data captured onto computer storage media during the cruise. All the records are filed there unless indicated otherwise in parentheses.

QTC acoustic seabed classification data
TOAD digital video tapes (VHS & MDV)
ArcView GIS track files and shape files
ADCP DOPPLER ping data files on CD-ROM*
CTD Station Data Log Sheet
Seabird CTD data files on CD-ROM*
Digital camera photos (JPG file format) on CD-ROM*

Marine Operations Log
Project Area and Operations Chartlets
Scientist's Log
SCS data files (raw & compressed) on CD-ROM*
Station Number and Activity Log

*All data files together on the same (1) CD-ROM

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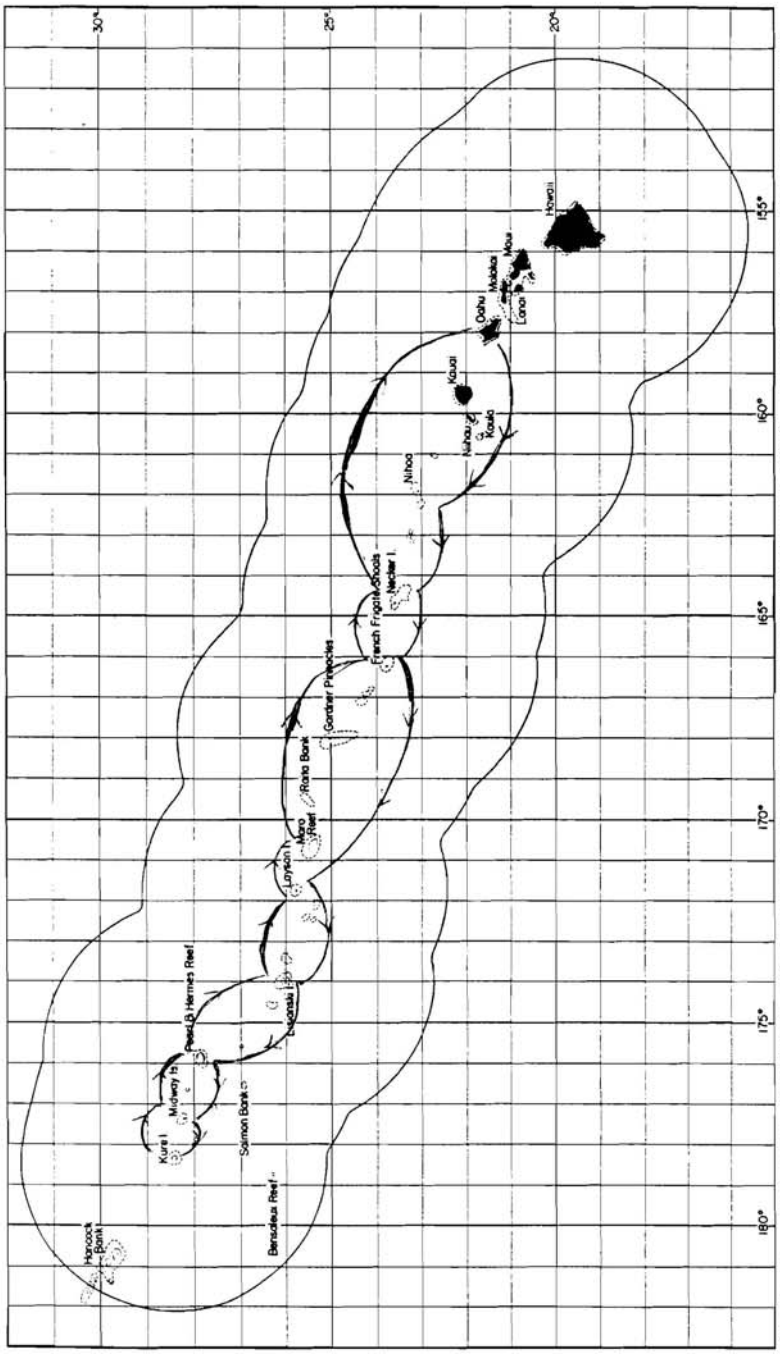

Figure 1.--Track of the NOAA ship Townsend Cromwell cruise TC-02-07 (TC-281), September 8 to October 7, 2002.

Appendix A.

Materials and Methods

Rationale: Quantitative algal sampling in the NWHI has been limited by four factors: short visits to each site (40-50 minutes/year), the inability of phycologists to work away from the "fish transects," only having one phycologist per benthic team, and lack of expertise in the field. The techniques presented here were written by phycologists with first-hand experience from previous research missions, and give divers the ability to sample on and slightly away from the fish transect line, quickly record percent cover using photoquadrats and sample species without the aid of trained phycologists.

Strengths of this method:

- one person will analyze all field collected images. This will provide consistency of analysis instead of having multiple divers with varying levels of expertise trying to subjectively determine percent cover of various genera in the field.
- fish transects are usually laid at a constant depth. Previous phycologists have been frustrated by seeing large amounts of algae growing in shallower water a short distance away from the fish transect and being unable to sample those areas because of sampling constraints placed on the benthic team. This method allows phycologists to move off the main transect into shallower water.
- specimens collected from each photoquadrat will allow for easier species determination and take the guesswork out of trying to determine which genera appear in each picture.
- preserved specimens will allow for subsequent analysis of epiphtyes.

2-person algal sampling

1.) The evening before diving, determine how many sites will be visited the following day. For each site, prepare the following:
- random numbers for fish transect. Select three random numbers between 1 and 25 (do this twice because two 25-meter transects will be sampled at each site (see red dots on Figure 1). Record random numbers on data sheets.

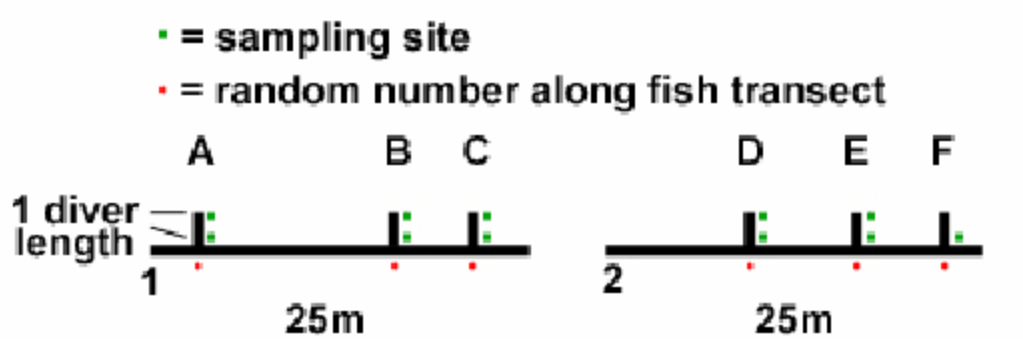

Figure 1: Diagram of fish and sampling transects. Fish transects are labeled "1" and "2." Three sampling "transects" (labeled "A-F") arise from random points (red dots) along each of the fish transects. One ¼ m^2 quadrat (green dots) is sampled at the intersection of the fish and sampling transects, another ¼ m^2 quadrat is sampled one diver length off the fish transect.

- label ziploc bags for samples. Twelve bags will be required for each site. Labels should contain collection date, site, fish transect number, sampling transect letter, and quadrat number (e.g., 05-28-2002, FFS 14 (French Frigate Shoals, site 14), 1A1 (fish transect 1, sampling transect A, quadrat 1).
- label two extra ziploc bags with date and site. These bags will be used for collecting macroalgae that does not appear in quadrats, but are representative of the site.
- place ziploc bags labeled for the first site, transect tape, clipboards, and data sheets for the first site in goody bag.

2.) In the morning, load the small boat with the following:
- prepared goody bag
- labeled ziplocs and data sheets for additional sites
- cooler or bucket for samples
- camera stand
- camera and strobes
-diving gear

3.) When you reach your dive site, set up camera and strobes on stand before getting in water. Once in the water, one diver should carry the camera plus stand, and the other diver should carry the goody bag.

4.) When divers reach their first random point on the fish transect, determine which side of the fish transect will be sampled. ALWAYS SAMPLE TOWARDS SHALLOWER WATER.

5.)

Diver 1	Diver 2
- Place camera stand next to random point on fish transect. Be consistent about which side of the sampling transect you sample. - focus camera and take photo - continue to hold camera frame in place as Diver 2 samples algae. - swim approximately one diver length away from fish transect (perpendicular from fish transect toward shallower water). - repeat photographic and sampling methods.	- while Diver 1 is focusing camera and taking photo, get labeled ziploc bag ready. Make sure you use the correct bag with the correct quadrat! If time permits, begin taking field notes. - when Diver 1 is finished taking photo, take one representative plant for each macroalga from the quadrat, outlined by the camera frame, and place in sampling bag. When you are done collecting algae from this quadrat, place sample bag in your goody bag. If no algae are present, make note of this on your data sheet. -move to next quadrat.

6.) Continue to next random point on fish transect and repeat procedure above.

7.) When photos have been taken and samples collected from all the quadrats, it is essential that divers write down field notes describing the environment. Swim around the general area and collect any macroalgal species that did not occur in sampling quadrats. Place these algae in the bags with date and site labels.

8.) In the evening, examine bags of algae collected. Make a list of what genera (and possibly species) were collected from each quadrat (and from the "general site" bags not associated with quadrats). Freeze algae in ziploc bags with a little seawater for later analysis.

9.) Download camera and save pictures for later analysis. Write up field notes, and add species found in each quadrat to database.

Specimen identification

1.) Identify site to process and thaw specimens.

2.) Under the fume food, place specimens from each quadrat into a separate, priorly labeled dish with a little 4% formalin.

3.) Decide which macroalgae to begin analyzing (e.g., if the same species of *Halimeda* occur in 9 of the 12 quads, it will only need to be identified at a microscopic level once). In your macroalgal species spreadsheet, indicate which photoquadrats contain this alga.

4.) Place samples of this alga under a dissecting microscope and identify epiphytes to genus (or species if easily recognizable). In an epiphyte spreadsheet, record the epiphytes that occur on each macroalgal species.

5.) Remove representative epiphytes from macroalga and place in a vial with 4% formalin (the same vial will be used for all epiphytes and turf from this site). Be sure vial is labeled with site number.

6.) Identify macroalga, be sure that the species name in your spreadsheet is correct!

7.) Press all specimens of each species from each site (combine all photoquadrats and random swim) on a single sheet of herbarium paper.

8.) Repeat steps 3-7 until all macroalgae for the chosen site have been identified.

9.) Identify any remaining turf to genus. Place turf algae into the site vial. Record main turf genera on your macroalgal species spreadsheet as "*Ceramium* spp. turf," "*Gelidium/Centroceras* spp. turf," or whatever one or two main genera are present. If turf assemblage is too diverse to characterize, call it "mixed genus turf."

Photoquadrat analysis

1.) Open photoquadrat pictures in Adobe Photoshop. Straighten photos, crop out quadrat frame, and adjust color. Save photos in separate modified photos folders with a "-ps"

(stands for photoshop) placed at the end of the original site number (e.g., folder would be "MAR30 modified," file would be "1A1-ps").

2.) Open modified photoquadrat pictures in PhotoGrid. Place 100 random points on picture. Referring to species lists created while identifying algae and original data sheets, identify algal species that fall under random points. Turf algae should be labeled with appropriate turf algal category (rubble or any other hard surfaces usually are covered with turf) and crustose coralline red algae should be labeled "crustose coralline red algae." Corals and other invertebrates should be labeled to species when possible. Unidentifiable areas should be labeled "black hole." Sand will probably be the only substrate category found.

3.) Save PhotoGrid files in a separate folder for final statistical analyses.

Results

Of the 10 Northwestern Hawaiian Islands, reefs, and shoals, only Nihoa and Gardner Pinnacles were not visited. The number of sites visited at a particular island is correlated to the number of algal genera found (see table below).

Island	**Number of sites visited**	**Number of quadrats photographed and sampled**	**Preliminary number of genera found***
Necker Island	1	12	7
French Frigate Shoals	12	144	18
Maro Reef	5	60	21
Laysan Island	3	36	15
Lisianski Island/Neva Shoals	7	84	22
Pearl and Hermes Reef	14	168	24
Midway Island	9	108	22
Kure Atoll	8	108 (one site was sampled twice at 2 depths)	23
Total	59	720	39 macroalgal genera found

*all genera require laboratory identification, multiple species of certain genera found

Preliminary analysis of samples immediately after collection indicates that at least 39 macroalgal genera were found. This number is an underestimation of the actual number of species found because it is already known that multiple species of genera such as *Caulerpa*,

Dictyosphaeria, *Halimeda*, *Laurencia*, *Liagora*, and the crustose reds were collected. Additionally, genera that could not be identified aboard ship were left out of our preliminary analysis entirely. It is predicted that, after analysis, the total number of macroalgal species collected will approach 60. If turf algae and epiphytes are eventually analyzed and included in the analysis, species number will probably increase to over 150.

Site descriptions and preliminary algal species lists

Necker Island

Site NEC4 (9/10/2002)
The benthos mainly consisted of sand-covered turf, with patches of deeper "*Halimeda*" sand. A small species of *Halimeda* was the dominant alga present, although *Halimeda opuntia*, *Dasya iridescens*, *Laurencia* sp., *Halichrysis coalescens* (growing under rocks, not readily noticeable), and *Gibsmithia hawaiiensis* were also collected. Coral cover was low, with occasional *Pocillopora meandrina* heads. Depth ranged from 40 to 50 feet deep.

Summary for Necker Island: at least six macroalgal genera found in photoquadrats. An additional species, *Halichrysis coalescens*, was found during the random swim.

One site was sampled. Table does not include algae found during random swim.

	% of quads sampled containing alga	Rank of alga*
Halimeda spp.	91.67%	1.00
Halimeda opuntia	8.33%	2.00
Dasya sp.	8.33%	2.00
Gibsmithia hawaiiensis	8.33%	2.00
Laurencia spp.	16.67%	1.50
crustose coralline	8.33%	4.00
blue-green	25.00%	2.67

1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

French Frigate Shoals

Site FFS20 – West of Tern Island, north of Shark Island (9/11/2002)
Lots of the coral *Porites lobata* interspersed with sand-covered turf and the occasional sand patch. *Halimeda* sp. was the only ubiquitously common alga at the site, although patches of *Caulerpa taxifolia* and *C. webbiana* were observed. *Haloplegma duperreyi* was found growing under rock overhangs. Depth ranged from 33 to 41 feet deep.

Site FFS21 – South of Shark Island (9/11/2002)
Site dominated by *Acropora cythera* mixed with sand-covered turf and occasional sand patches. *Halimeda* sp. common. *Caulerpa taxifolia*, *C. webbiana*, *Dasya iridescens*, *Turbinaria ornata*,

and *Haloplegma duperreyi* (growing under dark overhangs) were also found. Reproductive individuals of *Halimeda* sp. were observed and collected. Depth ranged from 31 to 37 feet deep.

Site FFS22 – West of Whale Skate Island (9/11/2002)
This shallow water site (9-11 feet deep) consisted of huge sand areas with fringing areas of coral rubble. Extensive beds of highly-epiphytized *Microdictyon* sp. covered the coral rubble, with occasional patches of a gregarious species of *Liagora*. A species of *Laurencia*, and both crustose and upright, branched coralline red algae were observed and collected.

Sites FFS24, 25, 26 – East side of FFS (9/12/2002)
All three sites visited were fairly similar in general appearance. The benthos consisted of sand-covered turf interspersed with sand patches/channels and coral (*Pocillopora meandrina*, *Porites lobata*, and small *Acropora* spp.). *Microdictyon* and *Halimeda* were the dominant algae present. Site 25 also had a large abundance of *Liagora*. A flattened species of *Laurencia*, *Lobophora variegata* (or possibly *Distromium* sp.), *Turbinaria ornata*, and *Neomeris* sp. were also found. All sites were about 35-42 feet deep.

Sites FFS27, 28, 29 – Northeast corner of FFS (9/13/2002)
All three sites visited contained spur-and-groove reef formations, exhibiting a considerable amount of vertical relief. Most surfaces were covered with a robust sand-covered algal turf. *Microdictyon setchellianum* and *Halimeda* spp. (possibly both *H. discoidea* and *H. velasquezii*) were the dominant macrophytes. Occasional *Turbinaria ornata*, *Caulerpa taxifolia*, *Haloplegma duperreyi*, and a flattened *Laurencia* species were found. Small coral heads (*Acropora* sp., *Porites lobata*, and *Pocillopora* spp.) were common. Depths ranged from 30 to 45 feet deep.

Site FFS30 – Southwest of Tern Island (10/4/2002)
This site consisted of a series of patch reefs separated by sand channels. Lots of *Acropora cytherea* table corals dominated the site, along with *Pocillopora meandrina* and *Porites lobata*. Two species of *Halimeda*, a robust species of *Laurencia*, and *Microdictyon* occurred in our photoquadrats. *Dasya iridescens*, *Haloplegma duperreyi*, *Kallymenia* sp., and *Caulerpa taxifolia* were collected during the random swim. Depths ranged from 15 to 24 feet deep.

Site FFS31 – Southeast of Trig Island (10/4/2002)
Dense *Porites lobata* and *P. compressa* patch reef, ranging in depth from 8 to 21 feet. Large *Lobophora variegata* blades occurred deep between coral fingers. A flattened species of *Laurencia* and *Microdictyon setchellianum* grew between fingers near the surface. Both *Dictyosphaeria cavernosa* and *D. versluysii* occasionally occurred in our photoquadrats, and crustose coralline red algae overgrew dead portions of coral below living coral tissue. Turf was also dense at times below living coral polyps.

Site FFS32 – West of East Island (10/4/2002)
Fifteen- to 25-foot reef covered with living ark shells. Turf and calcareous algae covered the hard substrate. *Halimeda* species were the most common macroalgae, although *Microdictyon* was patchily very abundant. *Kallymenia* sp. and *Lobophora variegata* also occurred in our photoquadrats. *Gibsmithia hawaiiensis*, *G. dotyii*, *Dasya iridescens*, *Haloplegma duperreyi*, and *Halichrysis coalescens* were found during the random swim.

Summary for French Frigate Shoals: at least 14 macroalgal genera found in photoquadrats. An additional four genera were found during the random swims: *Caulerpa taxifolia*, *C. webbiana*, *Haloplegma duperreyi*, *Dasya iridescens*, and a "*Graciliaria*"-ish genus.

Twelve sites were sampled. Table does not include algae found during random swims.

	% of quads sampled containing alga	Rank of alga*
Dictyosphaeria cavernosa	0.69%	3.00
Dictyosphaeria versluysii	1.39%	3.00
Halimeda spp.	68.06%	1.32
Halimeda opuntia	0.69%	1.00
Microdictyon setchellianum	50.69%	1.57
Neomeris sp.	1.39%	3.00
Kallymenia sp.	0.69%	3.00
Laurencia spp.	5.56%	2.53
Laurencia sp. flattened	4.86%	3.35
Liagora sp.	4.17%	1.50
Peyssonnelia spp.	5.56%	1.95
branched upright coralline	1.39%	3.00
crustose coralline	7.64%	2.71
Dictyota spp.	0.69%	4.00
Lobophora variegata	7.64%	2.80
Turbinaria ornata	0.69%	3.00
Blue-green cyanophyte	0.69%	3.00

* 1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

Species of *Halimeda* and *Microdictyon* were the most common macroalgae and usually dominated the areas they occurred. However, at the few sites where *Liagora* occurred, it was one of the most dominant algae present (as indicated by the low number of quads containing *Liagora*, but the high rank).

Maro Reef

Site MAR26 – Northwest corner (10/1/2002)
This site was characterized by lots of *Halimeda opuntia*, *H. velasquezii*, and a species of *Bryopsis* (probably *B. pennata*). *Hypnea* sp. was commonly entwined with *Halimeda*. Our photoquadrats also contained *Dictyosphaeria cavernosa*, *D. versluysii*, *Halymenia* sp., and branched and crustose coralline red algae. *Dasya iridescens*, *Exophyllum* sp. (courtesy of Scott Godwin, found under a stone), possibly *Chlorodesmis*, and an encrusting green alga were found during the random swim. Depths ranged from 36 to 50 feet.

Site MAR27 – West-northwest corner (10/1/2002)
Although situated on a slope very similar to MAR26, coral cover (particularly *Porites lobata* and *Montipora turgescens*) was high. *Bryopsis* was much less common (although a bit was present), and a robust species of *Laurencia* was found in most photoquadrats. *Halimeda opuntia* and *H. velasquezii* were among the most common algae in our photoquadrats, but we also found *Martensia*, *Hypnea*, *Dictyosphaeria versluysii*, *Portieria hornemannii*, branched and crustose coralline reds. A species of *Scinaia* was discovered during our random swim, growing under a branched coralline red alga.

Site MAR28 – East side (10/2/2002)
Extremely high coral cover (Jean Kenyon counted over 14 species). *Porites lobata*, *Montipora turgescens*, *Acropora valida*, and *Pocillopora meandrina* all very common. Consequently, algal cover was moderately low. Both *Halimeda opuntia* and *H. velasquezii* occurred in our photoquadrats. *Dictyosphaeria cavernosa*, a tiny, deep red *Laurencia*, both branched and crustose coralline red algae were also found. *Caulerpa webbiana*, *Haloplegma duperreyi*, *Portieria hornemannii*, and *Dasya iridescens* were discovered during the random swim. Depth ranged from 37 to 49 feet, and there was a strong (~1 knot surface current present).

Site MAR29 – Northeast side (10/2/2002)
We are all in agreement, this was the best dive of the trip. Coral cover was high and slopes were covered with uninterrupted sheets of *Porites lobata*. Invertebrates abounded, and algae were very diverse. Our photoquads contained the standard: *Halimeda opuntia*, *H. velasquezii*, *Dictyosphaeria cavernosa*, and *D. versluysii*. However, *Caulerpa webbiana*, *Boodlea composita* (just a tiny bit), and beautiful representatives of *Martensia fragilis* were also recorded. During the random swim we found *Caulerpa peltata*, *Bryopsis* sp., *Neomeris* sp., *Haloplegma duperreyi*, *Halichrysis coalescens*, *Portieria hornemannii*, *Peyssonnelia* sp., *Kallymenia* sp., *Dictyota* sp., and *Dasya iridescens*. Depths ranged from 32 to 45 feet deep, although the slope rapidly descended into much deeper water. Coral and other organisms continued to cover the slopes as far down as we could see.

Site MAR30 – Southeast corner (10/2/2002)
We are all in agreement, this was the worst dive of the trip. A current exceeding 1 knot was present from the surface all the way to the bottom, and visibility was limited to about 15 feet. Because we had to hang on for dear life, our sampling was probably not as thorough as at other sites. Despite this, the bottom seemed to be covered primarily with an algal microturf (very short turf), crustose coralline algae, and the occasional individual of *Halimeda*. Other than a little *Dictyosphaeria cavernosa* and *Lobophora variegata*, no other algae were found in our photoquadrats. Depths ranged from 27 to 33 feet deep.

Summary for Maro Reef: at least 13 macroalgal genera found in photoquadrats. An additional eight genera were found during the random swims: *Caulerpa peltata*, *Chlorodesmis* sp., *Neomeris* sp., *Dasya iridescens*, *Exophyllum* sp., *Halichrysis coalescens*, *Haloplegma duperreyi*, *Kallymenia* sp., and a species of *Peyssonnelia*.

Five sites were sampled. Table does not include algae found during random swims.

	% of quads sampled containing alga	Rank of alga*
Boodlea composita	1.67%	3.00
Bryopsis spp.	11.67%	2.86
Caulerpa webbiana	1.67%	2.00
Dictyosphaeria cavernosa	11.67%	3.00
Dictyosphaeria versluysii	11.67%	3.89
Halimeda spp.	73.33%	1.39
Halimeda opuntia	35.00%	1.83
Halymenia sp.	1.67%	5.00
Hypnea spp.	5.00%	4.00
Laurencia spp.	21.67%	2.99
Martensia fragilis	3.33%	3.00
Portieria hornemannii	1.67%	7.00
branched upright coralline	33.33%	2.94
crustose coralline	50.00%	2.11
Lobophora variegata	1.67%	2.00

1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

Laysan Island

Sites LAY4, 5 – Northeast and north sides of island (9/15/2002)
Site was characterized by high vertical relief. Algal cover was dense, particularly red algae. Large monotypic stands of *Asparagopsis taxiformis* were seen intermixed with red algal turf, epiphytized *Microdictyon setchellianum* and *Halimeda* species. A "nemalialious" red (possibly a species of *Galaxaura*) was commonly collected along with coralline reds (both crustose and branched). The turf algal assemblage was a chaotic mix of various species that will require significantly more analysis. Depths averaged between 36-41 feet deep.

Site LAY6 – West side of island (9/15/2002)
This site was among the most phycologically diverse visited so far. The vertical relief was a little less than the previous two sites, although the site exhibited a typical spur-and-groove reef formation. *Halimeda* and *Microdictyon* were mixed with large (1-2-foot diameter) coralline algal heads. *Gibsmithia hawaiiensis* was somewhat common along with *Laurencia* sp., *Portieria hornemannii*, *Martensia fragilis*, *Padina* sp., and a possible species of *Galaxaura*. The turf community was a nightmare and will require lab analysis. Depths ranged from 29 to 34 feet deep.

Summary for Laysan Island: at least 15 macroalgal genera found in photoquadrats. No additional genera were found during the random swims.

Three sites were sampled. Table does not include algae found during random swims.

	% of quads sampled containing alga	Rank of alga*
Halimeda spp.	97.22%	1.74
Microdictyon setchellianum	30.55%	1.10
Asparagopsis taxiformis.	11.11%	1.75
Galaxaura spp.	13.89%	3.60
Jania spp.	2.78%	3.00
Laurencia spp.	8.33%	4.33
Haloplegma duperreyi	2.78%	2.00
Martensia fragilis	8.33%	3.25
Peyssonnelia spp.	11.11%	1.50
Portieria hornemannii	2.78%	3.00
branched upright coralline	8.33%	2.67
crustose coralline	36.11%	2.04
Dictyota spp.	2.78%	3.00
Padina spp.	5.55%	4.00
Blue-green	13.89%	3.38

* 1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

Lisianski Island/Neva Shoals

Site LIS9 – Southeast of Neva Shoals (9/16/2002)
This site was characterized by an incredibly high abundance of pink crustose coralline algae. *Dictyosphaeria cavernosa*, *Caulerpa webbiana*, *Neomeris* sp., *Halimeda opuntia*, and *Halimeda* sp. were common, interspersed with dense algal turf. Coral diversity was high, especially fungiid corals, *Montipora flabellata*, etc. Lots of big ‘ulua. Depths ranged from 39 to 43 feet deep.

Site LIS10- South of Neva Shoals (9/16/2002)
Dense *Porites compressa* habitat with relatively low diversity of other organisms was characteristic of this location. Large patches of branched coralline algae were present, and *Halimeda opuntia* was found growing between coral fingers. Dense algal turf and crustose red algal pavement were found sporadically, and a fairly high cover of blue-green algae and other gunk was collected below living coral. Depths ranged from 31 to 37 feet deep.

Site LIS11 – Inside reef, northeast of island (9/29/2002)
Montipora tuberculosa and *Porites lobata* reef. Several *Halimeda* species were common, mixed with a little *Microdictyon*, *Dictyosphaeria versluysii*, *Haloplegma duperreyi*, and lots of coralline reds (*Peyssonnelia* sp., branched uprights, and crustose). Tiny individuals of *Martensia* also appeared in our photoquadrats. Scott Godwin collected *Exophyllum* sp. growing under rubble.

Site LIS12 – Barrier reef, northwest of island (9/29/2002)
This site consisted of large patch reefs separated by deeper sand channels. Our transects started on the far edge of one reef, extended across a sand channel, and then continued on the next patch reef. As with LIS11, at least two species of *Halimeda* were common (*Halimeda opuntia* and *H. velasquezii*??) mixed with crustose coralline algae, *Microdictyon*, *Peyssonnelia*, and *Haloplegma duperreyi*. *Caulerpa taxifolia*, *Dictyosphaeria versluysii*, *Ventricaria ventricosa*, *Amansia*, and *Portieria* were collected during the random swim.

Site LIS13 – Barrier reef, northwest of island (9/29/2002)
This ribbon reef had an algal species composition very similar to the two sites explored earlier in the day. *Halimeda* species, crustose and branched coralline reds, *Haloplegma duperreyi*, *Peyssonnelia* sp., *Microdictyon setchellianum*, and *Jania* species all occurred in our photoquadrats. *Portieria hornemannii* was recorded in our quadrats for the first time during the trip (although it had been collected numerous times on random swims). *Dictyosphaeria versluysii* and a thick, fleshy red alga were found during the random swim.

Sites LIS14, 15 – East and southeast of island (9/30/2002)
These two sites contained an amazing amount of healthy coral (*Porites lobata*, *P. compressa*, *Montipora turgescens*, *M. tuberculosa*, *Fungia scutaria*). *Halimeda opuntia* and *H. velasquezii* were common in our quadrats, and another species of *Halimeda* with huge segments was found during the random swim (possibly *H. discoidea*; this same large alga has commonly been found throughout the trip, but generally in small quanitities). A dense, but short, algal turf covered all hard surfaces. Branched and crustose coralline algal species commonly occurred in our photoquadrats, along with *Neomeris* (we took a photograph of the largest *Neomeris* patch I've ever seen at LIS14), *Dictyosphaeria cavernosa*, *D. versluysii*, *Microdicyton*, and occasionally *Haloplegma duperreyi* and *Martensia fragilis*. *Dasya iridescens*, a species of *Halymenia*, and *Caulerpa webbiana* were found during our random swims.

Summary for Lisianski Island/Neva Shoals: at least 17 macroalgal genera found in photoquadrats. An additional five genera were found during the random swims: *Caulerpa taxifolia*, *Ventricaria ventricosa*, *Amansia* sp., *Exophyllum* sp., *Halymenia* sp., and a species of *Liagora*.

Seven sites were sampled. Table does not include algae found during random swims.

	% of quads sampled containing alga	Rank of alga*
Caulerpa webbiana	2.38%	1.50
Dictyosphaeria cavernosa	8.33%	2.80
Dictyosphaeria versluysii	4.76%	4.17
Halimeda spp.	66.66%	1.66
Halimeda opuntia	29.76%	1.86
Microdictyon setchellianum	26.19%	2.17
Neomeris spp.	13.10%	2.82
Dasya iridescens	1.19%	4.00

	% of quads sampled containing alga	Rank of alga*
Jania spp.	8.33%	4.92
Laurencia spp.	1.19%	1.00
Haloplegma duperreyi	14.29%	2.50
Martensia fragilis	4.76%	4.17
Peyssonnelia spp.	15.48%	3.38
Portieria hornemannii	1.19%	3.00
branched upright coralline	28.57%	1.88
crustose coralline	46.43%	1.86
Dictyota spp.	1.19%	3.00
Lobophora variegata	2.38%	3.50
Blue-green cyanophyte	10.71%	2.56

1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

Pearl and Hermes Reef

Site PHR15 – Outside southeast side (9/17/2002)
Topography consisted of high reef ridges with deep sand channels in between. Although this was a really pretty reef, both algal and coral diversity were relatively low. *Microdictyon* and *Halimeda* were the major algal genera seen, but *Turbinaria ornata*, *Jania* sp., *Laurencia* sp., *Lobophora variegata*, and a species of *Padina* were found within our quadrats. A small *Stypopodium hawaiiensis* was collected during the random swim. Depths ranged from 29 to 33 feet on top of the reef ridges.

Site PHR16 – Outside east side (9/17/2002)
Topography of this site was similar to the previous site; however two species of *Laurencia* were among the most common algae found along with *Microdictyon* and *Halimeda*. A diminutive species of *Jania* was also found in many quadrats. Additional algae recorded include: *Halichrysis coalescens*, *Amansia* sp?, *Haloplegma duperreyi*, and a species of *Neomeris*. Depths ranged between 28-37 feet on top of the reef ridges.

Sites PHR17, 18 – Outside extreme northeast side (9/18/2002)
Both these sites were composed of ribbon reefs separated by deep sand channels. *Microdictyon* and *Halimeda* were the most common algae, although a fair amount of *Laurencia* and perhaps two species of branching coralline red algae were also observed and collected. *Dasya iridescens*, *Padina* sp., *Lobophora variegata*, and a species of *Neomeris* were found in our quadrats, and species of *Amansia* and *Haloplegma* were collected during the random swim. Mystery algae include a fuzzy, branched red (perhaps a *Dasya*?) and several specimens of a big fat *Halimeda*. Both sites averaged about 40 feet deep. An extreme coral bleaching event was in progress.

Site PHR19 – Outside north northeast side (9/18/2002)
Visibility was extremely bad during this dive, and algal diversity and cover were very poor. Many quadrats consisted of calcified pavement covered with turf algae, or crustose coralline red algae. *Halimeda* was the most common macroalga, but a little *Microdictyon* and *Neomeris* were also seen. Algae found on the random swim include: *Caulerpa serrulata*, *Dictyosphaeria versluysii* (very small specimens), *Turbinaria ornata*, *Haloplegma duperreyi*, and a species of *Peyssonnelia*. An extreme coral bleaching event was in progress.

Site PHR20 – Inner lagoon, SE corner near sand pass (9/19/2002)
This shallow water habitat (8-10 feet deep) was a haven for member of the Dictyotales. A basal layer of *Microdictyon* served as a host species for *Dictyota* and *Padina* (including a lot of *Vaughniella*). *Dictyosphaeria versluysii* was also collected. Many species of turf algae also grew on *Microdictyon*.

Site PHR21 – Inner lagoon inside the SE section of the "maze" (9/19/2002)
Visibility was extremely poor during this dive. We dove in the "maze," a habitat of *Porites compressa* ribbon reefs. *Porites compressa* cover was almost 100%, and many showed signs of bleaching. Almost no algae were seen in our photoquadrats. *Halimeda opuntia* (or perhaps *gracilis*?) was found growing near the base of one coral, and a species of *Peyssonnelia* was found growing on another. All other algae appeared to consist of blue-greens, or possibly some Ceramiacious turfs. Depth ranged between 26 to 34 feet deep.

Site PHR22 – Inside lagoon, backreef area on S side of atoll (9/19/2002)
This extremely shallow site (4-7 feet deep at high tide) received a lot of water motion. Sand patches and channels were colonized by a considerable amount of light pink *Liagora*. Hard substrate was colonized primarily by *Microdictyon* and a small species of *Laurencia* (or *Chondria*?). Branched coralline red algae and *Halimeda* were also found in our photoquadrats. *Turbinaria ornata* was found during the random swim.

Site PHR23 – Inside lagoon, west side of atoll (9/26/2002)
Ribbon reef. Our first transect started near the top of the reef and sloped diagonally down the reef slope to a sand plane located at about 30 feet deep. Although macroalgae were dense, they were highly epiphytized with blue-green cyanobacteria and filamentous algae and then covered in silt, making it virtually impossible to ascertain what genera were present (photoquadrat IDs might be difficult). Huge individuals of a dichotomously branched *Codium* were present all along the reef slope, mixed with a species of encrusting *Codium*, up to three species of *Halimeda*, and *Microdicyton setchellianum*. A small species of *Laurencia* and some coralline algae also occurred in our photoquadrats, and *Haloplegma duperreyi* was found during the random swim.

Site PHR24 – Inside lagoon, northwest side of atoll (9/26/2002)
Ribbon reef. This site was very similar to site PHR23, except that species of *Codium* were entirely lacking. *Halimeda velasquezii* and another species of *Halimeda* dominated almost all photoquadrats, but were so highly epiphytized and covered with silt that they were hard to distinguish. Both *Dictyosphaeria cavernosa* and *D. versluysii* were found in our quadrats, and *Caulerpa webbiana* (with exceptionally long upright axes) was found during the random swim.

Site PHR26 – Inside lagoon, north side of atoll, east of Engine Block Pass (9/26/2002)
This shallow water reef (3-6 feet deep) contained a lot of bleached (and unbleached) *Montipora turgescens* and bleached *Montipora capitata*. Sand channels ran between coral heads. A small species of *Laurencia* was among the most common algae present, along with species of *Halimeda*, a flattened *Laurencia*, *Microdictyon*, coralline red algae, *Turbinaria ornata*, and a species of *Neomeris*. *Halimeda opuntia*, *Caulerpa webbiana*, *Haloplegma duperrryii*, *Lobophora variegata*, *Dictyosphaeria cavernosa*, *Peyssonnelia rubra*?, and a blue-green cyanophyte were collected during the random swim.

Site PHR30 – Inside lagoon, southwest side of atoll (9/27/2002)
Shallow water backreef (6-8 feet deep). Extremely high current/surge (almost not swimmable). Large populations of a species of *Liagora* existed at this site, and individual plants commonly appeared in our photoquadrats. The benthos was covered with fine turf. Other macroalgae present included: *Microdictyon* (very short plants), two species of *Laurencia*, *Lobophora variegata*, *Dictyosphaeria versluysii*, possibly the *Vaughniella* stage of *Padina*, *Neomeris*, *Jania*, *Stypopodium*, *Turbinaria*, *Halimeda*, *Dasya iridescens*, and a branched coralline. Most large *Pocillopora meandrina* heads were dead and covered with turf and coralline algae.

Site PHR31- Inside lagoon, extreme southeast corner of atoll (9/28/2002)
At this site, parallel ridges rose to within 10 feet of the surface and were separated by broad 30-foot deep sand channels. Macroalgae and invertebrates were rather scarce, and very short turf algae (microturfs) covered the rubbly slopes. Macroalgae present were often covered by white silt, making field identification difficult. *Microdictyon*, *Neomeris*, *Dictyosphaeria versluysii*, *Halimeda*, and both crustose and branched corallines were found in our photoquadrats. During the random swim, *Hypnea*, *Lobophora*, *Dasya iridescens*, *Haloplegma duperreyi*, *Amansia*, and an unknown red (possibly something from the Rhodomeniales) were found.

Site PHR32
We anchored the boat above a shallow backreef (6-8 feet deep) where the diminutive, orange *Laurencia* and sharply-pointed, branched coralline red that we found so frequently during our trip were common. Transects were laid on a slope between 20-25 feet deep. Below the slope a large sand plane contained beds of *Halophila hawaiiana*. The slope that was sampled was almost completely covered by species of *Microdictyon* and *Padina*. *Stypopodium*, *Liagora*, and *Dictyosphaeria cavernosa* also occurred in our photoquadrats. *Caulerpa serrulata*, *Lobophora*, *Dictyosphaeria versluysii*, *Neomeris*, and *Halimeda* were discovered during our random swim. Almost all coral in the area (mostly *Pocillopora meandrina*) were dead and commonly covered with tufts of *Padina*.

Summary for Pearl and Hermes reef: at least 18 macroalgal genera found in photoquadrats. An additional six genera were found during the random swims: *Caulerpa serrulata*, *C. webbiana*, *Amansia* sp., *Halichrysis coalescens*, *Haloplegma duperreyi*, *Peyssonnelia* sp., and the native seagrass (a vascular plant), *Halophila hawaiiana*.

Fourteen sites were sampled. Table does not include algae found during random swims.

	% of quads sampled containing alga	Rank of alga*
Codium spp.	2.98%	2.20
Dictyosphaeria cavernosa	1.19%	2.50
Dictyosphaeria versluysii	6.55%	3.11
Halimeda spp.	52.98%	1.75
Halimeda opuntia	2.38%	1.34
Microdictyon setchellianum	58.93%	1.73
Neomeris spp.	6.55%	4.00
Dasya iridescens	1.19%	3.00
Hypnea spp.	0.60%	5.00
Jania spp.	5.95%	4.25
Laurencia spp.	33.33%	2.39
Laurencia sp. flattened	1.19%	3.00
Liagora sp.	9.52%	2.92
branched upright coralline	19.05%	2.67
crustose coralline	16.67%	2.61
Dictyota spp.	4.17%	2.59
Lobophora variegata	3.57%	3.17
Padina spp.	16.07%	3.00
Stypopodium hawaiiensis	0.60%	4.00
Turbinaria ornata	1.19%	2.50
Blue-green cyanophyte	1.19%	1.50

1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

Midway Island

Sites MID H11, H17X, H5X – Inside lagoon north of Green Island (9/20/2002)
These three small patch reefs ranged from 10 to 18 meters long, about 15-20 feet deep. A broad species of *Padina* with highly dissected blades was the most common alga, followed by *Dictyota* and *Lobophora variegata*. *Dictyosphaeria versluysii*, *Laurencia*, and *Galaxaura* were also found. Because these sites were so small in area, only one transect was needed to traverse the entire patch reef, meaning that the second transect contained only quadrats of sand.

Site MID H19 – Outside lagoon north of Sand Island (9/21/2002)
This was a highly scoured site subjected to a lot of surge. Macroalgae were scarce, although tiny individuals of *Halimeda* (with unusually small segments), *Galaxaura*, a small species of *Padina*, and *Dictyota* were recorded in our photoquadrats. Very short turf covered most of the benthos. *Portieria hornemannii* was collected during our random swim. Depth ranged from 35 to 41 feet.

Site MID H21 – Inside of lagoon north of Sand Island at "Reef Hotel" (9/21/2002)
This shallow water backreef was only 2 to 4 feet deep, and dominated by the corals *Montipora turgescens* (an iridescent blue species) and *Montipora capitata* (almost 100% bleached during our dive). Visible algae were scarce, with turf covering most of the hard substrate present. Most macroalgal diversity was discovered growing on the undersides of corals or between crevices. Species found include: *Dictyota* spp., *Neomeris* sp., *Caulerpa racemosa*, *C. serrulata*, *Boodlea composita*, *Amansia* sp., *Halichrysis coalescens*, *Hypnea* sp., *Portieria hornemannii*, *Predaea weldii*?? and *Lobophora variegata*.

Site MID1 – Inside of lagoon north of Sand Island (9/21/2002)
This site consisted mostly of large heads of *Montipora turgescens* that almost reached the surface, with sand channels between (about 4 feet deep). Turf algae grew on hard substrate, and *Halimeda opuntia* and *Halimeda* spp. were found growing in sandy areas. *Amansia* spp., *Halichrysis coalescens*, *Hypnea* sp., and *Galaxaura* grew under coral heads. The sites sampled on this dive do not reflect the true percent cover of organisms because the coral growing close to the surface meant that our photoquad and camera were above the surface of the water. The only places where photographs could be taken were in the deeper sand channels.

Site MID H10 – West side of atoll (9/25/2002)
This site was almost identical to MID H19. The area consisted of scoured spur-and-groove habitat covered with minute algal turf communities. A small species of *Padina*, *Laurencia*, *Lobophora*, and diminutive individuals of *Halimeda* were found in our photoquadrats. *Portieria hornemannii*, *Haloplegma duperreyi*, *Hypnea* spp., and *Peyssonnelia* spp. were collected during our random swim.

Site MID2 – South of Seal Spit Island (9/25/2002)
For the first time during this trip, large individuals of *Dictyota* were the dominant algae present (possibly two species). The site consisted of broad sand patches interspersed with rubbly reef areas. Species of *Laurencia*, *Padina*, and *Halimeda* occurred in our photoquadrats. *Haloplegma duperreyi*, *Caulerpa racemosa*, and *Galaxaura* were discovered during the random swim.

Site MID3 – At SST buoy in mid-lagoon (9/25/2002)
Two small, mostly-dead *Porites compressa* patch reefs rose out of an immense sand plane 30 feet deep. One transect line encircled each patch reef, the first being 16 m in circumference, the second being about 25 m. Very little macroalgae occurred between the dead coral fingers, but the reefs were covered in dense eukaryotic algal and cyanobacterial turf. In the three photoquads that contained macroalgae, *Dictyosphaeria cavernosa*, *D. versluysii*, *Lobophora variegata*, *Microdictyon setchellianum*, and a species of *Halimeda* were found. *Dictyota* spp. were found growing on the sand plane around the base of the patch reefs.

Summary for Midway Island: at least 15 algal genera found in photoquadrats. An additional seven genera were found during the random swims: *Caulerpa racemosa*, *C. serrulata*, *Halimeda opuntia*, *Amansia* sp., *Halichrysis* sp., *Haloplegma duperreyi*, *Hypnea* sp., *Peyssonnelia* sp., and *Portieria hornemannii*.

Nine sites were sampled. Table does not include algae found during random swims.

	% of quads sampled containing alga	Rank of alga*
Boodlea composita	0.93%	1.00
Dictyosphaeria cavernosa	1.85%	1.50
Dictyosphaeria versluysii	1.85%	3.50
Halimeda spp.	19.44%	2.56
Microdictyon setchellianum	4.63%	1.34
Neomeris spp.	1.85%	2.50
Dasya iridescens	0.93%	2.00
Galaxaura spp.	3.70%	1.25
Laurencia spp.	14.81%	2.05
branched upright coralline	14.81%	2.05
Dictyota spp.	23.15%	1.53
Lobophora variegata	12.04%	1.90
Padina spp.	16.67%	1.39
Stypopodium hawaiiensis	0.93%	3.00
Turbinaria ornata	6.48%	2.33
Blue-green cyanophyte	1.85%	1.50

1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

Kure Atoll

Sites KUR10, 11, 12 – Outside reef, east, southeast, and south of Kure Island (9/22/2002)
These sites represent typical spur-and-groove reef. At all sites, species of *Microdictyon*, *Padina*, and *Laurencia* covered the majority of the substrate. *Dictyota*, branched coralline red algae, *Jania*, *Lobophora variegata*, small individuals of *Dictyosphaeria cavernosa*, extremely small plantlets of *Sargassum*?, and a thick, decumbent species of *Codium* also occurred in our photoquadrats. A large, highly branched *Codium*, *Turbinaria ornata*, *Dasya iridescens*, and *Haloplegma duperreyi* were found during the random swims. Depth ranged from 33 to 47 feet.

Sites KUR13, 14 – Inside lagoon, north side of atoll (9/23/2002)
Both these sites ranged in depth from 2 to 4 feet and experienced a somewhat strong current because of the swell coming into the lagoon from the reef crest. Sand patches intermingled with coral heads (*Porites lobata* with a little *Montipora turgescens*) and patches of turf. *Microdictyon* dominated turf habitats, along with a diminutive species of *Laurencia*. Small, but dense, tufts of *Jania* occasionally occurred in our photoquadrats, along with *Turbinaria*, *Halimeda*, *Dictyosphaeria versluysii*, a flattened *Laurencia* species, *Padina*, and branched corallines. *Haloplemga duperreyi*, *Neomeris*, *Lobophora variegata*, *Dictyosphaeria cavernosa*, and a species of *Peyssonnelia* were found during the random swims.

Site KUR16 – Inside lagoon, north side of atoll (9/23/2002)
This site was slightly deeper than the previous two, ranging between 7 and 12 feet deep. Macroalgae were scarce, although a healthy turf community covered all hard substrate present. *Microdictyon* occurred in almost all photoquadrats, but at a density much lower than at other sites. The same small species of *Laurencia* found at sites KUR13 and 14 was also found, along with occasional species of *Halimeda*, *Jania*, *Lobophora*, and a branched coralline red. During our random swim, we found large turfs of a finely branched blue-green alga, *Liagora*, *Turbinaria*, and a distinctive species of *Laurencia*. Coral composition also differed between this site and the two others surveyed earlier in the day. *Montipora capitata* was the most common species found, and most individuals appeared bleached.

Site KUR18 – "Coral Gardens" in middle of lagoon (9/24/2002)
This site consisted of a *Porites compressa* ribbon reef. We conducted two dives here, one along the top of the ridge in 2-8 feet of water, and one near the bottom of the ridge between 15 and 25 feet. The reef ended in about 30 feet of water at a broad sand plane. Most of the coral on top of the reef ridge was bleached or already dead and covered with algal turf. Macroalgal species richness along the top of the ridge was relatively high compared to other areas studied. The following algae were found in our photoquadrats: *Dictyosphaeria cavernosa*, *D. versluysii*, *Caulerpa peltata*, *Laurencia* spp., *Peyssonnelia* spp., *Hypnea* spp., *Bryopsis* sp., branched coralline reds, and lots and lots of turf. During our random swim we found a species of *Predaea*, *Halimeda* spp., and *Dasya iridescens*.

Along the deeper side of the *P. compressa* ridge, coral appeared pigmented and healthy. One noticeable difference between the top of the ridge and this deeper site was that huge blades of *Microdictyon* grew between coral fingers (none was recorded from our site on top of the ridge). Both *Dictyosphaeria cavernosa* and *D. versluysii* were commonly intermixed with the *Microdictyon*. Our photoquadrats also contained *Hypnea*, *Halimeda*, *Peyssonnelia*, blue-green cyanobacteria, and a branched species of upright coralline red algae. Several large specimens of *Caulerpa webbiana* were found during the random swim.

Site KUR17 – Inside lagoon, west side of atoll (9/24/2002)
The site was located on the far western side of the atoll in about 10 feet of water. The site was very "rubbly," with relatively low macroalgal cover (although like almost every site surveyed during this expedition, turf algae grew densely over hard substrate). *Microdictyon*, *Halimeda*, and *Laurencia* were the only fleshy macroalgae recorded in our quadrats, along with crustose and upright, branched corallines. Blue-green cyanobacteria, *Turbinaria ornata*, *Peyssonnelia*, *Haloplegma duperreyi*, and *Caulerpa peltata* were found during the random swim.

Summary for Kure Atoll: at least 20 macroalgal genera found in photoquadrats. An additional three genera were found during the random swims: *Caulerpa webbiana*, *Neomeris* sp., *Haloplegma duperreyi*, and a species of *Predaea*.

Eight sites (7 with12 quadrats each, 1 with 24 quadrats at 2 different depths) were sampled. Table does not include algae found during random swims.

	% of quads sampled containing alga	Rank of alga*
Bryopsis spp.	0.93%	2.00
Caulerpa peltata	0.93%	2.00
Codium spp.	1.85%	1.50
Dictyosphaeria cavernosa	11.11%	3.48
Dictyosphaeria versluysii	10.19%	3.00
Halimeda spp.	23.15%	2.56
Microdictyon setchellianum	75.93%	1.20
Dasya iridescens	0.93%	6.00
Hypnea spp.	4.63%	3.38
Jania spp.	5.56%	3.00
Laurencia spp.	37.04%	2.58
Laurencia sp. flattened	1.85%	4.00
Liagora sp.	0.93%	2.00
Peyssonnelia spp.	7.41%	2.50
branched upright coralline	28.70%	2.59
crustose coralline	10.18%	2.43
Dictyota spp.	6.48%	2.67
Lobophora variegata	5.55%	2.83
Padina spp.	27.78%	3.18
Sargassum spp.	3.70%	3.34
Turbinaria ornata	2.78%	3.75
Blue-green cyanophyte	4.63%	2.00

1 = most abundant, 2 = next most abundant, etc. (numbering scheme does not imply anything about percent cover).

Discussion

Quantitative algal data collected from the Northwestern Hawaiian Islands between September 8 – October 7, 2002 revealed two important discoveries. First, although the Rhodophyta (red algae) are the most diverse algal group present in the Northwest Hawaiian Islands, the vast amount of algal biomass is found among the Chlorophyta (green algae). Second, our sampling is beginning to show which species are ubiquitous to the entire Northwestern Hawaiian Island chain, which species are localized in certain regions, and which species are relatively uncommon.

The calcified green alga *Halimeda* is the most important alga in the Northwest Hawaiian in terms of abundance and biomass (see Chlorophyta Summary Table below). Species of *Halimeda* (*H. discoidea*, *H. velasquezii*, *H. gracilis*, *H. opunita*, *H. tuna*) play a critical role in sand production and the build-up of the reef. Vast patches of *Halimeda* sand were readily

observed on all islands visited. Unlike other genera, all environments from high-energy fore-reefs to quiet back-reefs contained representatives of this alga.

Chlorophyta Summary Table. Six most common Chlorophyta (green algae) found in the Northwestern Hawaiian Islands. Top numbers indicate the percentage of photoquadrats in which the alga occurred; bottom numbers refer to the overall algal abundance along transects (1 = most abundant, 2 = next most abundant, etc.). This abundance data contains no numerical counts and does not represent percent cover.

	Halimeda spp.	*Halimeda opuntia*	*Microdictyon* spp.	*Dictyosphaeria cavernosa*	*Dictyosphaeria versluysii*	*Neomeris* spp.
Necker Island	91.67% (1.00)	8.33% (2.00)				
French Frigate Shoals	68.06% (1.32)	0.69% (1.00)	50.69% (1.57)	0.69% (3.00)	1.39% (3.00)	1.39% (3.00)
Maro Reef	73.33% (1.39)	35.00% (1.83)		11.67% (3.00)	11.67% (3.89)	
Laysan Island	97.22% (1.74)		30.55% (1.10)			
Lisianski Island	66.66% (1.65)	29.76% (1.86)	26.19% (2.17)	8.33% (2.80)	4.76% (4.17)	13.10% (2.82)
Pearl and Hermes Reef	52.98% (1.75)	2.38% (1.34)	58.93% (1.73)	1.14% (2.50)	6.55% (3.11)	6.55% (4.00)
Midway Island	19.44% (2.56)		4.63% (1.34)	1.85% (1.50)	1.85% (3.50)	1.85% (2.50)
Kure Atoll	23.15% (2.56)		75.93% (1.20)	11.11% (3.48)	10.19% (3.00)	

The green alga, *Microdictyon* (probably *M. setchellianum*, but laboratory confirmation is still required) was also extremely common and in large quantities, particularly in quiet water habitats (inner lagoons and backreef regions). Because this alga is rather fragile, it is assumed that winter storms must rip up large amounts of this plant and that rapid regrowth during the spring and summer replenishes the standing stock each year. Although this hypothesis requires further testing, growth and subsequent removal of large masses of this alga may contribute to nutrient cycling within inner lagoon regions. *Microdictyon* also serves as a substrate for numerous red algal epiphytes and is often so overgrown as to be almost unrecognizable in the field

Dictyosphaeria cavernosa, *D. versluysii*, and *Neomeris* were present in low abundance at almost every island. Although they are ubiquitous, they are not as important in terms of biomass as *Halimeda* or *Microdictyon*. *Codium*, a relative of *Halimeda*, proved an enigmatic genus. It was only observed occasionally, but when found, was often the dominant alga present in the environment in which it was growing. For instance, at Pearl and Hermes Reef site 23, a dichotomously branched species of this genus formed huge mats that dominated the substrate. Yet our next site (located fairly close) exhibited a very similar habitat, with no trace of this alga. It is unclear what factors favor growth of *Codium* at one site and not at another.

Among the Rhodophyta (red algae), coralline algae were the most common species present, with both crustose and upright branching forms occurring in many of our photoquadrats at all islands. This group of algae has been understudied, and assigning genus names to the

representatives we discovered will not be possible until further laboratory analysis is conducted. It is probable that numerous species fall into the general category "coralline algae." Although these algae were common, the Rhodophyta Summary Table clearly shows that they were not necessarily abundant in the quadrats in which they were found.

Rhodophyta Summary Table. Six most common Rhodophyta (red algae) found in the Northwestern Hawaiian Islands. Top numbers indicate the percentage of photoquadrats in which the alga occurred; bottom numbers refer to the overall algal abundance along transects (1 = most abundant, 2 = next most abundant, etc.). This abundance data contains no numerical counts and does not represent percent cover.

	Branched coralline	Crustose coralline	*Laurencia* spp.	Flattened *Laurencia* spp.	*Dasya iridescens*	*Liagora* spp.
Necker Island		8.33% (4.00)	16.67% (1.50)		8.33% (2.00)	
French Frigate Shoals	1.39% (3.00)	7.64% (2.71)	5.56% (2.53)	4.86% (3.350)		4.17% (1.50)
Maro Reef	33.33% (2.94)	50.00% (2.11)	21.67% (2.99)			
Laysan Island	8.33% (2.67)	36.11% (2.04)	8.33% (4.33)			
Lisianski Island	28.57% (1.88)	46.43% (1.86)	1.19% (1.00)		1.19% (4.00)	
Pearl and Hermes Reef	19.05% (2.67)	16.67% (2.61)	33.33% (2.39)	1.19% (3.00)	1.19% (3.00)	9.52% (2.92)
Midway Island	14.81% (2.08)		14.86% (2.05)		0.93% (2.00)	
Kure Atoll	28.705% (2.59)	10.18% (2.43)	37.04% (2.58)	1.85% (4.00)	0.93% (6.00)	0.93% (2.00)

Many other species of red algae, although found in small numbers at almost every site, were not particularly important in terms of abundance or biomass. *Dasya iridescens* was collected during the random swims from every island, but it's abundance was too low to regularly show up in our photoquadrats. Other species, such as *Haloplegma duperreyi*, were among the most prevalent red algae found during our research expedition; however, the preferred habitat of this species made it almost impossible for representatives to appear in our photoquadrats. This alga tends to grow in dark holes and underneath coral heads. Although it was collected at almost every site, it was rarely recorded via our sampling method.

The majority of algae found among the turf community are red algae, and it is among the turf algae that scientists often find the greatest diversity. Because these algae are too small to identify (or even see) in natural field settings, this diversity cannot be included in any type of rapid ecological assessment (REA) monitoring project. Samples of turf and epiphytic algae will be preserved by site for possible future analysis. The Phaeophyta (brown algae) are the most poorly represented macroalgae in the tropics. Except for one site at Midway Island (MID2) that was dominated by large individuals of *Dictyota*, brown algae were relatively scarce. However, it was not uncommon to find patches of *Turbinaria ornata* at many of our sites (including both fore and backreef regions), and small individuals of *Dictyota* were often observed among the turf community (but usually too small to collect). In certain places, *Padina* was also found in

relatively high abundance. Most species collected were very small and light tan in color, so that they blended into the substrate and may be hard to see during photoquadrat analysis. The only large representatives of *Padina* were found at patch reefs located in Wells Harbor at Midway Island and a few sites at Pearl and Hermes Reef.

A final comment should be made about algal growth in respect to the large amount of coral bleaching that was observed at the northwesternmost atoll studies. Although the bleaching event could not have been more than 2 or 3 months old when we conducted our REA studies, blue-green cyanophytes, turf, and coralline algae were already starting to settle on and grow over bleached coral heads. We have several photographs documenting algal growth beginning at the tips of whitened coral branches (see photos from Kure Island, KUR18). Clearly, such coral colonies are beyond hope of recovering and will probably be completely overgrown by our return next year.

Phaeophyta Summary Table. Four most common Phaeophyta (brown algae) found in the Northwestern Hawaiian Islands. Top numbers indicate the percentage of photoquadrats in which the alga occurred; bottom numbers refer to the overall algal abundance along transects (1 = most abundant, 2 = next most abundant, etc.). This abundance data contains no numerical counts and does not represent percent cover.

	Dicyota spp.	*Lobophora variegata*	*Padina* spp.	*Turbinaria ornata*
Necker Island				
French Frigate Shoals	0.69% (4.00)	7.64% (2.80)		0.69% (3.00)
Maro Reef		1.67% (2.00)		
Laysan Island	2.78% (3.00)		5.55% (4.00)	
Lisianski Island	1.19% (3.00)	2.38% (3.50)		
Pearl and Hermes Reef	4.17% (2.59)	3.57% (3.17)	16.07% (3.00)	1.19% (2.50)
Midway Island	23.15% (1.53)	12.04% (1.90)	16.67% (1.394)	6.48% (2.33)
Kure Atoll	6.48% (2.67)	5.55% (2.83)	27.78% (3.18)	2.78% (3.75)

A. A total of 83 towed-diver habitat/fish count survey dives were conducted by the CREI towboard team (Rusty Brainard, Stephani Holzwarth, Brian Zgliczynski, Joe Chojnacki, and Bill Mowitt (operations officer aboard the *Townsend Cromwell*) to characterize and map the benthic habitats of the shallow water reef resources of French Frigate Shoals (15), Maro Reef (6), Laysan Island (4), Lisianski Island/Neva Shoals (10), Pearl and Hermes Atoll (22), Midway Atoll (15), and Kure Atoll (11). Each towed-diver survey consisted of a pair of divers on towed diving sleds equipped with a downward-looking video camera and a forward-looking video camera, SBE39 precision temperature-depth recorders, and paired scaling lasers. Brainard and Chojnacki/Mowitt recorded habitat

complexity, percentage cover of different habitat types (corals, sand, algae, and rock), structural habitat descriptions, and occurrences of marine debris and conspicuous macroinvertebrates. The towboard video data are being used collaboratively with National Ocean Service and UCSC to ground-truth IKONOS multispectral imagery for production of high quality maps of the shallow water coral reefs of the NHWI. Holzwarth and Zgliczynski recorded abundance and distribution of ecologically and economically important fish taxa (sharks, jacks, snappers, groupers, etc.). GPS positions, temperature, and depth were recorded every 5 seconds for downloading into an ArcView GIS database. The standard dive protocol consisted of 50-minute transects with divers maintaining the towboards and cameras about 1 m above the bottom followed by a 10-minute safety stop at a depth of about 5 m. For the shallow back reef habitats, video surveys were extended to 60-minute bottom transects. All of the towed-diver surveys focused on areas and habitats not surveyed in 2000 and 2001. Since many of the 2000 and 2001 surveys focused on forereef slopes, this year's surveys focused more on lagoonal habitats. In total, the towed-diver surveys mapped about 232 km of habitat.

At French Frigate Shoals, towed-diver surveys covered the entire windward forereef slope from the southeast corner of the open atoll to just north of Tern Island, an area previously inaccessible as a result of adverse sea conditions experienced in 2000 and 2001. In addition, several areas of the northern interior were surveyed for the first time.

At Laysan Island, the four towed-diver surveys focused on deeper depths (15-20 m) on the west, south, east, and northeast sides than those depths surveyed in 2000. These deeper habitats were predominantly spur and groove with high abundances of fleshy algae and sand. Generally, live coral cover was low, except for some portions on the northeast side. The water visibility was unusually low at Laysan because of an apparent algal bloom of some sort.

At Maro Reef, the six towed-diver surveys again focused on deeper depth habitat not well surveyed in 2000 or 2001. Deeper habitats on the north, northeast, and east sides of Maro Reef were surveyed. Almost all of the areas surveyed consisted of deep *halimeda* sand (30-60%) with very high relief coral covered pinnacles rising from depths of 20 to 30 m to less than 10 m. Intake covered most of the major remaining areas not completed during the 2000 towboard surveys.

Towed-diver habitat mapping/fish count surveys were not conducted at Lisianski/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Pioneer Bank, Northampton Seamounts, Gardner Pinnacles, St. Rogatien and Brooks Banks, Necker Bank, and Nihoa Bank as a result of the engine casualty and early termination of the cruise on September 23.

B. Two oceanographic buoys were permanently established to remotely monitor oceanographic conditions over the long term and transmit vital environmental data in near real-time to the Honolulu Laboratory using ARGOS satellite. These stations are part of a national Coral Reef Early Warning System (CREWS) of buoys and fixed stations that are being established in the U.S. coral reefs environment to provide advance notification of changing oceanographic conditions which may adversely impact coral reef ecosytems. In addition to the telemetry of a subset of the data in near real-time, the full high resolution data sets are recorded internally for downloading during buoy servicing. The monitoring buoy at French Frigate Shoals was moored in 8 m of water at lat. 23˚51.407'N, long. 166˚16.310'W. This buoy is instrumented to observe: sea surface temperature, salinity, underwater photosynthetically active radiation (PAR) and ultraviolet radiation (UV-B) at a depth of 1 m, air temperature, atmospheric pressure, wind direction and speed, and atmospheric UV-B and PAR. The monitoring buoy at Maro Reef was moored in 8 m of water at lat. 25˚26.791'N, long. 170˚38.029'W. This buoy is instrumented to observe: sea surface temperature at a depth of 1 m, air temperature, atmospheric pressure, and wind direction and speed. Both moorings were established by separately towing the 1200-lb anchor to the deployment site using a 2000-lb lift bag and the instrumented buoy. At the deployment site, Brainard attached the mooring accumulator cable between the anchor and buoy, and Holzwarth slowly deflated the lift bag to lower the anchor to the bottom at the desired site. Prior to deflation, the anchor was anchored in place above the site with two small Danforth anchors.

An array of sixteen settlement plates were installed at the base of each long-term oceanographic mooring by Kenyon to observe settlement of corals, algae, invertebrates over time. The settlement plates consist of 8 in by 8 in unglazed ceramic tiles. They are configured with two vertical and two horizontal tiles in each of the four cardinal compass points (N, S, E, and W). These tiles will be removed and replaced annually to observe temporal changes in settlement rates and species composition.

Permanent long-term oceanographic monitoring buoys and settlement plates were not deployed at Lisianski/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll as a result of the engine casualty and early termination of the cruise on September 23.

C. The Questar Tangent Corporation(QTC) acoustic seabed classification system was used by Miller and Hoeke to conduct habitat classification surveys at French Frigate Shoals (516.2 nmi), W. St. Rogatien Bank (61.3 nmi), Raita Bank (477.4 nmi), and Maro Reef (425.9 nmi). Transit data were collected on Necker Bank (29.0 nmi), the three Brooks Banks, and East St. Rogatien (38.0 nmi) and Gardner Banks (31.8 nmi). Total survey mileage for the cruise was approximately 1,600 nmi. The QTC was operated primarily during night operations and transits (system settings for the QTC are noted at the end of this report and must remain the same to integrate additional data). These acoustic surveys were validated using the Towed Optical Assessment Device (TOAD) and occasional bottom grab samples. TOAD towed and drift dives were conducted at all survey (not transit)

locations with still photos and video being shot at all locations. The photography yielded varying degrees of success depending upon conditions (e.g., day vs. night operations, camera settings, towing vs. drifting). The TOAD altimeter only worked on the first two deployments, but water depth and fish altitude could be used to determine the distance off of the bottom. Two grab samples were done at French Frigate Shoals.

At French Frigate Shoals, orthogonal survey lines at ½ nm spacing were set up for the main QTC survey area on the southwest quadrant of FFS. All lines in this grid were completed in depths between 20 and 100 m. One line was run around the perimeter of the island in approximately 50 m of water. Five TOAD deployments were conducted. TOAD deployment FFS1 (23-26 m depth) was a tow test in the SE portion of the survey area over coral rubble and live coral. TOAD deployment FFS2 (13 m depth) was a drop at anchorage north of the survey area over deep, medium-grained sand and sand waves. TOAD drift deployment FFS3 (22 m depth) in the northeastern part of the survey area was done over a flat bottom with sand veneer with occasional algal covered rocks and some scattered rubble. TOAD tow deployment FFS4 (27-29 m depth) was in the north central survey area over a varied bottom of live coral. This night tow ended with a crash into coral, and the TOAD proved its versatility by providing a sample of rose coral (the camera lens was scratched and the wing shaft bent slightly). FFS5 included two daylight drift deployments – one just south of the FFS anchorage in hummocky, reworked fine to medium-grained sand in 26 m water depth; the second was a redeployment in the FFS4 area (29-30 m depth) to double-check QTC data and the previous results. There are 96 minutes of video data and 76 still photos from the TOAD surveys over FFS.

Two transit lines each were run across Brooks, East St.Rogatien, and Gardner Banks. These banks are particularly interesting in that they lie at different depths, and the QTC data seems to sort primarily by depth in most areas.

At West St. Rogatien Bank, NNW-SSE survey lines at roughly 1 mile spacing and ENE-ESE lines with 1-2-nmi spacing were run. This is a small bank at a constant depth and is relatively uniform with respect to QTC data. A single TOAD drift deployment showed a general flat, hard bottom with occasional ridges at depths of 56-61 m. Ridge crests were sparsely covered with algae. There were 55 minutes of video data and approximately 95 still photos over this very uniform bottom.

At Raita Bank, orthogonal survey lines were completed at 1 mile spacing in the NW-SE direction and 1.5 mile spacing in the NE-SW direction. Additionally, several lines were run along an apparent high topographic area along the SE side of the bank to locate areas shallow enough for diving. Three TOAD drop dives were conducted at Raita with similar results on this largely algae covered bank with occasional isolated *Pocillopora sp.* coral heads (varying from approximately 1 to 2% coral coverage) in 25-27 m water depths. A total of 77 minutes of video and 99 still photos were collected at Raita.

At Maro Reef, a partial survey was done on the NE, NW, and SW sides of the reef. In the N and NW sides of the reef, E-W lines at approximately a 2-mile spacing and N-S lines at a 2-4-mile spacing were completed. Miscellaneous lines south of the island were completed and this survey was terminated as a result of the shaft bearing problems. Two TOAD drift deployments were conducted at Maro Reef. The first, MAR1, (25-30-m water depth) yielded 45 minutes of video and 10 photos over a flat bottom with sand veneer and occasional algal covered rocks. MAR2 produced 24 minutes of video and 46 photos over a hard, rough bottom of dead coral covered by coralline algae with numerous sand pockets and occasional isolated live coral heads and fleshy algae.

D. Two APEX profiling drifters and two surface velocity program (SVP) drifters were deployed at Necker Bank and Maro Bank by Brainard, Hoeke, and Miller to investigate larval transport and recruitment of fishes and invertebrates along the Hawaiian Archipelago. The APEX profiling drifters are designed to migrate vertically in the water column in a manner similar to many larval species. They are programmed to submerge to a depth of 100 m during daylight hours and to spend the nighttime hours at the surface transmitting positions and temperature profiles to the Honolulu Laboratory using ARGOS satellites. In this manner, the drifters will simulate the drift patterns of diurnal vertically-migrating planktonic animals, where the larval drift with the wind-driven surface currents at night and with the density-driven subsurface currents during the day. The APEX drifters were deployed over Necker Bank at lat. 23˚19.287'N, long. 164˚27.813'W and Maro Bank at lat. 25˚19.234'N, long. 170˚39.862'W.

The SVP drifters have drogues at a depth of 35 m attached to surface GPS-equipped floats which transmit drift positions with the ARGOS satellites. These drifters record and transmit hourly positions and temperatures. The SVP drifters were deployed over Necker Bank at lat. 23˚18.885'N, long. 164˚28.497'W and off Maro Bank in deeper waters at lat. 25˚18.288'N, long. 170˚46.584'W. Four additional pairs of APEX and SVP drifters intended for deployment at Lisianksi/Neva Shoals, Pearl and Hermes Atoll, Kure Atoll, and Nihoa Island were not deployed as a result of the engine casualty and early termination of the cruise.

E. Three long-term oceanographic monitoring stations were occupied at Nihoa, Necker, and French Frigate Shoals with standard 500-m CTDs with sampling bottles. These monitoring stations provide time series information about the vertical structure of temperature, salinity, oxygen, and chlorophyll in the NWHI ecosystem. Standard CTD stations at Gardner Pinnacles, Laysan, Lisianski, Pearl and Hermes, Midway, and Kure could not be conducted as a result of the engine casualty and early termination of the cruise. Standard acoustic Doppler current profiler (ADCP) and thermosalinograph (TSG) data were collected throughout the cruise to describe upper ocean current structure and surface temperatures and salinities.

F. A derelict Fish Aggregating Device (FAD) buoy “EK” was removed from the outer barrier reef at the northeast end of French Frigate Shoals (lat. 23˚52.2'N,

long. 166˚12.5'W). This steel FAD had about 40 m of ½ inch chain attached. The chain was entangled around the reef substrate in about 20 m of water temporarily anchoring the FAD to the bottom. Most likely, this entangled chain would have broken free and dragged the chain and buoy over the shallow barrier during the upcoming winter swells. Brainard and Holzwarth attached a line to the chain and Lt. Ellis hauled the chain off the bottom and towed it to deeper water where the ship hauled the buoy aboard for return to the State of Hawaii in Honolulu.

G. Collection of coral cores was accomplished by Siciliano and Maragos using a coral corer designed and assembled at the University of California, Santa Cruz. The corer consists of a pneumatic drill outfitted with a steel cylinder with a diamond sawing edge. The corer permits the extraction of $CaCO_3$ cores from massive domes of scleractinian corals up to 40 cm in length. A shorter (20 cm) coring barrel is used to core nodules of coralline algae. A total of four coral cores were collected during the *Cromwell* 2001 expedition. The cored specimen include two heads of *Porites evermanni* at French Frigate Shoals, and 1 *P. evermanni* and 1 *Porites lobata* from Maro Reef, all collected from a range of depth spanning 8-13 m. Because of the amount of bioerosion on the cored coral heads, most of the cores retrieved were fragmented into small sections. The purpose of this study, which is a collaboration among the University of California Santa Cruz (UCSC), the U.S. Fish and Wildlife Service and the Department of Aquatic Resources of the State of Hawaii is to determine the growth rate and the absolute age of corals along the NWHI. Differences in growth rate of corals in both a spatial and temporal context are expected. The optimal length of the coral core is 40 cm. This is necessary under the assumption of a maximum growth rate of 1 cm/year allowing the acquisition of a 40-year record by ^{14}C dating methods. Growth rate and age of corals will be subsequently determined at UCSC. The techniques include examination of density banding by X-radiography of sections of cores to determine yearly growth rate as well as isotopic analyses to determine absolute age of corals.

H. In addition to the towed-diver habitat surveys to ground-truth satellite and aerial imagery of coral reef ecosystems, Siciliano performed two other distinct ground-truthing activities: (*a*) building of a hyperspectral library using a hyperspectral radiometer, and (*b*) collection of information on the dominant benthic substrates at the surveyed sites. The hyperspectral library is important to understand the spectral characteristics of the different benthic communities, facilitating the interpretation of satellite and aerial imagery collected for the NWHI; information of the dominant benthic substrates at specific geo-referenced locations guides and corrects ("ground-truth") supervised and unsupervised classifications applied to the imagery.

(*a*) The hyperspectral survey consisted of use of a hyperspectral radiometer (manufactured by Geophysical and Environmental Research Corp. –GER, New York), encased in a custom-made underwater housing. The instrument records upwelling Radiance (□W/cm^2/sr), and (in conjunction with a Spectralon© reference plate) downwelling Irradiance (□W/cm^2) in 512 contiguous spectral bands, each 3 nm wide, spanning the visible and

near IR (350-1050 nm). The ratio of these parameters yields % Reflectance, the physical parameter directly comparable with remotely sensed images. Readings were collected from the most common substrates including corals, algae, sand, and rubble. A total of 167 readings were collected during the *Cromwell* 2001 expedition. The spectrometer was held at a 45º angle from a distance of 10 cm from the target substrates. Substrate identification to the highest possible taxonomic level (in the case of coral or algae) or a detailed description of the physical substrate accompanied each reading, along with observations on depth, pigmentation, morphology, size of substrate, and photographic documentation.

(*b*) The methods for collection of information on the dominant benthos at each geo-referenced REA site included estimates of percent cover of biotic (coral, algae) and physical (sand, rubble, rock) substrates using quantitative transect surveys in conjunction with coral and algae surveys concurrently conducted by Jim Maragos and Linda Preskitt, respectively. Transect surveys involved videotaping the bottom habitats at two 25-m transect lines previous laid down and surveyed by the fish team.