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

Executive Summary 2011

Overview

- The Coral Reef Evaluation and Monitoring Project (CREMP) completed its 15th year of annual surveys in the Florida Keys in 2010.
- The project continues to use two primary methods for evaluating the status and trends of the coral communities in the Florida Keys: (1) in situ stony coral species richness surveys and (2) video transects to quantify the percent cover of major benthic taxa (e.g. stony corals, octocorals, macroalgae, and sponges). All surveys are performed at 22m x 2m sampling stations within each site (Figure 1). Each site has two to four stations.
- In 2010, 40 sites were sampled in the Florida Keys. This included 12 shallow forereefs, 11 deep forereefs, and 15 patch reefs spanning the Upper, Middle and Lower Keys regions and 2 backcountry patch reefs located in Florida Bay, north of the Lower Keys. Collectively, a grand total of 109 stations were sampled.
- Statistical differences in stony coral, octocoral, sponge, and macroalgal percent cover between 2009 and 2010 were compared with a two-way mixed model ANOVA with year and location as factors. Multiple analyses were completed at the site, habitat, and regional*habitat level (e.g. Middle Keys patch reefs).
- This summary highlights the differences between 2009 and 2010 and summarizes the impacts of the 2010 winter mortality on the percent cover of stony corals, octocorals macroalgae, and sponges. Additionally, it describes the overall impact on the long-term trends of these benthic taxa and to five sentinel coral species including *Montastraea annularis*-complex, *M. cavernosa, Colpophyllia natans, Porites astreoides,* and *Siderastrea siderea*.

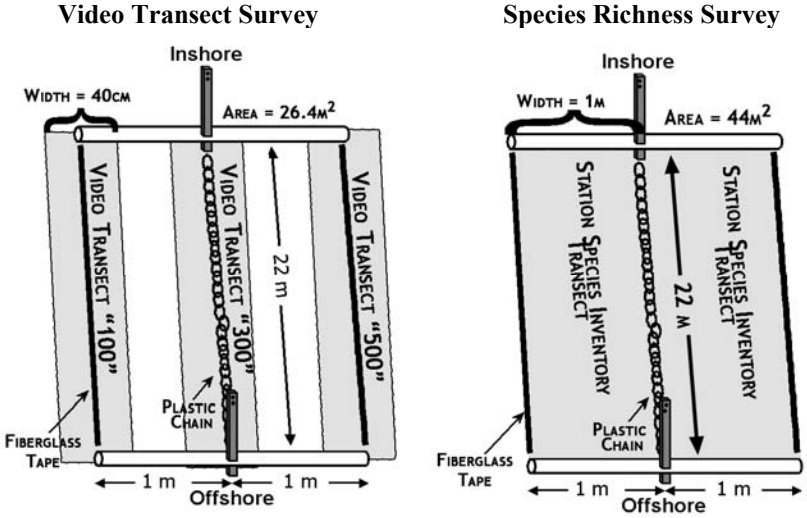

Figure 1: CREMP sites consist of two to four monitoring stations delineated by permanent markers. Stations are approximately 22m x 2m. Three video transects are filmed per station totaling 26.4m^2 of substrate and the species richness survey encompasses a survey area of 44m^2. Both surveys are conducted annually.

Results

2009 vs. 2010

- CREMP observed a significant decline in stony coral between 2009 and 2010 (Table 1). Overall stony coral cover declined from 7.3%±0.9% to 5.9%±0.7%. The decline was entirely due to the record breaking winter of 2010 which depressed water temperatures in nearshore environments below the lethal temperature for corals and other associated reef fauna. Patch reefs in the Upper and Middle Keys underwent the most severe declines in cover. Stony coral cover decreased by nearly two-thirds on Upper Keys patch reefs, from 14.7%±3.1% to 4.8%±1.0% (Table 1). Across middle Keys patch reefs, cover decreased from 17.1%±1.7% to 12.6%±0.8% (Table 1). In all, 6 of the 15 patch reefs monitored by CREMP showed a significant reduction in stony coral cover between 2009 and 2010 with five of the six located in the Upper or Middle Keys. On a positive note, across all regions, no declines in stony coral cover were observed at any of the shallow and deep forereefs (Figure 1).
- Overall octocoral cover significantly decreased from 14.8%±1.1% to 13.3%±0.9% (Table 1). Similar to stony coral cover, the decline was entirely due to the record breaking winter of 2010 and the majority of the mortality was relegated to patch reefs in the Upper and Middle Keys (Table 1). Octocoral cover decreased by more than half on Upper Keys patch reefs, from 26.5%±3.2% to 10.6%±3.1% and by nearly half in the Middle Keys patch reefs, dropping from 25.8%±2.7% to 13.2%±1.5%. In all, 8 of the 15 patch reefs monitored by CREMP showed a significant reduction in stony coral cover between 2009 and 2010. All were located in the Upper and Middle Keys. Although a significant change was not found for any other habitat*region combination (Table 1), significant increases were observed at several shallow forereef sites, continuing a trend of the last decade of octocorals replacing the stony corals as the dominant taxa on shallow forereefs.
- There was no significant difference in the overall cover of sponges between 2009 and 2010 (Table 1). However, a significant decline occurred on Middle Keys patch reefs, with cover dropping from 4.9%±0.8% to 2.6%±0.4%. Conversely, sponge cover did increase on Middle Keys deep forereefs rising from 4.6%±0.8% to 6.6%±1.6%. (Table 1). This supports the theory that lethally cooled water, transported either from Florida Bay or via the advection of shallow bank environments only affected nearshore patch reefs but not offshore reefs during the winter of 2010.
- Another discouraging result is that macroalgal cover significantly increased between 2009 and 2010 (Table 1). Overall macroalgal cover rose from 13.7%±1.6% to 18.7%±1.6%. Although much of the increase followed the mortality on the patch reefs in the Upper and Middle Keys, significantly higher macroalgal values were also found at deep forereefs in the Lower and Middle Keys (Table 1). When the results for all CREMP sites across the Keys are pooled together, higher macroalgal values were found at three of the four habitat types including deep forereefs, shallow forereefs, and patch reefs (Figure 1). This suggests that the increase in macroalgal cover is related to additional factors other than the winter mortality because the increase in cover appears widespread in the Florida Keys.

Table 1. Change in mean percent cover (±SE) at 10 habitat*region combinations and overall in the Florida Keys between 2009 and 2010. Significant differences between years are denoted by ↓ = significant decrease, ↑ = significant increase, and NC = no change. Regions defined as LK = Lower Keys; MK = Middle Keys; UK = Upper Keys. Habitats defined as BCP = Backcountry patch reef; OD = deep forereef; OS = shallow forereef; P = patch reef. Number in parenthesis indicates number of stations sampled in each habitat*region combination.

	Stony Coral			Octocoral			Sponge			Macroalgae		
	2009	2010	Diff.	2009	2010	Diff.	2009	2010	Diff.	2009	2010	Diff.
LK BCP (6)	1.4±0.5	1.3±0.6	NC	0±0	0±0	NC	0.6±0.1	1.5±0.5	NC	62.3±6.3	41.4±11	↓
LK OD (14)	2.8±0.3	2.6±0.3	NC	11.4±0.9	12.1±1.0	NC	3.2±0.5	3.0±0.4	NC	15.8±2.7	34.5±2.6	↑
LK OS (16)	5.3±1.8	5.5±1.7	NC	8.3±0.9	10.8±1.3	NC	0.3±0.1	0.4±0.1	NC	5.4±1.0	8.4±1.1	NC
LK P (14)	24±2.2	21.7±2.3	NC	13.3±3.1	13.4±3.5	NC	4.3±0.9	4.0±0.8	NC	7.0±3.1	10.0±4.4	NC
MK OD (6)	2.4±0.6	3.0±0.6	NC	9.7±1.3	10.9±1.8	NC	4.6±0.8	6.6±1.6	↑	7.7±2.1	13.1±2.0	↑
MK OS (10)	1.7±0.3	1.8±0.3	NC	19.0±1.7	21.0±1.3	NC	1.5±0.4	1.9±0.5	NC	13.1±2.9	15.4±1.8	NC
MK P (11)	17.1±1.7	12.6±0.8	↓	25.8±2.7	13.2±1.5	↓	4.9±0.8	2.6±0.4	↓	4.2±1.6	7.9±1.3	↑
UK OD (6)	3.3±0.6	3.6±0.4	NC	16.1±1.7	16.1±2.1	NC	5.6±1.6	5.7±1.2	NC	20.1±3.6	29.3±7.7	NC
UK OS (13)	5.0±1.5	4.9±1.4	NC	17.3±2.5	17.2±2.6	NC	0.5±0.1	0.6±0.2	NC	8.7±2.1	12.7±3.3	NC
UK P (13)	14.7±3.1	4.8±1.0	↓	26.5±3.2	10.6±3.1	↓	1.1±0.2	1.1±0.4	NC	13.6±2.0	24.1±3.5	↑
Overall (109)	7.3±0.9	5.9±0.7	↓	14.8±1.1	13.3±0.9	↓	2.4±0.3	2.3±0.3	NC	13.7±1.6	18.7±1.6	↑

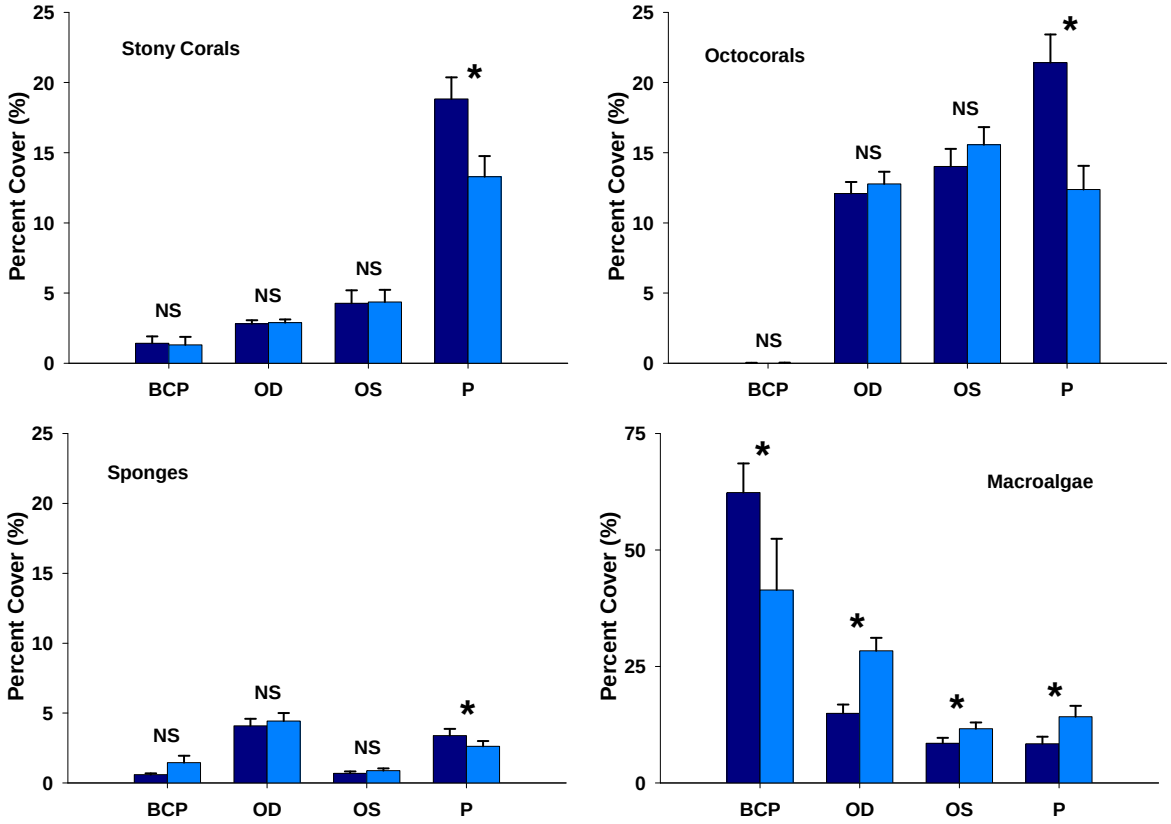

Figure 1. Change in mean percent cover (±SE) of stony corals, octocorals, sponges and macroalgae between 2009 and 2010 at four reef types monitored by CREMP. Reef types defined as BCP = Backcountry patch reef; OD = deep forereef; OS = shallow forereef; P = patch reef. Significant differences between years denoted by * (mixed model ANOVA; $p<0.05$); NS indicates not significant.

Long-term Trends from 1996-2010

- Coral cover reached its lowest point in 2010 at 5.9%. The coral cover value attained in 2010 represents an approximate 53% decline in cover since project inception in 1996 (Figure 2). The change between 2009 and 2010 marks the third largest single year decrease; however, all of the mortality in 2010 was relegated to the patch reefs (Table 1). The pattern of mortality observed in 2010 is in stark contrast to that observed between 1997 and 1999. The prolonged thermal stress event during the 1997/1998 El Nino event substantially reduced the cover at the deep and shallow forereefs, but left cover mostly unchanged at the patch reefs.
- *Montastraea annularis* complex was particularly vulnerable to cold water stress in 2010. Although *M. annularis* complex had been trending negative since 1996, the year to year decline in *M. annularis* complex cover between 2009 and 2010 was the greatest recorded in project history (Figure 3). *Montastraea annularis* complex cover decreased from 2.9%±0.7% to 1.5%±0.4% (Figure 3); a reduction of nearly 50%. This result is extremely discouraging because *M. annularis* complex did indicate some recovery between 2008 and 2009 and *M. annularis* complex is the largest contributor to stony coral cover in the Florida Keys (Figure 3).
- In addition to *M. annularis* complex, *M. cavernosa* was highly susceptible to hypothermic stress. Similar to *M. annularis* complex, *M. cavernosa* had been trending negative since 1996 but a significant decline in cover is apparent between 2009 and 2010.
- Two of the other five most spatially common stony corals, *Colpophyllia natans* and *Porites astreoides*, also show a long-term decreasing trend in cover (Figure 3). *Siderastrea siderea* has proven itself to be tolerant of both cold water and warm water disturbances and is the only coral among the five most spatially abundant not to show a declining trend in cover.
- Although overall octocoral cover significantly declined between 2009 and 2010, octocoral cover has been steadily rising after reaching a low point in 2000 (Figure 2). As discussed above, the decrease in octocoral cover between 2009 and 2010 was entirely due to the thermal stress associated with the winter of 2010. In spite of the large declines on Upper and Middle Keys patch reefs, octocoral cover did increase at some shallow forereefs. The increase of octocoral cover has been clearly evident on the shallow forereef sites since 2000 because all 12 shallow sites have demonstrated a strong positive trend. Between 2009 and 2010 four shallow forereefs showed a significant increase suggesting this trend is continuing. The increase follows the removal of *Acropora palmata* and *Millepora complanata* from these habitats after the mass bleaching event during the 1997/1998 El Nino, however, this shift in community structure may also begin at patch reefs following the mass mortality of *M. annularis* complex at some sites during the 2010 winter.
- Due to its high annual variability, no trend in macroalgae cover has been reported in previous years. Mean macroalgal cover throughout the project is approximately 11.5%. The 2010 value, however, represents the second highest macroalgal cover level ever recorded and does provide concern because it continues a recent trend of increasing macroalgal cover since 2005 (Figure 2). Although the rise in macroalgal in 2010 can be partially attributed to the mortality following the winter of 2010, the increase in cover was widespread because significant increases were found in multiple reef habitats and regions (Table 1 and Figure 1).

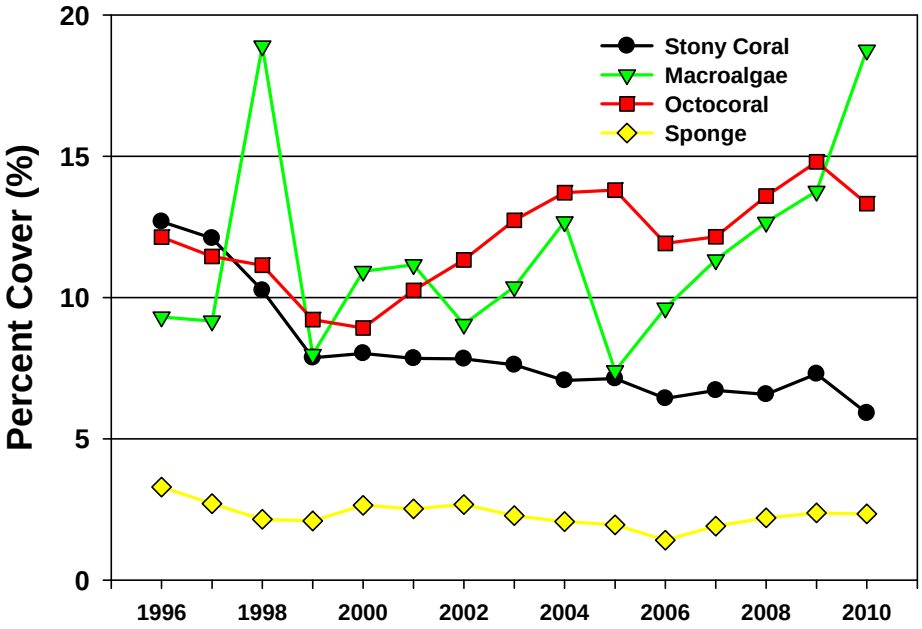

Figure 2. Mean annual percent cover for the four major benthic taxa recorded in CREMP image analysis. Mean percent cover is the average of 97 stations in the Florida Keys monitored since 1996. Overall trends from 1996 through 2010 determined with a mixed model regression. Trends are as follows: Stony Coral: decreasing ($p<0.001$); Macroalgae: no change ($p>0.05$); Octocoral: increasing ($p<0.001$); Sponge: decreasing ($p<0.001$).

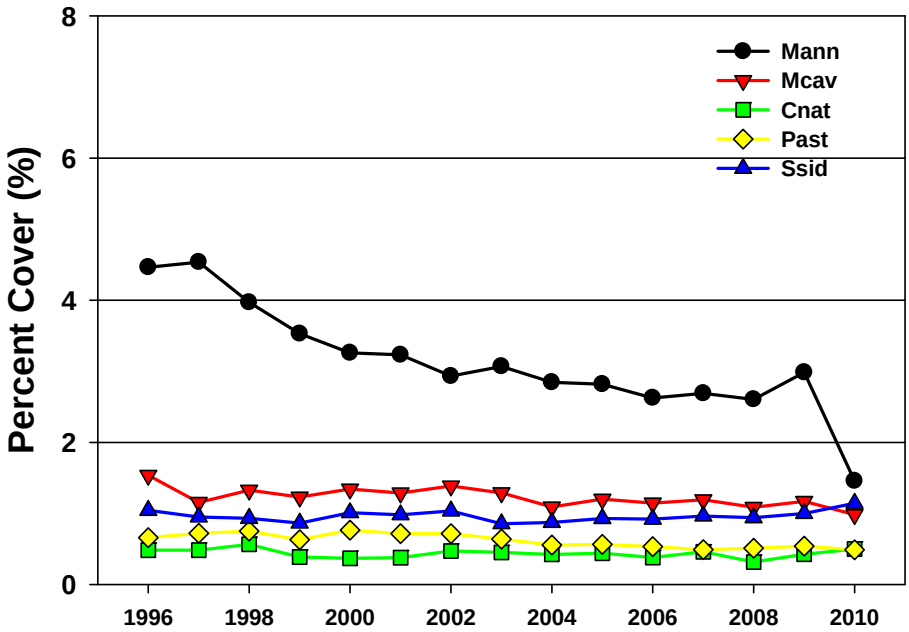

Figure 3. Mean annual percent cover for the five most spatially common species of corals recorded in CREMP image analysis. Mean percent cover is the average of 97 stations in the Florida Keys monitored since 1996. Overall trends from 1996 through 2010 were determined from a mixed model regression. Trends are as follows: *Montastraea annularis*: decreasing ($p<0.001$); *Montastraea cavernosa*: decreasing ($p<0.001$); *Siderastrea siderea*: no change ($p>0.05$)); *Porites astreoides*: decreasing ($p<0.001$); *Colpophyllia natans*: decreasing ($p<0.001$).