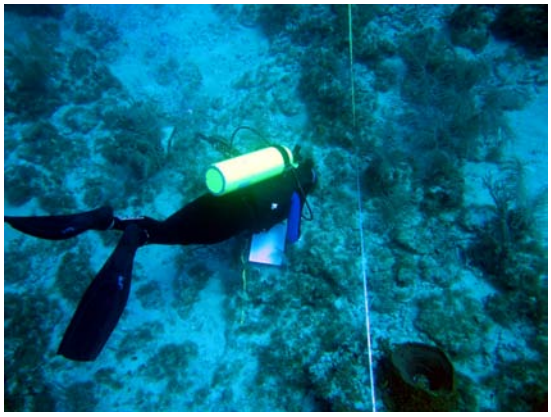
Assessment of Benthic Coral Reef Organisms in Dry Tortugas National Park and the Western Florida Keys National Marine Sanctuary

2008 Quick Look Report and Data Summary



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UNCW

NOAA CORAL REEF CONSERVATION PROGRAM

Florida Keys National Marine Sanctuary

2008 Quick Look Report and Data Summary

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Cover photos. Benthic surveys and examples of habitats and coral reef organisms sampled in Dry Tortugas National Park and the western Florida Keys National Marine Sanctuary during May-June 2008.

Table of Contents

2008 Executive Summary

Surveys of benthic coral reef organism found in habitats from ~2 m to 26 m depth were undertaken in the Dry Tortugas region during two 5-day research cruises (May 12-30, 2008) aboard the R/V *Fort Jefferson* and a subsequent 10-day research cruise (May 31-June 8, 2008) aboard the M/V *Spree* (Gulf Diving, Houston, TX). A total of 43 sites within Dry Tortugas National Park (DTNP) and the western region of the Florida Keys National Marine Sanctuary (FKNMS) were surveyed for species richness, coverage, abundance, size, and condition of a diversity of benthic coral reef organisms, including stony corals, gorgonians, algae, urchins, anemones, and corallimorpharians. Fieldwork during mid- to late-May was coordinated with National Park Service scientists (M. Patterson, A. Davis, B. Ruttenberg, R. Waara and B. Witcher) who concurrently installed permanent reef monitoring stations inside and outside of the newly designated Research Natural Area of DTNP. Fieldwork during early June was done in coordination with reef fish and spiny lobster surveys conducted by scientists from NOAA Fisheries, the University of Miami, and the Florida Fish and Wildlife Research Institute. This quick-look report provides a summary of the major findings and site-level data for the benthic variables measured at 43 sites visited during May-June 2008. The 2008 sampling adds to a growing spatial and temporal data set in the Tortugas region that complements similarly organized research cruises in 1999 (24 sites surveyed), 2000 (35 sites), 2002 (24 sites), and 2006 (45 sites), for a total of 171 sites surveyed from 1999 through 2008. The Tortugas regional sampling is part of a larger program dating back to 1999 that documents the status and condition of benthic coral reef resources throughout the Florida Keys ecosystem, with a focus on documenting spatial and temporal patterns in the abundance, size, and condition of benthic coral reef organisms in relation to the zoning action plan for the FKNMS.

Benthic surveys of hard-bottom and coral reef habitats in the Tortugas region were accomplished by a three to four person survey team represented by scientists from the Center for Marine Science-University of North Carolina at Wilmington (CMS/UNCW) and RSMAS-University of Miami. Enriched air Nitrox was used at most sites to allow for multiple daily dives within the 2.4 m to 26.2 m depth range surveyed. Surveys of the 43 sites required 173 dives and ~176 hours of underwater bottom time by the UNCW and UM team. An additional 118 dives constituting 86 hours of underwater bottom time was spent by NPS personnel installing a subset of their permanent monitoring stations inside and outside of the Research Natural Area (RNA) of Dry Tortugas National Park (DTNP). The 43 survey locations represented a variety of hard-bottom and coral reef habitat types within four management zones in the region: sites within the newly designated RNA of DTNP; sites within DTNP, but outside the RNA; sites within the Tortugas North no-fishing reserve; and sites outside of the Tortugas North Reserve, but within the FKNMS boundary. Bottom types surveyed represented eight habitat and depth strata encompassing

DTNP and the deeper Tortugas Bank: shallow (< 6 m) patch reefs and deeper (15-21 m) reef knolls, low-relief hard-bottom (< 6 m to 15 m), patchy hard-bottom (6-21 m), low-relief spur and groove (6-15 m), medium-profile reefs (< 6 to 21 m), high-relief spur and groove (6-15 m), and reef terraces (6-26 m). A stratified random sampling design using pre-existing benthic habitat and bathymetry data were used to allocate sampling effort (number of sites per habitat type) and to randomly select sites. The following benthic variables were measured in the Tortugas region during 2008: percent cover of biotic and abiotic components; species richness (number of species per 60 m^2 area) of sponges and benthic cnidarians; gorgonian densities by species; stony coral density, size, and condition by species; urchin densities and sizes (test diameters) by species; densities of anemones and corallimorpharians; and topographic measurements of minimum and maximum transect depth, maximum vertical relief, and estimations of coverage by relief categories. All of the variables were recorded underwater on pre-formatted plastic PVC slates, with data entered into a database entry program onboard to accomplish rapid data processing. Transects 15 m in length were used to obtain percent coverage using the linear point-intercept technique, while data on species richness and invertebrate densities and sizes were collected in belt transect areas using a 0.5 m scale bar along the same 15-m transects.

General impressions of the Tortugas region during 2008 from a benthic perspective are summarized as follows. The benthic sampling was concentrated along a band from the southwestern to northeastern area of DTNP, in addition to nine sites scattered across the Tortugas Bank, including Little Tortugas Bank and the Sherwood Forest areas. The eastern and southeastern areas of DTNP were not sampled due to inclement weather and time constraints. Relative to 2006, many of the areas surveyed in 2008 appeared to be recovering from tropical cyclones that impacted the region in previous years. Gorgonian recruitment was evident in areas scoured by storms that were largely denuded when surveyed in 2006. Reef terraces on Little Tortugas Bank and the northwestern Tortugas Bank (Sherwood Forest) are still in relatively good condition in terms of coral abundance, but coral cover has apparently declined from ~50% in 1999-2000 to less than 30% in 2008. In these same sites, we noticed a high prevalence of the brown alga *Lobophora variegata* that is now occupying space once covered by live coral. A few sites also exhibited relatively high prevalence of coral disease, especially by what we believe to be white plague, especially on Little Tortugas Bank. The reef terrace habitat west and northwest of Loggerhead Key in western DTNP (Loggerhead Forest) has also experienced declines in coral cover and exhibited relatively high prevalence of coral disease compared to previous years. The factors responsible for the increased disease prevalence observed compared to previous years are not known. The hypothesis that coral bleaching and other stressors increase susceptibility to disease has not been tested by us, but data from other regions

around the world suggest a relationship. The extent, severity, and degree of recovery from coral bleaching that occurred in 2005 are unknown.

Relative to 1999-2000, but in contrast to 2006, sea urchins, particularly *Diadema antillarum*, exhibited similar densities, but larger test sizes at many of the shallow-water patch reef, hard-bottom, and medium-profile reef areas sampled in DTNP. Although *Diadema* densities are still below the presumed historical (pre-1983) density level of ~1 individual per m^2 in certain habitats, urchin densities in the Tortugas region, especially within DTNP, are now generally lower than for similar habitats and depths along the rest of the Florida Keys reef tract. Of the 41 *Diadema* surveyed from the 43 sites, ~76% were > 4 cm in test diameter, while few recently settled recruits were encountered compared to previous years.

I. Introduction

Like many coral reef ecosystems, the Florida Keys have experienced signs of degradation in recent decades, including declines in urchins and corals, particular acroporid corals that have also occurred in the wider Caribbean (Jaap 1984; Dustan and Halas 1987; Aronson and Precht 2001; Chiappone et al. 2002). For the two *Acropora* coral species that occur in the region, both were under consideration for addition to the U.S. Endangered Species List since the early 1990s and were formally added to the list as threatened in 2006 based upon Caribbean-wide population declines and poor recovery (see the *Acropora* Biological Review Team summary at http://sero.nmfs.noaa.gov/pr/pdf/050303%20status%20review.pdf). Symptoms of degradation include declines in the abundances of corals, concurrent increases in algae, increased prevalence of disease, bleaching events, and overfishing. In addition to impacts from over-use and coastal development, there are a considerable array of natural phenomena affecting Florida Keys reefs such as atmospheric cold fronts because of high latitude, continental influence (Florida Bay-Atlantic Ocean exchange), and destructive tropical storms (Precht and Miller 2007). The multitude of stressors has made it difficult to discern the degree to which human activities have affected ecological integrity relative to natural system variability (Somerfield et al. 2008).

Part of the uncertainty in understanding what factors drive decreases in populations stems from the quality of the data used to document spatial patterns and temporal changes. Many historical studies lacked the statistical rigor necessary to adequately evaluate changes at the population-scale. Generally, sampling has been at a habitat-level of stratification; that is, limited to a few reef sites within particular habitat types in restricted portions of the total reef area (Dustan and Halas 1987; Porter and Meier 1992; Chiappone and Sullivan 1997). Frequently, selection of sampling sites within a given habitat did not follow standard randomization protocols, and consequently, the derived abundance metrics may not have

been representative of the sampled habitats (Murdoch and Aronson 1999). Additionally, the locations sampled may not have been representative of the full range of habitats. Despite these considerations, there is no doubt there is no doubt that areas historically dominated by *Acropora* corals, particularly the shallow (< 6 m) and deeper (8-15 m) fore-reef, have changed substantially, largely due to Caribbean-wide disease events (Dustan and Halas 1987; Aronson and Precht 2001) and bleaching (Somerfield et al. 2008). However, debate continues regarding the causes of coral reef decline (Porter and Meier 1992; Precht and Miller 2007; Somerfield et al. 2008), thus making it important for resource managers to distinguish between the significance of localized threats and larger-scale factors such as climate change.

The Tortugas region has a long history of scientific study, summarized in earlier works such as Davis (1982) and Jaap et al. (1989), including several historical assessments of reef geomorphology and community structure dating back over a century (e.g. Shinn et al. 1977; Dustan 1985). The Dry Tortugas, near the western extent of the Florida Keys National Marine Sanctuary (FKNMS), include an island group 117 km west of Key West, which consists of an elevated atoll-like rim measuring about 27 km from southeast to northeast and 12 km wide that rests atop a Pleistocene mound (Shinn et al. 1989). Reefs are found along a discontinuous elevated rim of Holocene coral and several small sandy islands such as Loggerhead Key (site of the original Carnegie Institute Marine Laboratory), and Garden Key. Deep channels (~10-20 m depth) separate three major banks (Pulaski, Loggerhead, and Long Key) within what is now Dry Tortugas National Park (formerly Ft. Jefferson National Monument). The Tortugas region represents the western extent of extensive reef growth in the Florida Keys archipelago, with Holocene accumulations up to 17 m (55 feet) in some locations (Shinn et al. 1977). West of the shallow bank encompassing Dry Tortugas National Park is the Tortugas Bank, a deeper (> 12 m) water area extending to the western boundary of the FKNMS. Prior to research cruises in 1999 and 2000 by UNCW, NMFS, and RSMAS-UM, little scientific information existed on the benthic habitats of the Tortugas Bank and few mapping data existed except for the area within Dry Tortugas National Park (Davis 1982). Since 1999, however, fishery independent surveys and habitat mapping have elucidated the spatial pattern of habitats for much of the Tortugas Bank (Franklin et al. 2003), along with the responses of fishery organisms to spatial management zones (i.e. no-take reserves) protected from fishing (Ault et al. 2006).

In response to concerns about declining regional trends in coral reef habitats and multi-species reef fish stocks (see Ault et al. 2002), the FKNMS, National Park Service, State of Florida, and the Gulf of Mexico Fishery Management Council designated 518 km^2 of no-take ecological reserves that includes the Research Natural Area (RNA) within the park, but also two reserves further west: the Tortugas North Ecological Reserve encompassing the northern half of the Tortugas Bank, and the Tortugas South Ecological Reserve

encompassing the Riley's Hump area. Because of its up-current position located on the southwestern Florida shelf in the Florida Current, the Tortugas Region is widely considered to provide an essential source of larvae for many invertebrates and commercially important fishes to the Florida Keys region (Lee et al. 1994, Ault et al. 2006).

During just over three weeks of underwater fieldwork in the Florida Keys, we had the opportunity to sample 43 different locations stratified by habitat structure, depth, and management zone in the Tortugas region, encompassing both Dry Tortugas National Park (DTNP) and the western extent of the Florida Keys National Marine Sanctuary (FKNMS). The measured variables (coverage, species richness, abundance, size, condition) add to a growing spatial and temporal database of observations made by our program since 1999 (Chiappone et al. 2002a, b; Miller et al. 2002). Previous surveys conducted by this program aided in optimizing a sampling plan for obtaining estimates for abundance, size, and condition of benthic coral reef algae invertebrates. Quick Look reports from previous years are available at http://people.uncw.edu/millers, including similar research cruises to the Tortugas region in 1999, 2000, 2002, and 2006 (Figure 1-1). These observations are designed to help resource managers evaluate the performance of smaller protected areas (no-take zones) relative to other factors that influence the larger ecosystem. In this report, we provide a variable-by-variable summary of significant findings from the 2008 Tortugas region surveys. We have included comparisons to the 2006 surveyss, as well as a list of published and planned papers and other products developed from this effort. Accompanying tables and figures summarize site-level coverage, species richness, and density/size data for stony corals, gorgonians, urchins, and anemones/corallimorpharians.

Figure 1-1. Survey locations in Dry Tortugas National Park (DTNP) and the western Florida Keys National Marine Sanctuary (FKNMS) during 1999-2000, 2002, 2006, and 2008, showing the current locations of the Tortugas North Ecological Reserve (ER) and Research Natural Area (RNA), designated in 2000 and 2008, respectively.