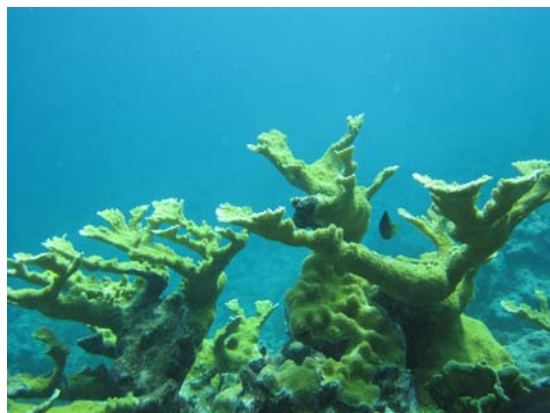


Large-scale Assessment of the Abundance, Distribution and Condition of Benthic Coral Reef Organisms in the Florida Keys National Marine Sanctuary

2009 Quick Look Report and Data Summary



December 2009

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Cover photo. Examples of benthic coral reef organisms sampled during 2009 in the Florida Keys. Species richness, density, size, and condition of benthic organisms were quantified at 160 sites during May to September. Upper left: Acropora palmata, Upper right: Cribrochalina vasculum, Lower left: Eucidaris tribuloides, Lower right: Discosoma sanctithomae

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2009 Executive Summary

During 44 days of fieldwork from May 30th through September 6th, 2009, research scientists from the Center for Marine Science, University of North Carolina at Wilmington, surveyed the density, size, and condition of benthic coral reef organisms in the Florida Keys National Marine Sanctuary (FKNMS) from northern Key Largo to SW of Key West. This work is part of a larger program that started in 1999 that documents the status and condition of benthic coral reef resources in the Florida Keys in relation to cross-shelf position, regional location, and the location of spatial management zones (no-take areas). We also collaborated this year with Ms. Nancy Sheridan from the Florida Fish & Wildlife Research Institute (FWRI/FWCC), who is pursuing research funding to sample nearshore habitats for species targeted by the marine life trade.

Benthic survey methods are built around a two-stage stratified random sampling design that partitions the Florida Keys sampling domain by benthic habitat type, regional sector, and management zone. Five main hard-bottom and coral reef habitat types were sampled from inshore of Hawk Channel to the deeper fore-reef from 0.9 m to 13.1 m depth: inshore patch reefs, mid-channel patch reefs, offshore patch reefs, shallow hard-bottom, platform margin high-relief spur and groove (< 6 m depth), and the deeper fore-reef (6-13 m depth) encompassing continuous hard-bottom, patchy hard-bottom, and low-relief spur and groove. Sites were further partitioned by regional sector (upper, middle, and lower Keys) and management zone within the FKNMS. The 2009 sampling included all 23 no-take zones from northern Key Largo to SW of Key West, designated as Sanctuary Preservation Areas, Ecological Reserves, and Special-use Areas/Research Only Areas. For the 160 sites sampled, latitude/longitude points were randomly generated in a geographic information system (GIS) incorporating available benthic habitat and bathymetry data for the sampling domain. At each site, four 15-m transects were deployed to inventory: depth and topographic complexity; species richness of stony corals, gorgonians, and sponges; percent cover of abiotic (e.g. sand and rubble) and biotic (e.g. algae, sponges, stony corals, gorgonians) components; stony coral density, colony size, and condition; juvenile coral density and size; gorgonian density and gorgonian host occupation patterns by flamingo-tongue (*Cyphoma*) snails; density and size (test diameter) of urchins; density of anemones and corallimorpharians; and density of selected mollusks (sea slugs, nudibranchs, and certain gastropods). These variables have been assessed periodically by our program over the past ten years and add to a growing spatial and temporal data set to document their status and trends, specifically in relation to no-take management strategies in the Sanctuary.

This report summarizes the major findings and provides descriptive data for the benthic variables measured during 2009. The report is divided by chapter for each of the major categories of variables

measured, and includes data tables, underwater photographs, maps, and data charts. The data were collected by a four-member survey team that conducted 505 SCUBA dives and approximately 700 hours of underwater bottom time.

Species richness surveys for stony corals, gorgonians, and sponges encompassed 9,600 m² of benthic habitats among the 160 sites. A total of 43 stony coral taxa were encountered, with a range in site-level species richness of 5 to 26 species per 60 m². Similar to previous years, mid-channel and offshore patch reefs tended to yield the greatest numbers of species, especially in the lower Florida Keys region. A total of 31 gorgonian taxa were encountered, with a range of two to 25 species per 60 m² among sites. A total of 82 sponge taxa were encountered and site species richness ranged from one to 46 species. Surveys of percent cover of major bottom components using the point-intercept technique indicated patterns of coverage that were generally consistent with similar surveys in 1999-2001 and 2005. Total coral cover showed a considerable range among habitats (0.3-58.3%), but was generally greater on patch reefs in both reference areas and no-take zones. Greater coral cover on patch reefs reflected the dominance of massive framework corals. On the platform margin, algae were dominant (> 75% cover) at the majority of sites sampled and consisted primarily of turf algae, crustose coralline algae, but also certain macroalgal genera such as *Dictyota*, *Halimeda*, and *Styopodium*.

A total of 14,685 stony corals were counted, measured, and assessed for condition, including disease, bleaching, and predation. In contrast to 2005, coral bleaching was mild during 2009 and the prevalence of disease-like conditions was less than one percent. Patch reefs continue to harbor the greatest densities of corals, especially massive framework builders such as *Diploria*, *Colpophyllia*, *Montastraea*, and *Siderastrea*. A total of 5,544 juvenile (< 4 cm max. diameter) scleractinian corals were identified, enumerated, and measured for maximum length representing at least 32 different coral taxa. Juvenile coral densities were relatively high (> 8 per m²) on mid-channel and offshore patch reefs, especially in the lower Florida Keys. Overall, the dominant corals comprising the juvenile coral assemblage paralleled the patterns of relative abundance in the adult coral community. A total of 34,965 gorgonians were identified and counted, along with assessments of the density, shell length, and host occupation patterns of flamingo-tongue snails (*Cyphoma* spp.) among 160 sites (2,560 m²). With the exception of some patch reef and shallow spur and groove sites, gorgonians are a dominant component of the sessile invertebrate assemblage, with densities as high as 38 colonies per m². A total of 111 *C. gibbosum* snails were encountered and all but one was found on gorgonian hosts. Similar to surveys in 2001 and 2008, *Cyphoma* snails appeared to preferentially occupy certain gorgonian genera in relation to their abundance,

but not others. In contrast to previous surveys in 2001 and 2008, *Cyphoma* densities were more similar between reference areas and no-take zones for several habitat types.

Five urchin species were encountered and 1,768 individuals were counted and measured for test diameter (TD). Of these, 90% were either *Echinometra viridis*, which was particularly abundant on mid-channel and offshore patch reefs, or *Eucidaris tribuloides*, which was most abundant on high-relief spur and groove and deeper fore-reef habitats. Densities of the long-spined sea urchin (*Diadema antillarum*) are still relatively low (< 0.3 individuals per m^2) by historical (pre-1983) standards; however, two temporal trends are noteworthy. First, densities of *D. antillarum* have slowly increased since 1999, and the highest densities presently occur on mid-channel and offshore patch reefs. Second, there has been a shift in the average and maximum sizes of individuals encountered over the past 10 years to larger individuals. In 2009, individuals as large as 9.3 cm TD were recorded, which we never encountered from 1999-2005. The average size of *Diadema* encountered up until 2005 was < 3.0 cm TD, while 2009 yielded an average size of 5.0 cm TD. Where aggregations of urchins were found, there were clear and obvious impacts to the substratum. Assuming these trends continue, and as more space becomes cleared of algae, it will be important to monitor for recruitment of invertebrates, including perhaps corals.

Five anemone species and three corallimorpharian species were encountered and frequency of occurrence and densities were determined among habitat types, regions, and between no-take zones and reference areas. A total of 461 anemones were counted, of which ~91% were either *Bartholomea annulata* or *Lebrunia danae*. Anemones and corallimorpharians exhibited similar spatial patterns in abundance among habitats in 2009 compared to previous surveys in 2000, 2005, and 2008. A total of 5,418 corallimorpharians were counted, of which ~79% were *Ricordea florida*, followed by two *Discosoma* species. *R. florida* was most abundant on mid-channel and offshore patch reefs, especially in the lower Keys, and was particularly abundant in no-take zones in the Western Sambo and Looe Key areas compared to patch reefs outside of FKNMS no-take zones.

I. Introduction

Like many coral reef ecosystems, the Florida Keys have experienced significant decline in recent decades, including loss of urchins and corals due to disease and for corals loss from bleaching during warm-water events that have also occurred throughout the wider Caribbean (Jaap 1984; Dustan and Halas 1987; Aronson and Precht 2001; Chiappone et al. 2002). In addition, impacts to reefs are also evident from over-use such as from finfish fishing and harvesting ornamentals, coastal development, and a considerable array of natural phenomena affecting Florida Keys reefs including atmospheric cold fronts

because of high latitude, continental influence (including Florida Bay exchange), and destructive tropical storms (Precht and Miller 2007). This 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).

While understanding the causes of coral reef decline is a fundamental pursuit among coral reef ecologists, our sampling program was designed specifically to document the status and trends of no-take management zones throughout the FKNMS. To evaluate potential changes in no-take management zones, it is necessary to also document changes caused by natural system variability or stressors, such as mortality events caused by disease or bleaching, coral recruitment events (especially related to *Acropora* corals), or recovery of the previously abundant sea urchin, *Diadema antillarum*. By broadly sampling populations across multiple habitat types, from nearshore to offshore, inside and outside of the no-take management zones, and throughout the Florida Keys from south of Miami to the Dry Tortugas, over a ten-year period, we have documented the distribution, abundance, and changes over time, of coral reef communities in the region. Our data and results are unprecedented in spatial coverage and establish a baseline from which future comparisons can be made, related to further decline, recovery, or stasis. It is important to note that our program began in the late 1990s, long after major declines had already occurred in the region, specifically the loss of *D. antillarum* and *Acropora* corals. One way we are addressing the absence of earlier information (from the 1970s before the major die-offs) is through a data-rescue project that will begin in 2010. In partnership with the FKNMS, we have identified a previously-funded NSF project that sampled reefs in the lower Florida Keys, but was never published. We are working with the Principal Investigator of that project to incorporate the historical data set with ours and to resample these same sites originally surveyed over 30 years ago.

In 2009, during just over six weeks of fieldwork in the Florida Keys, we sampled 160 different sites stratified by habitat, regional sector, and management zone from northern Key Largo to Key West within the FKNMS. These measurements add to a growing temporal base of observations made by our program since 1999 (Chiappone et al. 2002a, b; Miller et al. 2002). Previous surveys aided in optimizing a sampling plan for obtaining estimates of abundance and size of benthic coral reef organisms (see previous Quick Look reports at <http://people.uncw.edu/millers>). Our sampling program is specifically designed to help resource managers evaluate the performance of smaller protected areas (no-take zones) relative to other factors that influence the larger ecosystem.