Mass mortality of sessile organisms at patch reefs following a cold water disturbance in January 2010.

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Introduction

In January of 2010 water temperatures near shore in the Florida Keys dropped below the minimum thermal threshold for corals (16ºC) and other invertebrates for several days resulting in widespread mortality. Events of this kind are known to have happened several times in the past and are thought to be an important determinant of community structure along the Florida Reef tract (Burns 1985).

Severe cold weather events occurred in southern Florida 19 times between 1880 and 1980 (Hudson et al. 1989). Prior to 2010 the most recent severe cold spell was documented in 1981. Mortality of stony corals was observed following severe cold weather in 1970, 1977 and 1981. At 'Hens and Chickens' patch reef in 1970 80% to 90% mortality was observed and attributed to extreme cold water temperatures (Hudson et al. 1976). In 1977 water temperatures dropped below 16ºC for at least 7 days across Florida Bay and the northern Bahamas Banks. Following this event near complete mortality was observed in shallow water *Acropora cervicornis* thickets in the Dry Tortugas (Porter et al. 1982). Mortality also occurred in the Bahamas, where mortality was observed in the majority of octocorals, *Acropora palmata* and *A. cervicornis* (Roberts et al. 1982). In 1981 mortality at patch reef and shallow outer-reef locations in the Florida reef-tract was attributed to the offshore movement of cold Florida Bay waters. At patch reefs near Elliot Key partial mortality of *Montastrea annularis* and *Agaricia agaricites* and total mortality of *Porites astreoides* was observed. At Looe Key two thickets of *A. cervicornis* and two smaller patches of *A. palmata* bleached and were subsequently killed (Walker et al. 1982).

The Coral Reef Evaluation and Monitoring Project conducts annual surveys of coral reef habitat at fixed survey stations throughout the Florida Keys. These fixed stations provide a means to quantify the loss of living coral cover associated with the severe cold weather event of 2010.

Methods

Eight CREMP survey stations at 4 patch reefs sites were visited in the first week of February 2010, just over 2 weeks following severe cold water temperatures (Figure 1). Hourly temperature data was recorded at 3 of these locations during the mortality event. At each of these stations percent cover was determined using video transects and in situ measurement of stony corals was conducted using the standard Florida Reef Resiliency Project (FRRP) methods. The FRRP surveys were conducted within the existing CREMP survey stations and was used to gather demographic information on corals including prevalence and severity of bleaching and disease.

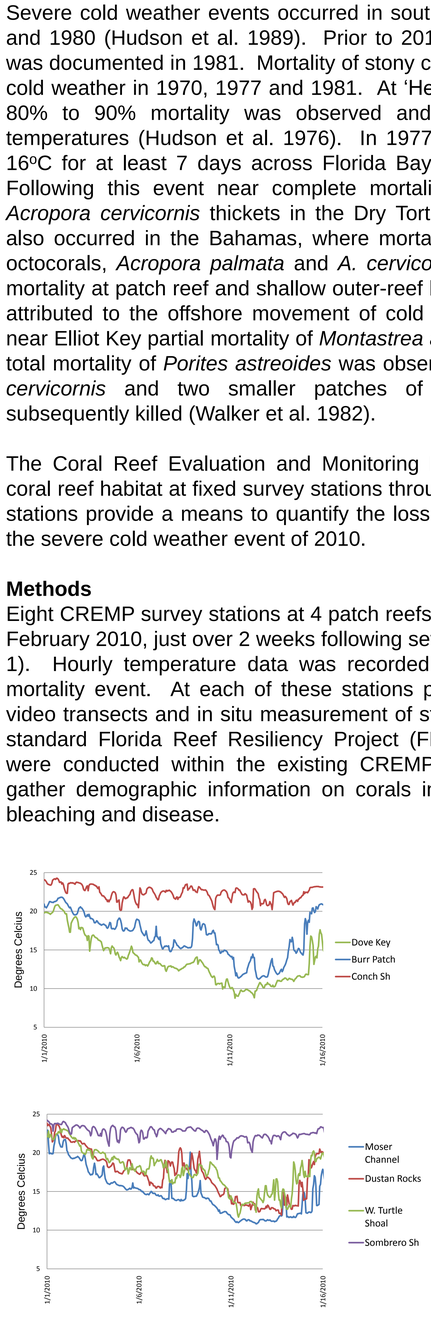

Figure 3: Temperature Logger data for the cold spell in early January 2010.

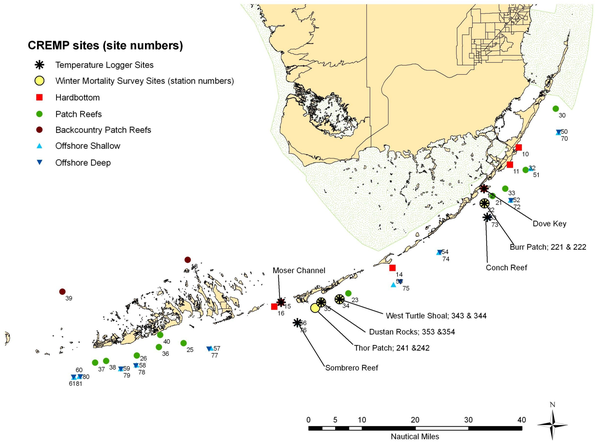

Figure 1: Location of all CREMP sites, winter surveys and temperature logger locations.

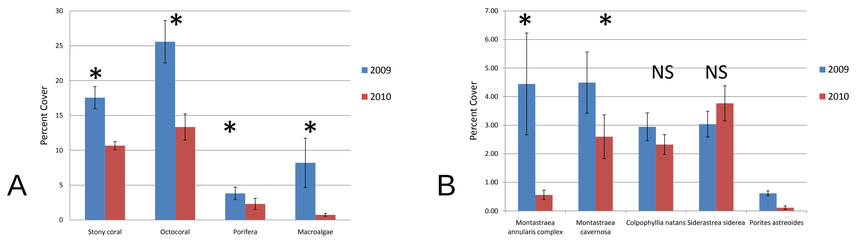

Figure 4: A) Changes in percent cover at selected sites/stations from Summer 2009 to February 2010, error bars are standard error. Significant decreases in stony coral, octocoral, sponges and macroalgae were observed (Wilcoxin paired samples test, P<0.001). B) Of 5 selected coral species *M. annularis* and *M. cavernoa* significantly decreased (Wilcoxin paired samples test, P<0.001). Significant declines were not found for *Colpophyllia natans* or *Siderastrea siderea* and *P. astreoides* was not tested.

	Burr Patch				W. Turtle Shoal				Dustan Rocks				Thor Patch			
	relative % cover decrease	number of colonies	prevalence	severity	relative % cover decrease	number of colonies	prevalence	severity	relative % cover decrease	number of colonies	prevalence	severity	relative % cover decrease	number of colonies	prevalence	severity
Montastrea annularis (complex)	88.15	28	96.43	79.37	0.00	1	100.00	85.00	95.68	12	91.67	83.18	70.38	2	50.00	10.00
Montastrea cavernosa	65.84	6	83.33	79.00	45.18	29	58.62	32.35	63.75	17	76.47	57.69	20.79	11	63.64	32.14
Colpophyllia natans	19.51	4	25.00	35.00	16.95	7	0.00	-	0.00	11	54.55	35.83	35.82	3	0.00	-
Porites astreoides	100.00	28	96.43	93.33	87.26	23	86.96	80.00	100.00	14	100.00	92.86	43.87	17	17.65	30.00
Siderastrea siderea	0.00	36	16.67	13.33	0.00	76	2.63	7.50	0.00	58	13.79	10.63	0.00	34	2.94	10.00

Table 1: Loss of 5 key species at the four winter survey sites. Prevalence and severity of recent mortality was quantified from FRRP data. Prevalence is the percent of colonies experiencing mortality and severity is the mean percentage of tissue loss in the affected colonies.

Results and Discussion

The minimum temperature recorded at the winter survey sites was 11.2ºC at Burr Patch on January 12th. For comparison the minimum temperatures at Dove Key, a nearby hardbottom and at Conch Shallow were 8.8ºC and 21.2ºC, respectively, during this time period. Similar, though less severe patterns were found at the other sites surveyed in February 2010 (Figure 3).

Analysis of point count data shows that significant decreases were detected in all major benthic substrate groups (stony corals, octocorals, sponges and macroalgae) . Octocorals were the most severely affected with the average canopy cover across all survey stations decreasing by nearly 50%(Figure 4a). *M. annularis* and *P. astreoides* were the most severely affected stony coral species. Most *M. annularis* colonies suffered considerable amounts of partial mortality and had only small patches of surviving polyps. *P. astreoides* colonies suffered complete mortality at 2 of the 4 survey sites. Conversely, *C. natans* decreased in cover only slightly and *S. siderea* actually increased slightly. The slight increase in *S. siderea* is more likely a result of other benthic organisms dying off the would have previously obscured these colonies in point count images such as octocorals and macroalgae (Figure 4b, Table 1).

Mortality was not consistent across the survey sites. Burr Patch and Dustan Rocks were the most severely affected and lost the most coral cover mostly due to the high proportion of *M. annularis* at those sites in 2009. Thor patch was the least affected of the reefs surveyed (Table 1).

Patterns of loss and mortality are similar to what was observed during the last cold water mortality in 1981 described by Walker et al. (1982). Though no sites were surveyed, no mortality was reported at offshore reefs which makes sense given the observed temperature minima (Figure 3).

Although not surveyed in February, annual surveys conducted in the Summer of 2010 indicated that several other patch reefs suffered severe mortality likely due to the winter event. In the Upper Keys site 21 suffered similar mortality to Burr Patch and site 33, Admiral Patch, suffered complete mortality of nearly every coral species except *S. siderea*. Sites 30 and 32 were relatively unaffected. In the lower keys octocoral and some coral mortality was observed at site 40 and some signs of mortality were present at site 25, but other patch reefs remained unaffected.

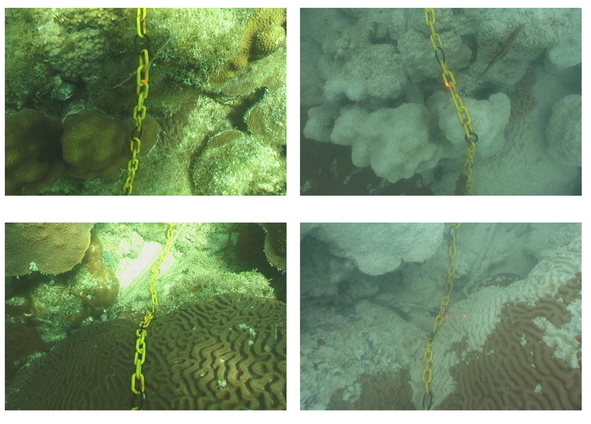

Figure 5: Examples of coral mortality at Burr Patch. Complete mortality of *M. annularis* and *P. astreoides* (top). Complete mortality of *M. annularis* and partial mortality of *C. natans* (bottom).

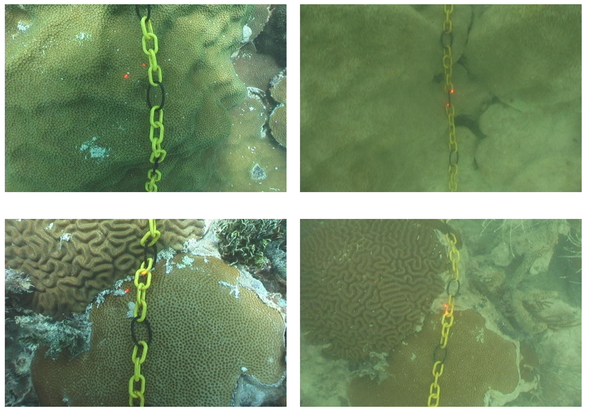

Figure 6: Examples of coral mortality at Dustan Rocks. Complete mortality of *M. annularis* (top). *C. natans* and *S. siderea* colonies that experienced little to no mortality due to cold (bottom).

For more information on the Coral Reef Evaluation and Monitoring Project please visit our webpage at http://www.floridamarine.org or contact us at Corals@MyFWC.com