Florida Reef Resilience Program

Disturbance Response Monitoring and

Hurricane Irma Rapid Reef Assessment

Quick Look Report:

Summer 2017

INTRODUCTION

The Florida Reef Resilience Program (FRRP) is a collaborative effort among local, state and federal environmental managers, scientists, conservation organizations and reef users to develop resilience-based management strategies for anticipating and addressing climate change and other stressors on Florida's coral reefs. Coral bleaching is projected to increase in response to climate change-induced warming of ocean temperatures, and the FRRP Disturbance Response Monitoring program (DRM) was developed for monitoring shallow coral reefs from the Dry Tortugas to Martin County to facilitate adaptive management in a changing environment. The DRM consists of a probabilistic sampling design and a condition monitoring protocol for stony corals implemented during the annual period of peak thermal stress. Each year, survey teams from federal, state, and local government agencies, universities and non-governmental organizations cooperate to complete surveys across the entire south Florida Reef Tract within an eight to ten-week period.

In late July, the NOAA Coral Reef Watch Bleaching Alert System reported both the southeast Florida mainland reefs and the Florida Keys under a low-level bleaching '*watch*'. Southeast Florida reefs were upgraded to a coral bleaching '*warning*' in early September while the Florida Keys were upgraded to an Alert Level 1. When Hurricane Irma made landfall in the Florida Keys on September 10th both sections of the reef tract were reduced back down to a low-level '*watch*' only days after the storm.

Prior to Hurricane Irma, only a few survey teams had conducted their DRM surveys, and that effort was greatly reduced once the storm had passed. Many of our partners suffered damages from the storm that hindered their ability to complete surveys for the remainder of the season. Therefore, the DRM survey sites completed for the 2017 season were localized to the Broward-Miami, Middle Keys, Lower Keys and Dry Tortugas sub-regions. No 2017 DRM sites were completed in the Martin County, Palm Beach County, Biscayne National Park, and Upper Keys sub-regions. In 2017, surveyors included: Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission (FWCC), Miami-Dade County, Mote Marine Laboratory, National Oceanic and Atmospheric Administration (NOAA), National Park Service, Nova Southeastern University and The Nature Conservancy.

Separate from the DRM, funding from the National Fish and Wildlife Foundation, NOAA and the State of Florida convened a large group of partners to conduct a rapid, post-hurricane reef damage assessment of "high value" sites in the Florida Keys. The assessment took place from October 9 – 18, overlapping the regular DRM season, and surveyed 57 sites from Biscayne National Park through Key West. The survey methods conducted at each of the rapid assessment sites included the DRM's standard belt transect methodology along with roving diver and reef fish visual census surveys. The sites surveyed during the rapid assessment were pre-selected based on preexisting documentation of high cover of reef building corals, long-term monitoring locations, and/or areas of high tourism value. Although the sampling design differed between the DRM program and the Hurricane Irma rapid assessment, the in-water belt transect survey methodologies were the same. Therefore, the results from both efforts are presented in this FRRP Quick Look Report to inform the reef community on coral health and condition for the 2017 bleaching season and provide summary information on hurricane related impacts to the reef.

The objectives of the Hurricane Irma rapid response assessment were to: 1) collect coral health condition data post-hurricane, 2) locate areas with fragmented corals for subsequent stabilization, 3) assess storm-related impacts, 4) assess coral disease, 5) assess reef fish community, and 6) collect images of impacts to the reef. This report will cover coral health condition data, coral impact assessment, and coral disease data collected during the rapid assessment. Partners included in the rapid assessment effort were Boston University, Coral Restoration Foundation, Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, Florida Keys Community College, National Oceanographic and Atmospheric Administration, National Park Service and The Nature Conservancy.

METHODOLOGY

The DRM consists of a probabilistic sampling design that focuses on sampling the coral population based on how corals are distributed spatially within and across different sub-regions and zones of the overall reef tract. For the 2017 DRM season, 234 potential sample sites were allocated across 28 discrete reef zones in 10 sub-regions. Eight survey teams of scientific divers conducted the monitoring in 2017.

The Hurricane Irma rapid assessment selected sites from existing long-term datasets where known high coral cover of important reef building species and/or high economic value to the dive tourism industry existed. Those source datasets included the FWCC's Coral Reef Evaluation and Monitoring Program (CREMP), NOAA's National Coral Reef Monitoring Program (NCRMP) sites from 2016, as well as FRRP DRM sites from 2015 and 2016. Of these source datasets, CREMP is the only program that has fixed monitoring sites with permanent transect markers. Both NCRMP and DRM generate random sample sites each time they survey. For the rapid assessment, 120 potential sites from these datasets were selected covering several habitat types along the Florida Keys. Surveys were conducted from a liveaboard vessel and a twin-vee tender supplied by FWCC.

The randomly selected sites and strategically selected sites for both the DRM and Irma rapid assessment consisted of two independent 1x10m belt transects that were randomly placed within a 100x100m sample area. At all sites, indicators were recorded for all stony corals greater than 4cm including: 1) hard coral size and 2) hard coral condition as determined by the presence of bleaching, presence of paling (i.e., the precursor to bleaching), presence of disease, and percent morality. An additional data column was added to the belt transect survey for the Irma assessment wherein the diver could identify hurricane related impacts for each coral colony. Those hurricane related impact categories included; abrasion, dislodgement, breakage, or covered by sediment.

At the fixed CREMP sites, a 1x10m belt transect was completed at plots 1 and 2. Transect tapes were run from the offshore to the inshore stake within each plot. Surveyors then completed the 1x10m belt transect starting from the offshore stake, working inshore.

Roving diver surveys conducted at each site collected broad-scale disease occurrence information by tallying both healthy and diseased corals of target species >10 cm in diameter to derive a disease prevalence value over the area surveyed. The target species included *Colpophyllia natans, Dendrogyra cylindrus, Dichocoenia stokesi, Diploria labyrinthiformis, Eusmilia fastigiata, Meandrina meandrites, Montastraea cavernosa, Orbicella annularis, Orbicella faveolata, Orbicella franksi, Pseudodiploria clivosa,* and *Pseudodiploria strigosa*.

2017 DRM RESULTS

A total of 75 sites were completed from the stratified random sample draw for the DRM program. Twenty-four sites were completed in the Broward-Miami sub-region, 15 in the Lower Keys, 5 in the Middle Keys, and 31 in Dry Tortugas.

The prevalence of bleaching and paling in each zone was determined and broken into three categories: mild (0-20%), moderate (21-50%) and severe (>50%) (**Figure 1**; **Table 1**). Severe bleaching and paling, which is defined as >50% of all hard corals over 4 cm surveyed showing signs of bleaching or paling, occurred at only six of the 75 sites, five in the Broward-Miami sub-region and one in the Lower Keys sub-region. All severely bleached sites in the Broward-Miami sub-region had less than 10 total coral colonies. One site had only one bleached *Porites divaricata* colony recorded equaling 100% bleaching prevalence.

Moderate bleaching and paling (21-50%) occurred in all zones within the Broward-Miami sub-region and in two zones in the Lower Keys. Mild bleaching and paling (0-20%) occurred in two zones in the Broward-Miami sub-region, two zones in the Middle Keys, and in both zones of Dry Tortugas sub-region.

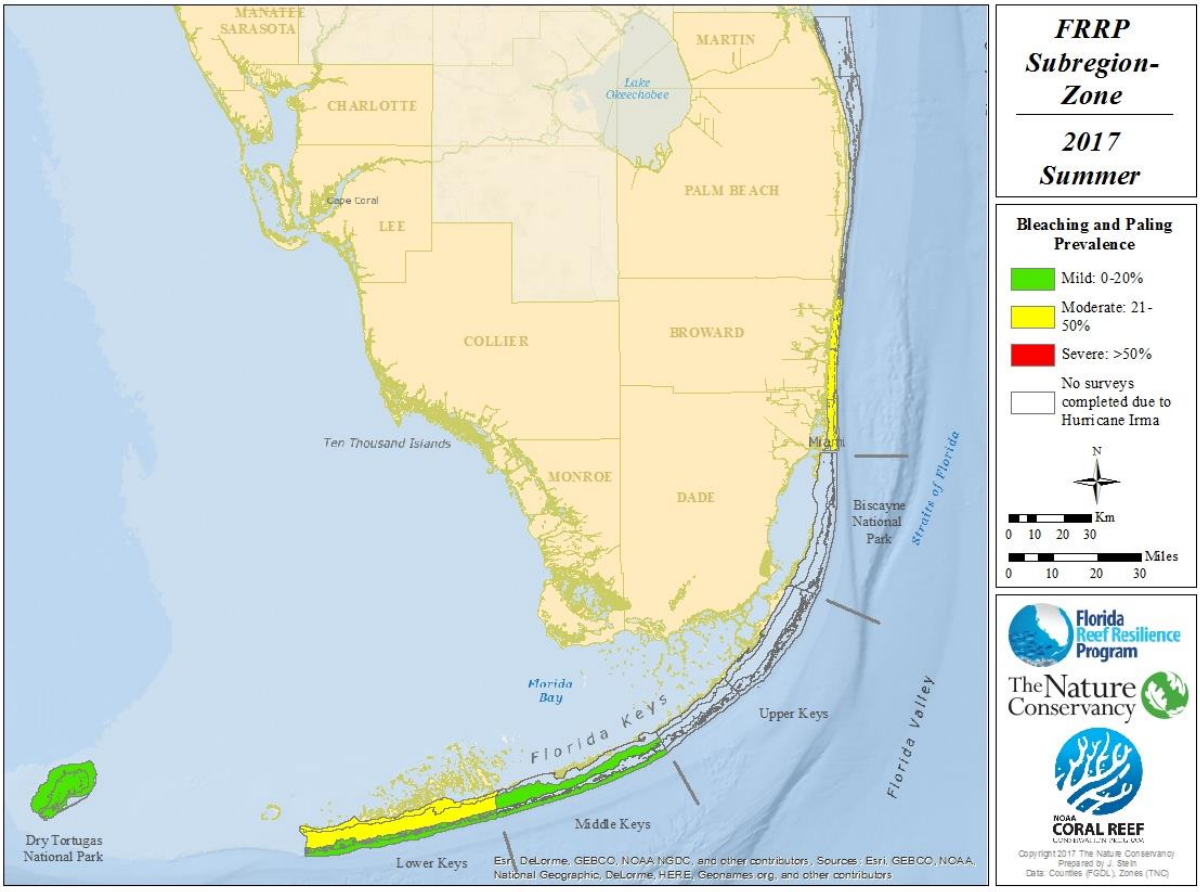

Figure 1: Percent bleaching and paling prevalence of surveyed hard coral colonies by sub-region and zone for the DRM program.

Table 1: Bleaching and paling prevalence of hard coral colonies surveyed by sub-region and zone for the DRM program. Yellow indicates moderate (21-50%) and green indicates mild (0-20%) bleaching and paling prevalence.

Sub-Region Zone	# of Sites	% Paling Prevalence	% Bleaching Prevalence	% Bleaching and Paling Prevalence
Broward-Miami-Inshore	8	18	19	37
Broward-Miami-Inner Reef	5	18	6	23
Broward-Miami-Middle Reef	6	15	6	21
Broward-Miami-Outer Reef	5	19	12	31
Middle Keys-Mid Channel	2	5	3	9
Middle Keys-Forereef	3	9	2	11
Lower Keys-Inshore	3	27	6	34
Lower Keys-Mid Channel	6	29	9	38
Lower Keys-Offshore Patch Reef	2	18	0	19
Lower Keys-Forereef	4	18	1	19
Tortugas--Dry Tortugas NP-Forereef	22	9	4	13
Tortugas--Dry Tortugas NP-Lagoon	9	8	3	11

The disease prevalence at each DRM site was determined and broken into three categories: mild (0-5%), moderate (5-10%), and severe (>10%) (**Figure 2**; **Table 2**). Across the 75 sites surveyed for the 2017 DRM, only two sites were recorded above 5% disease prevalence. Both of these sites were located in the Lower Keys just offshore of Key West. One mid channel site was recorded with 6% prevalence of unknown disease mostly observed on *Siderastrea siderea*. The other site, located on the inshore reef, was recorded with 23% prevalence of unknown disease mostly observed on *Orbicella* spp. and *Siderastrea siderea*. None of the sites surveyed in Dry Tortugas National Park were found to have disease prevalence above 5%.

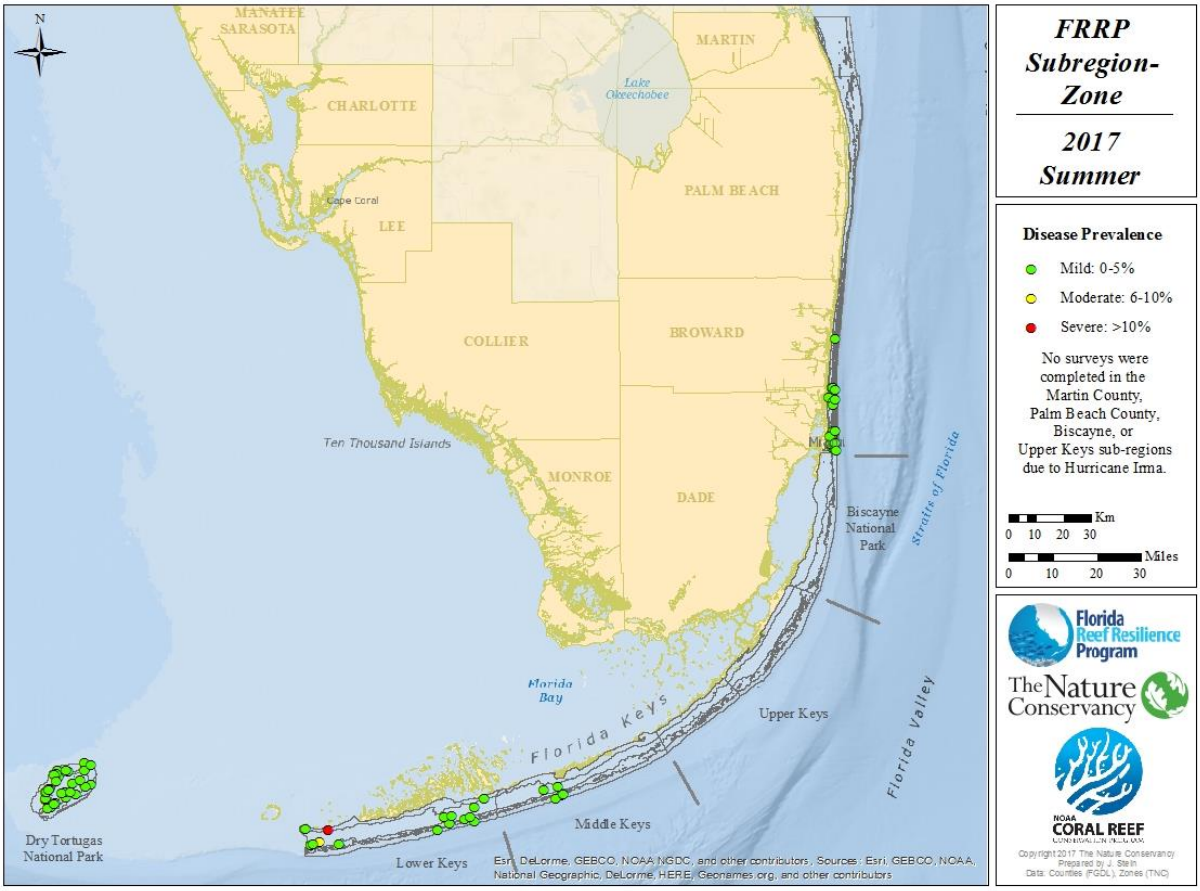

Figure 2: Percent disease prevalence of surveyed hard coral colonies by site for the DRM Program.

Table 2: Disease prevalence of hard coral colonies surveyed by sub-region and zone for the DRM program. Yellow indicates moderate (6-10%) and green indicates mild (0-5%) disease prevalence.

Sub-Region Zone	% Disease Prevalence
Broward-Miami-Inshore	0
Broward-Miami-Inner Reef	0
Broward-Miami-Middle Reef	0
Broward-Miami-Outer Reef	0
Middle Keys-Mid Channel	1
Middle Keys-Forereef	0
Lower Keys-Inshore	9
Lower Keys-Mid Channel	2
Lower Keys-Offshore Patch Reef	1
Lower Keys-Forereef	1
Tortugas--Dry Tortugas NP-Forereef	1
Tortugas--Dry Tortugas NP-Lagoon	0

HURRICANE IRMA RAPID ASSESSMENT RESULTS

From the belt transect data collected at each site, the prevalence of bleaching and paling was calculated for each site. The prevalence of bleaching and paling was determined and broken into three categories: mild (0-20%), moderate (21-50%) and severe (>50%) (**Figure 3**). Of the 57 sites surveyed for the rapid assessment, none were recorded with severe bleaching and paling prevalence. Sites with moderate bleaching and paling prevalence occurred in all sub-regions surveyed during the rapid assessment from Biscayne National Park to Key West. Prevalence of paling had a stronger influence on these moderate scores than did bleaching. Although these surveys were completed during the late summer months, it is possible that some degree of the paling and bleaching observed could be the result of hurricane induced stress as opposed to heat stress.

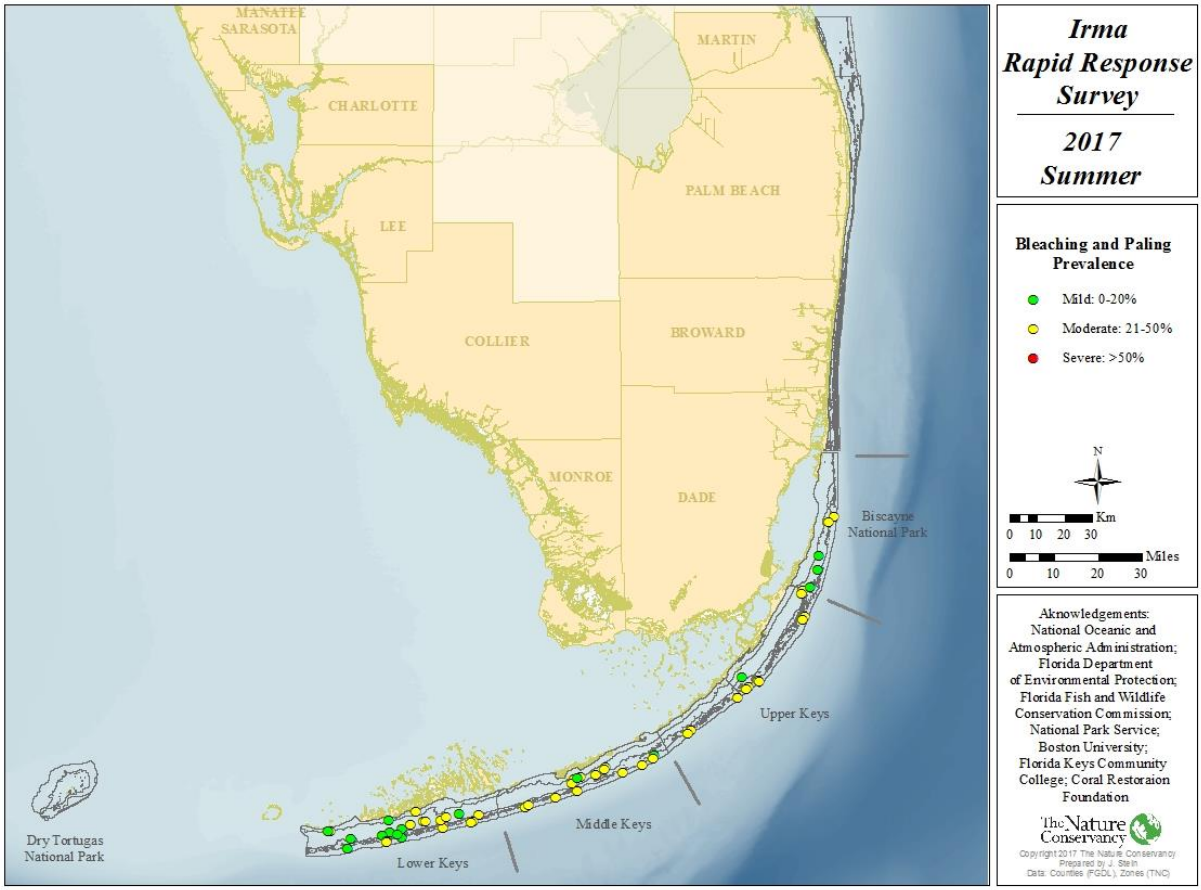

Figure 3: Percent bleaching and paling prevalence of surveyed hard coral colonies by site from belt transect data for the Irma rapid assessment.

The disease prevalence collected from the belt transect survey at each site was determined and broken into three categories: mild (0-5%), moderate (5-10%), and severe (>10%). Across the 57 sites surveyed for the rapid assessment, none were recorded above 5% disease prevalence along the belt transects. The disease prevalence values from the roving diver surveys however, presented different results. Covering a larger area of the reef, the roving diver surveys identified disease prevalence at a broader scale than the belt transects. The roving diver survey targeted colonies >10 cm from a list of specific structurally important reef building coral species. Disease prevalence calculated from the roving diver surveys showed 15 sites above 5% disease prevalence, seven of which were above 25% (**Figure 4**; **Table 3**).

Among the sites with the highest disease prevalence values, one site had only one coral colony of the target species *Orbicella franksi* and it was diseased. Therefore, that site had 100% disease prevalence. Another site had only four of the target species *Montastraea cavernosa* where two were diseased equaling 50% disease prevalence. Sites with disease prevalence values above 10% were mainly in the Upper Keys sub-region and the eastern portion of the Middle Keys sub-region.

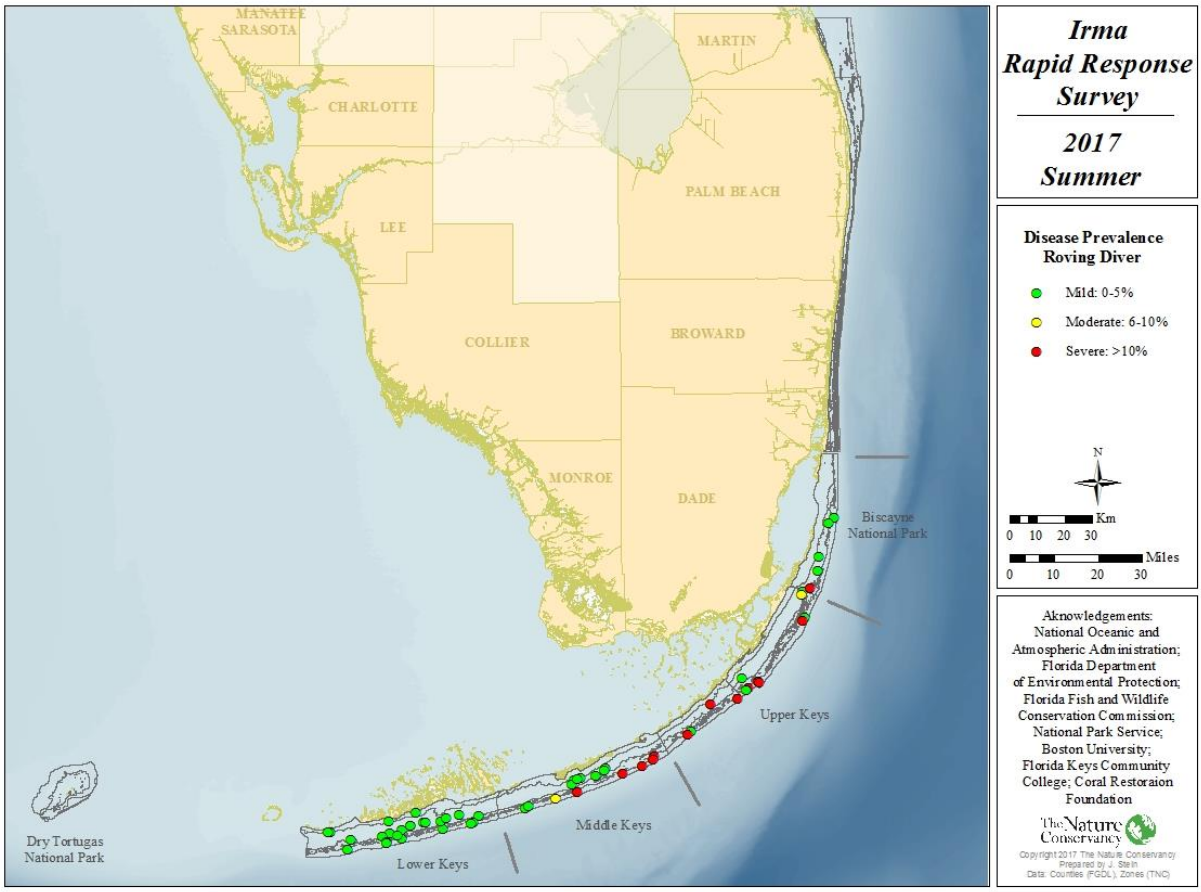

Figure 4: Percent disease prevalence of surveyed hard coral colonies by site collected from roving diver data for the Irma rapid assessment.

Table 3: Moderate (5-10%) and high disease prevalence (>10%) of hard coral colonies surveyed by site for the Irma rapid assessment.

Site ID	Latitude	Longitude	Estimated Survey Area	Total # of Corals	% Disease Prevalence	Sub-Region
IRMA_023	24.98885	-80.41365	400	1	100	Upper Keys
IRMA_092	25.0072	-80.3756	500	4	50	Upper Keys
IRMA_081	25.0088	-80.3765	1000	7	43	Upper Keys
IRMA_025	24.934383	-80.5494	400	52	31	Lower Keys
IRMA_095	24.7527	-80.7578	700	47	28	Middle Keys
IRMA_093	24.9519	-80.4513	500	20	25	Upper Keys
IRMA_108	25.20969	-80.21816	500	20	25	Upper Keys
IRMA_043	24.76336	-80.75519	500	31	23	Middle Keys
IRMA_004	24.730754	-80.798771	600	194	19	Middle Keys
IRMA_103	25.3162	-80.188	NA	17	18	Biscayne National Park
IRMA_115	24.64668	-81.0322	400	100	18	Middle Keys
IRMA_119	24.8357	-80.63258	500	63	17	Upper Keys
IRMA_016	24.706446	-80.868015	300	35	14	Middle Keys
IRMA_071	25.29313	-80.22094	500	33	9	Upper Keys
IRMA_096	24.6253	-81.1116	500	127	7	Middle Keys

The prevalence of hurricane related impacts collected along the belt transects during the rapid assessment was determined and broken into five categories: 0-5%, 6-10%, 11-20%, 21-50% and >50% of colonies impacted (**Figure 5**). Impacts included in the prevalence values are abraded, dislodged, broken and sediment covered. The sites with >20% prevalence of impacted corals were focused in the Lower Keys where the eye of Hurricane Irma crossed the Keys. However, one severely impacted site (61% impacted corals), within the Biscayne sub-region was heavily influenced by the presence of *Acropora cervicornis*. *Acropora cervicornis* is a fragile branching coral that uses fragmentation as a means of propagation however due to the severity of Hurricane Irma, the impacts of breakage, abrasion and sediment cover may have resulted in negative impacts to the colonies at that site.

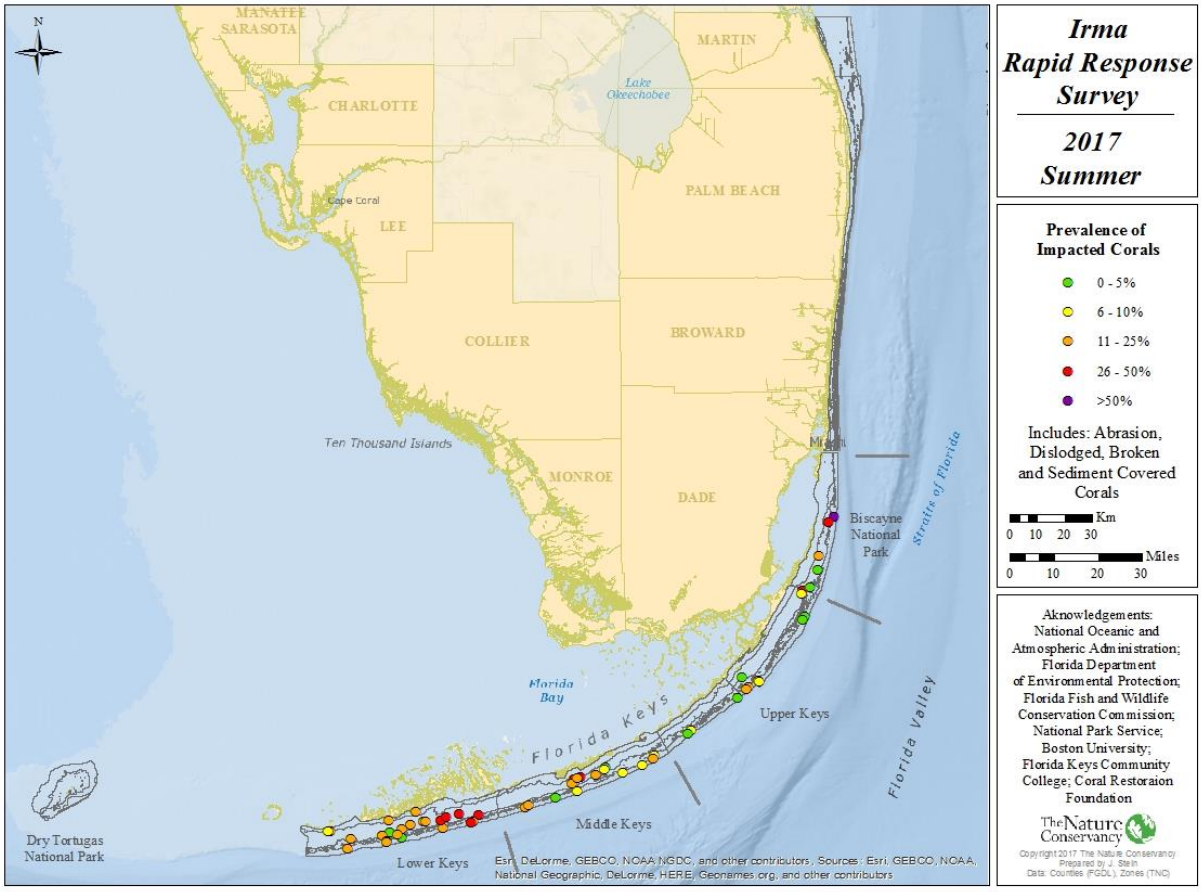

Figure 5: Percent hurricane related impact prevalence of surveyed hard coral colonies by site collected from belt transect data.

A comparison of the 2016 DRM dataset with the 2017 DRM and the Hurricane Irma Rapid Reef Assessment datasets, shows that bleaching and paling was again mild to moderate in 2017. Despite another mild to moderate bleaching season, the prevalence of coral disease collected from roving diver surveys during the Irma assessment showed disease continuing to move south down the reef tract through the Upper Keys and into the Middle Keys.

The highest prevalence of hurricane related impacts was concentrated in the Lower Keys where the eye of Hurricane Irma made landfall in early September. Moderate impacts were observed in the Middle Keys and decreased in the Upper Keys. Two sites within Biscayne National Park had >10% prevalence of impacted corals however, one of those sites was heavily influenced by the breakage of fragile *Acropora cervicornis* colonies.

North of the Broward-Miami sub-region, no surveys were completed along the northern portion of the reef tract. Therefore, the results of this report do not reflect conditions experienced in the Martin County and Palm Beach County sub-regions for the 2017 bleaching season.

For more information about FRRP and its DRM effort see the website www.frrp.org. For more information about the Summer 2017 DRM results and the Hurricane Irma Rapid Reef Assessment contact Chris Bergh, South Florida Program Manager, at cbergh@tnc.org or at (305) 872-7071.