Florida Fish And Wildlife Conservation Commission
Fish And Wildlife Research Institute
Coral Reef Evaluation & Monitoring Project

Executive Summary 2016

Overview

- The Coral Reef Evaluation and Monitoring Project (CREMP) completed its 20th year of annual surveys in the Florida Keys in 2015.
- Survey methodology employs two primary methods for evaluating the status and trends of the benthic communities in the Florida Keys: (1) demographic surveys to quantify coral, octocoral, and *Xestospongia muta* abundance, size class distribution, and condition and (2) photographic transects to quantify the percent cover of major benthic taxa (e.g., stony corals, macroalgae, etc.). Surveys are performed at 4, 22m x 2m sampling stations within each site (Figure 1).
- In 2015 40 sites were sampled Keys-wide. This included 12 shallow forereef sites, 11 deeper forereef locations, 15 patch reefs, and 2 backcountry patch reefs located gulf-side of the Florida Keys. Coral surveys were completed at 40 sites, octocoral surveys at 21 sites, and *X. muta* surveys at 11 sites.
- Statistical comparisons in the percent cover of coral, octocorals, and macroalgal between 2013 and 2014 were tested with a two-way repeated measures ANOVA with year and habitat as factors. The abundance of corals was also analyzed between 2012 and 2015 using a repeated measures ANOVA. Transect data was pooled for each site for this analysis.
- This summary highlights changes (if any) in percent cover between 2013 and 2014 and updates long-term records. Additionally, using the coral population data, this summary provides a preliminary analysis of the effects of the 2014-2015 bleaching event on coral abundance.

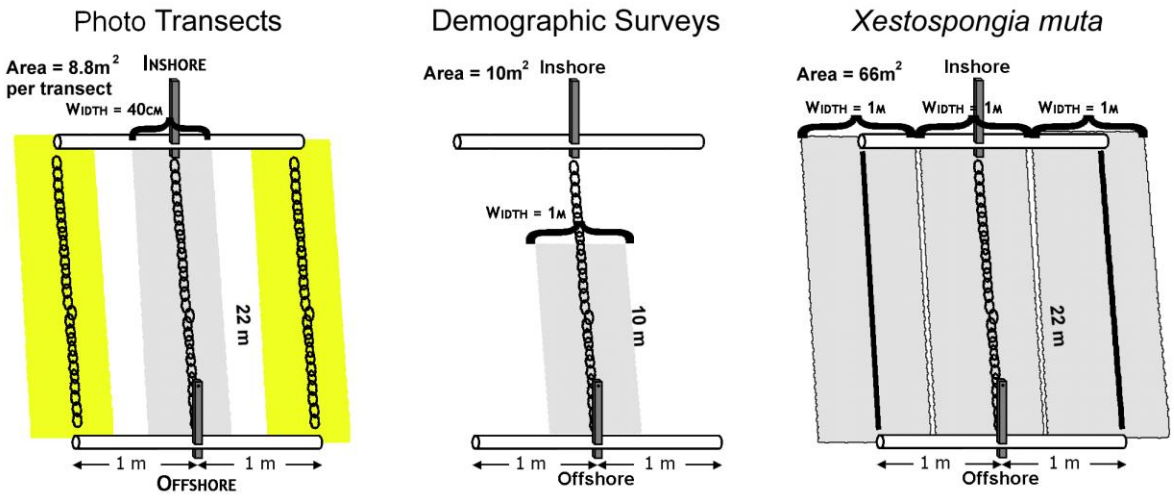

Figure 1: Every CREMP site in the Florida Keys consist of four monitoring stations delineated by permanent markers. Stations are approximately 22m x 2m. Photographic transects survey 8.8m^2 of reef per station and date back to 1996. Octocoral and stony coral demographic surveys are 1m x 10m belt transects and were implemented in 2011. Three 1m x 22m belt transects are surveyed at two stations for *Xestospongia muta*. Surveys are conducted annually. Transects shaded in yellow represent previously filmed (video) transects prior to modifications in 2011.

Results

Percent Cover 2013 vs. 2014

- **Corals:** There was no significant difference in total coral cover between 2013 and 2014. Total coral cover, averaged for all 40 sites was 8.45±1.3% (±SE) in 2013 and 8.36±1.3% in 2014. Including only the 34 sites in which sampling dates back to 1996, coral cover was 7.03±1.1% in 2013 and 7.04±1.1% in 2014 (Figure 2). No year to year changes were observed within the different habitat types (Figure 3). Patch reefs contain the highest cover of any habitat while backcountry patch reefs have the lowest. This marks the third consecutive year that CREMP has not observed a change in coral cover. Coral cover in 2014 is nearly 1% higher than the low point recorded in 2010 after the mortality associated with the winter cold-water event.

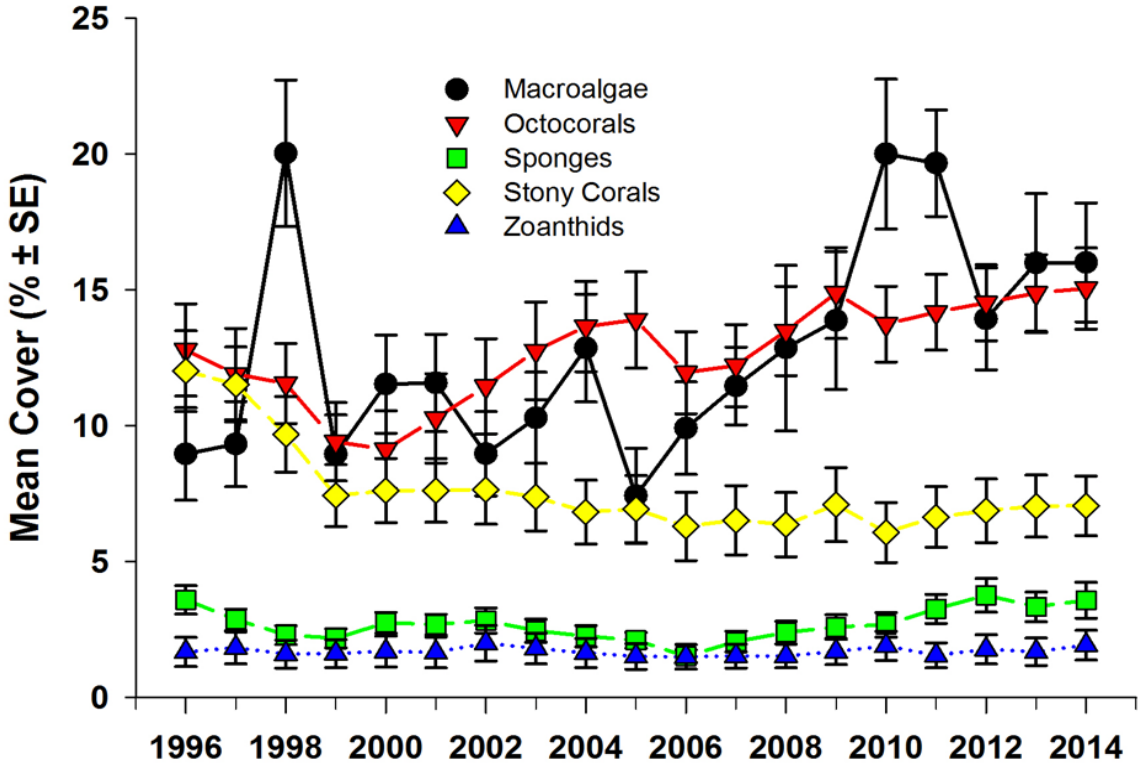

Figure 2. Mean percent cover (±SE) of the five most spatially common tax in the Florida Keys between 1996 and 2014.

- **Octocorals**: There was no significant difference in total octocoral cover between 2013 and 2014. Total octocoral cover, averaged for all 40 sites, was 14.8±1.3% (±SE) in 2013 and 14.5±1.4% in 2014. Including only the 34 sites in which sampling dates back to 1996, octocoral cover was 14.8±1.4% in 2013 and 15.0±1.5% in 2014 (Figure 2). Although there was no effect of year on overall octocoral cover, a significant decrease at the offshore deep sites was recorded (Holm-Sidak Multiple Comparisons Test; $p = 0.007$). Octocoral cover has continued to rise following the 2010 winter cold-water mortality and is the second greatest contributor to benthic cover after macroalgae.

- **Sponges:** There was no significant difference in total sponge cover between 2013 and 2014. Total sponge cover, averaged for all 40 sites, was 3.4±0.45% (±SE) in 2013 and 3.7±0.6% in 2014. Including only the 34 sites in which sampling dates back to 1996, sponge cover was 3.3±0.6% in 2013 and 3.6±0.7% in 2014 (Figure 2). No year to year changes were observed within the different habitat types. The highest sponge cover is found on the deeper forereef sites and patch reefs. Sponges are the fourth largest contributor to benthic cover in the Florida Keys.

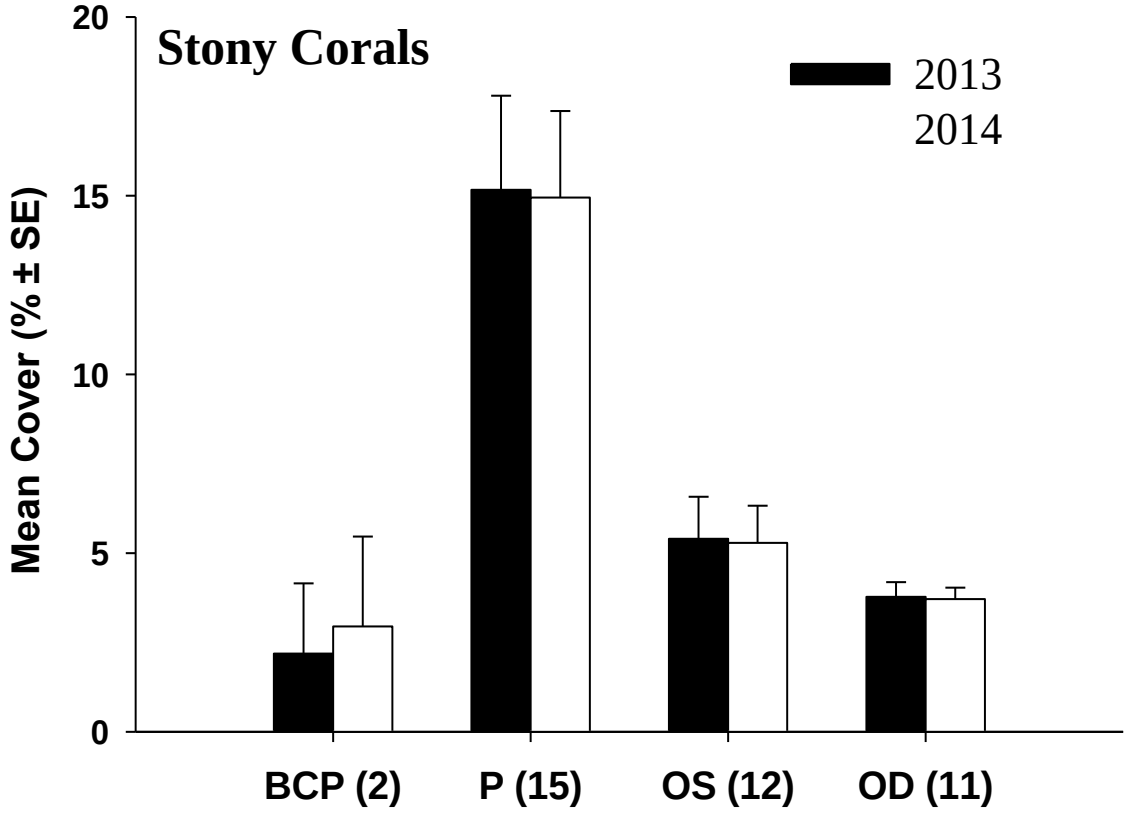

Figure 3. Mean percent cover (±SE) averaged for all reefs surveyed for each habitat type between 2013 and 2014. No significant differences between years were found for any habitat. Habitats defined as BCP = backcountry patch reef; P = patch reef; OS = shallow forereef; OD = deep forereef. Number in parenthesis indicates number of reefs sampled in each habitat.

- **Macroalgae:** There was no significant difference in total macroalgal cover between 2013 and 2014. Total macroalgal cover, averaged for all 40 sites, was 14.9±2.3% (±SE) in 2013 and 15.7±2.0% in 2014. Including only the 34 sites in which sampling dates back to 1996, macroalgal cover was 16.0±2.6% in 2013 and 16.0±2.2% in 2014 (Figure 2). Although there was no effect of year on overall macroalgal cover, a significant decline was observed at the backcountry patch reefs (Holm-Sidak Multiple Comparisons Test; $p = <0.001$). Macroalgal values reported here are inclusive of filamentous cyanobacteria. This is to maintain consistency with how macroalgal values have been reported historically by CREMP. Enhanced resolution provided by better imagery technology has allowed for separate identification of cyanobacteria in recent years (both filamentous and matting forms). Cyanobacteria cover was 0.6±0.3% (±SE) in 2013 and 2.4±0.4% in 2014. Thus, though fleshy macroalgal cover did

decline between 2013 and 2014 the decrease was offset by an increase in cyanobacteria. Macroalgal cover is highest on the backcountry patch reefs and deeper forereef sites. The majority of fleshy macroalgae is composed of *Dictyota* spp.

- **Zoanthids:** There was no significant difference in total zoanthid cover between 2013 and 2014. Total zoanthid cover, averaged for all 40 sites, was 1.7 ±0.5% (±SE) in 2013 and 1.9±0.5% in 2014. Including only the 34 sites in which sampling dates back to 1996, zoanthid cover was 1.7±0.5% in 2013 and 1.9±0.5% in 2014 (Figure 2). No year to year changes were observed within the different habitat types. The highest zoanthid cover is found on the shallow forereef sites. Nearly all of the zoanthid cover measured by CREMP is *Palythoa caribaeorum.*

Preliminary findings after the 2014 Bleaching Event

- There has been widespread concern that a strengthening, ongoing El Nino weather pattern heating waters across the equatorial Pacific will lead to a third global mass bleaching event. The last mass bleaching event in the Florida Keys occurred during 1997/1998 El Nino and resulted in substantial coral mortality (see Figure 2). Bleaching assessments by the Nature Conservancy's Disturbance Response Monitoring (TNC DRM) Program (conducted annually during the peak heating months of August and September) have categorized the rate of bleaching as "severe" in both 2014 and 2015. TNC DRM classifies bleaching prevalence as "severe" when >50% of all corals are either paling, partially bleached, or fully bleached. This elevated frequency of bleaching has also been detected by CREMP. The prevalence of bleaching was <5% in 2011, 2012, and 2013, but prevalence rose to 17.7% in 2014 and 14.1% in 2015 (Table 1). The lower values recorded by CREMP, in comparison to TNC DRM, is the result of CREMP surveys being conducted throughout the summer (e.g. surveys start in May and generally end in mid-August) and only partially occur during the peak bleaching timeline. The most important conclusions stemming from the CREMP results are the striking differences in bleaching prevalence across years and that corals were bleaching during the months of May through July, well ahead of the peak bleaching activity. With the prevalence of bleaching so high and being sustained for multiple years, these results substantiate why there is so much concern about the potential coral mortality associated with this current bleaching event.

- The prevalence of bleaching was slightly higher in 2014 than in 2015 (Table 1). This finding was consistent between CREMP and TNC DRM. The five corals (*Colpohyllia natans*, Montastraea *cavernosa*, *Orbicella annularis* complex, *Porites astreoides*, and *Siderastrea siderea*) that contribute the most to spatial coverage in the Keys all had elevated rates of bleaching in 2014 and 2015 compared to previous years (Table 1). By species, the greatest rates of bleaching were present on *Colpohyllia natans*, *Montastraea cavernosa*, *Siderastrea siderea*, and *Undaria/Agaricia agaricites*. Twenty percent or more of all colonies for these species were bleached in 2014.

Table 1. Bleaching Prevalence 2011 through 2015. Prevalence equals the total number colonies paling, partially bleached, or fully bleached divided by the total number of colonies recorded. Data is pooled for all reefs surveyed (N = 40). Coral abbreviations are CNAT = *Colpohyllia natans*; DSTO = *Dichocoenia stokesii*; MMEA = *Meandrina meandrites*; MCAV = *Montastraea cavernosa*; PAST = *Porites astreoides*; SSID = *Siderastrea siderea*; SMIC = *Stephanocoenia intersepta*; UAGA = *Undaria/Agaricia agaricites*; OANN = *Orbicella annularis* complex

YEAR	CNAT	DSTO	MMEA	MCAV	PAST	SSID	SMIC	UAGA	OANN	All Corals
2011	1.46	1.64	0.00	1.84	1.18	2.78	2.69	1.16	2.05	2.31
2012	10.80	1.67	2.94	1.51	3.22	6.41	1.51	2.49	8.95	4.41
2013	0.55	1.63	0.00	2.19	0.75	3.23	0.23	0.72	4.15	1.66
2014	28.57	10.66	10.81	23.20	11.38	22.56	11.22	20.02	15.99	17.72
2015	18.38	10.77	12.20	10.97	8.54	17.39	12.38	17.03	16.67	14.07

- At present, only the effects of the 2014 bleaching can be assessed. Data collected in 2016 will be required to determine the impacts of the elevated rate of bleaching that persisted into 2015. CREMP demographic surveys are used to calculate coral abundance (either the total number of corals measured or standardized to the number of corals per square meter). Information provided from coral abundance can be used to supplement and enhance information provided via coral cover. At the time of the 2016 meeting, benthic cover values for 2015 were not available but coral abundance estimates were complete.

- Coral abundance for nine coral species is provided in Table 2. In terms of abundance, aggregated for the 40 CREMP sites, *Siderastrea siderea*, *Porites astreoides*, *Stephanocoenia intersepta*, and *Undaria/Agaricia agaricites* are the four most common corals. Of these four, only *Siderastrea siderea* and *Porites astreoides* are top contributors to coral cover (Figure 4). Corals like *Undaria/Agaricia agaricites* are relatively small in size and contribute little to overall coral cover. Between 2014 and 2015 the abundance of eight of the nine corals was not significantly different in 2015 as compared to previous years (two-way repeated measures ANOVA; F = varies, $p > 0.05$). *Undaria/Agaricia agaricites* was the only coral that demonstrated a significant decline in abundance between 2015 and all other years tested (two-way repeated measures ANOVA; F = 7.029, $p < 0.001$). Between 2011 and 2014 CREMP recorded a mean of 1,258.9±37.5 *Undaria/Agaricia agaricites* colonies per year (±SE). In 2015, only 822 colonies were counted (Table 2). Although changes in overall abundance were not observed for the other 8 species in Table 2, size class metrics for these corals needs to be analyzed. It is plausible that even though the abundance of these species has remained similar, partial mortality inflicted as a result of the bleaching could have reduced the amount of living tissue associated with these corals.

Table 2. Species Specific & Total Coral Abundance 2011 through 2015. Abundance equals the total number of colonies recorded. Data is pooled for all reefs surveyed (N = 40). Abundance was standardized per square meter and tested with a two-way repeated measures ANOVA (year and habitat as factors). Asterisks denote corals whose abundance was significantly different across survey years. NS denotes corals whose abundance did not significantly differ across survey years. Coral abbreviations are CNAT = *Colpohyllia natans*; DSTO = *Dichocoenia stokesii*; MMEA = *Meandrina meandrites*; MCAV = *Montastraea cavernosa*; PAST = *Porites astreoides*; SSID = *Siderastrea siderea*; SMIC = *Stephanocoenia intersepta*; UAGA = *Undaria/Agaricia agaricites*; OANN = *Orbicella annularis* complex

YEAR	CNAT	DSTO	MMEA	MCAV	PAST	SSID	SMIC	UAGA	OANN	All Corals
2011	206	122	33	597	1698	2412	1041	1206	292	8786
2012	176	120	34	664	2019	3040	1258	1368	313	10372
2013	183	123	36	639	2010	3065	1282	1247	289	10106
2014	196	122	37	612	1916	2961	1221	1214	269	9632
2015	185	130	41	629	1991	3191	1292	822	264	9528
P	NS	NS	NS	NS	NS	NS	NS	*	NS	NS

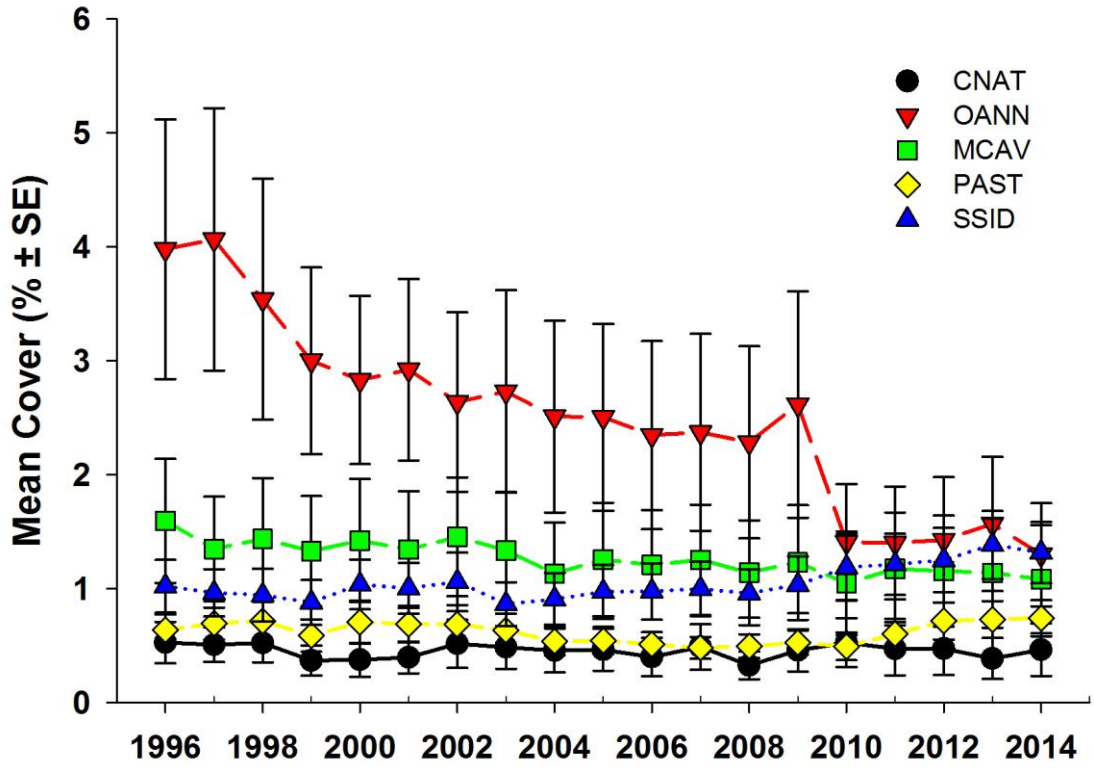

Figure 4. Mean percent cover (±SE) of the five most spatially common corals in the Florida Keys between 1996 and 2014. Coral abbreviations are CNAT = *Colpohyllia natans*; OANN = *Orbicella annularis* complex; MCAV = *Montastraea cavernosa*; PAST = *Porites astreoides*; SSID = *Siderastrea siderea*.