

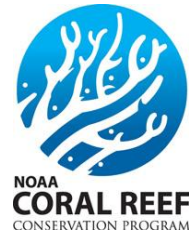
Florida Reef Resilience Program

Disturbance Response Monitoring



Quick Look Report:

Summer 2018



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 Martin County to the Dry Tortugas 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 System within an eight to ten-week period.

In late June and early July of 2018, the NOAA Coral Reef Watch Bleaching Alert System reported both the southeast Florida mainland reefs and the Florida Keys reefs under a low-level bleaching '*watch*'. By late July, temperatures did begin to quickly increase, and Southeast Florida reefs were upgraded to a coral bleaching '*warning*' and the Florida Keys were upgraded to an Alert Level 1. However, in August frequent storms throughout the month reduced the sea surface temperatures in both southeast Florida and the Florida Keys and subsequently returned the region to a '*watch*' level although Alert Level 1-temperatures remained in some portions of the upper Keys. Both regions were downgraded to low-levels of bleaching heading into the first week of October.

For the 2018 DRM season, 72 surveys were completed in southeast Florida, 73 surveys in the Florida Keys, and 50 in Dry Tortugas National Park between August and October. Survey partners included Biscayne National Park, Broward County, Dry Tortugas National Park, Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission (FWC), John Pennekamp Coral Reef State Park, Keys Marine Lab, Miami-Dade County, Mote Marine Laboratory, National Oceanic and Atmospheric Administration (NOAA), Nova Southeastern University, Rosenstiel School of Marine and Atmospheric Science, and The Nature Conservancy.

Results from the 2018 surveys showed a mild to moderate bleaching year for Florida's coral reefs. Moderate bleaching occurred in the outer reefs of the Upper Keys and in the southern

reefs of Palm Beach County. A high prevalence of coral diseases was recorded in the Upper Keys Mid Channel reefs and a medium disease prevalence was observed throughout the Middle Keys zones, similar to the conditions recorded in 2017.

This summary report describes the prevalence of coral bleaching, paling, and disease in 2018. Prevalence values were calculated by pooling all corals across all zones within a particular subregion. Reef zones were classified by cross-shelf position, distance from shore, and depth while subregions were stratified latitudinally. In addition, the mean recent mortality per colony from a tissue loss disease was averaged across the zones for each subregion to show where the disease was most active during the 2018 DRM season. Although the pathogen or cause of the unknown tissue loss disease still remains unidentified, researchers and managers now collectively refer to the cause of the outbreak as Stony Coral Tissue Loss Disease (SCTLD). Case definitions of SCTLD and existing information are compiled in a document developed by the Florida Keys National Marine Sanctuary and can be found at (<https://floridakeys.noaa.gov/coral-disease/>).

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 system. For the 2018 DRM season, 250 potential sample sites were allocated across 30 discrete reef zones in 10 sub-regions.

Sites were randomly selected and consisted of two replicate 1x10m belt transects that were haphazardly placed within a 100x100m sample area. At all sites, the indicators recorded for all stony corals greater than 4cm were: 1) hard coral size (max diameter and height) and 2) condition as determined by the presence of bleaching, presence of paling (i.e., the precursor to bleaching), presence of disease, and percent mortality. Percent mortality was assigned as either old mortality, recent mortality due to any diseases, and recent mortality due to other biotic or abiotic factors. If recent mortality from disease was identified, surveyors then described the tissue loss pattern and rate of spread and identified the condition as a known coral disease or as ‘unknown’ scleractinian tissue loss disease now called SCTLD.

2018 DRM RESULTS

A total of 195 sites were completed from the stratified random sample draw for the 2018 DRM survey season. Three sites were completed in Palm Beach County, 47 in Broward-Miami, 22 in Biscayne, 22 in the Upper Keys, 11 in the Mid-Upper Keys Transition, 11 in the Middle Keys, 29 in the Lower Keys, and 50 in the 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 and 2; Table 1 and 2**). When looking at only bleached and partially bleached colonies and excluding pale colonies, moderate bleaching, occurred at 23 of the 195 sites. This included 11 sites in the Broward-Miami subregion and six in the Upper Keys subregion (**Table 1**). Only one site was recorded with severe bleaching in the Upper Keys Forereef.

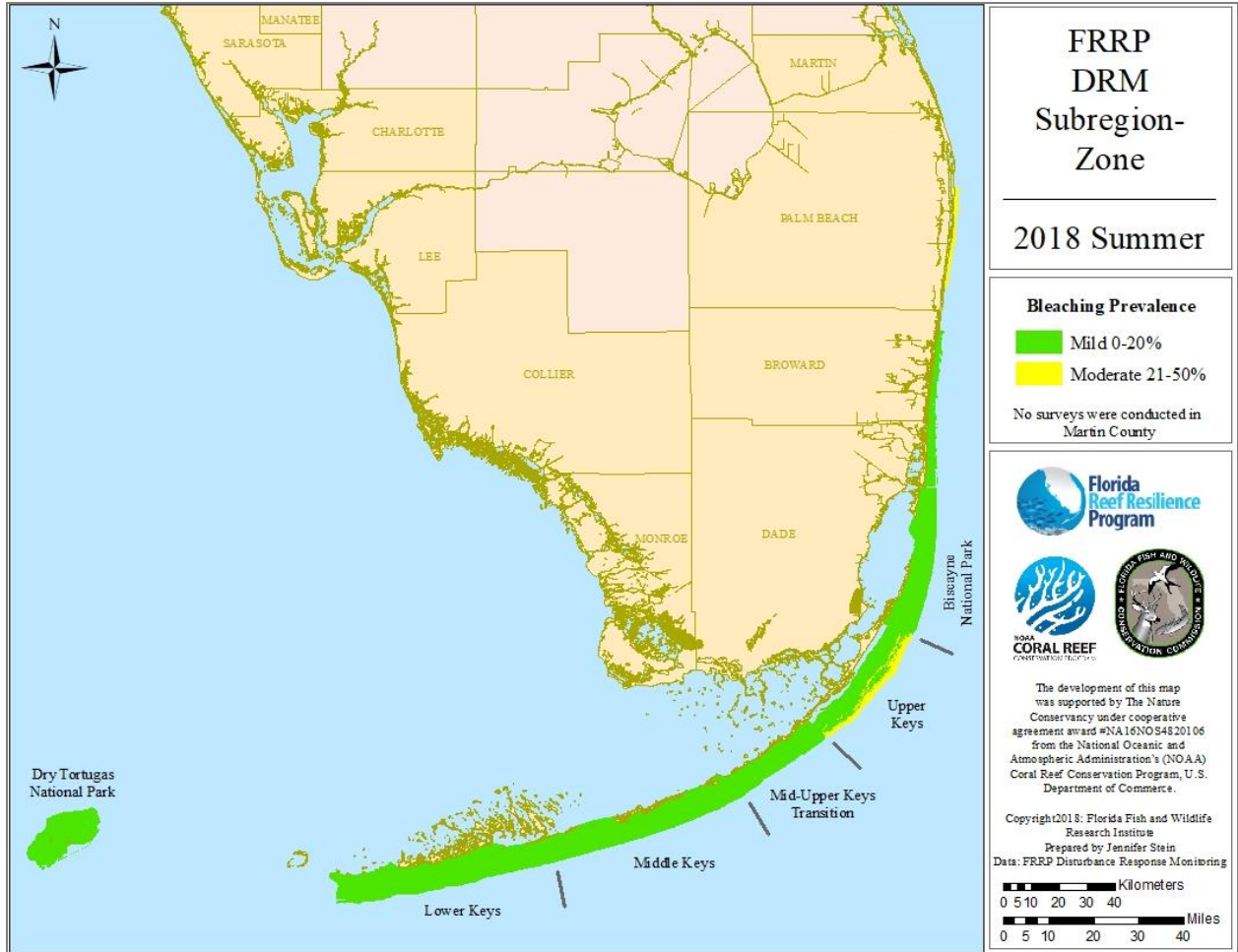


Figure 1: Bleaching prevalence of surveyed coral colonies by subregion-zone.

Table 1: Total number of sites within each subregion-zone recorded with mild, moderate or severe bleaching prevalence of coral colonies.

Subregion	Zone	Total Sites	Bleaching Prevalence		
			Mild 0-20%	Moderate 21-50%	Severe >50%
Palm Beach	Undetermined	3		3	
Broward-Miami	Inshore Reef	22	17	5	
	Inner Reef	8	4	4	
	Middle Reef	13	12	1	
	Undetermined	4	3	1	
Biscayne	Inshore Reef	2	2		
	Mid Channel Reef	12	12		
	Offshore Patch Reef	1	1		
	Forereef	7	6	1	
Upper Keys	Mid Channel Reef	7	7		
	Offshore Patch Reef	9	6	3	
	Forereef	6	2	3	1
Mid-Upper Keys Transition	Inshore Reef	1	1		
	Mid Channel Reef	3	2	1	
	Offshore Patch Reef	1	1		
	Forereef	6	6		
Middle Keys	Inshore Reef	1	1		
	Mid Channel Reef	3	3		
	Offshore Patch Reef	1	1		
	Forereef	6	6		
Lower Keys	Inshore Reef	3	3		
	Mid Channel Reef	12	12		
	Offshore Patch Reef	6	6		
	Forereef	8	7	1	
Dry Tortugas	Lagoon	10	10		
	Forereef	40	40		
Total		195	171	23	1

If paling corals are included within the analysis for colonies that were bleached or partially bleached, prevalence values increase to severe (>50%) in the outer reefs of the Upper Keys and the Mid-Upper Keys Transition as well as in the southern reefs of Palm Beach County (**Figure 2** and **Table 2**). Moderate bleaching and paling (21-50%) occurred in all zones within the Upper Keys and Mid-Upper Keys Transition subregions and continued north along the outer reefs of Biscayne National Park and across all zones in the Broward-Miami sub-region. Dry Tortugas National Park also experienced moderate bleaching and paling in both the Lagoon and Forereef zones. Mild bleaching and paling was recorded in the Inshore and Mid Channel reefs of Biscayne National Park and across all zones in the Middle and Lower Keys.

Paling of coral tissue is most commonly attributed to thermal stress but can also be the result of the initial phases of SCTL. Discoloration of tissue and paling from disease can often be difficult to distinguish in the field and can occur simultaneously with thermal paling on a reef. Therefore, caution is advised when interpreting high prevalence values of paling in an area also affected by SCTL.

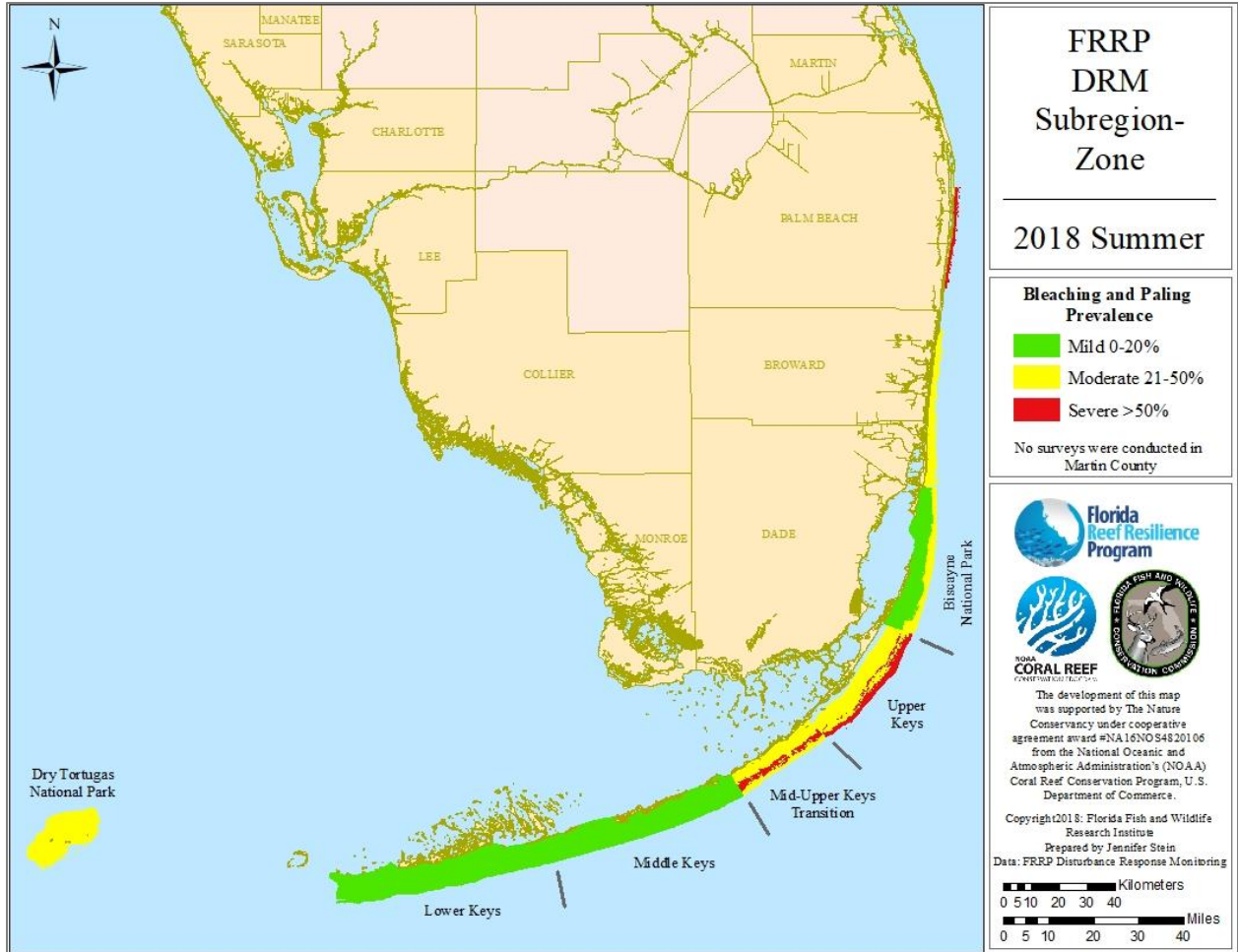


Figure 2: Bleaching and paling prevalence of surveyed coral colonies by subregion-zone.

Table 2: Total number of sites within each subregion-zone recorded with mild, moderate or severe bleaching when paling is included.

Subregion	Zone	Total Sites	Bleaching and Paling Prevalence		
			Mild 0-20%	Moderate 21-50%	Severe >50%
Palm Beach	Undetermined	3		1	2
Broward-Miami	Inshore Reef	22	9	9	4
	Inner Reef	8	1	6	1
	Middle Reef	13	4	8	1
	Undetermined	4	1	3	
Biscayne	Inshore Reef	2	2		
	Mid Channel Reef	12	9	3	
	Offshore Patch Reef	1		1	
	Forereef	7	4	3	
Upper Keys	Mid Channel Reef	7	1	3	3
	Offshore Patch Reef	9		5	4
	Forereef	6		1	5
Mid-Upper Keys Transition	Inshore Reef	1		1	
	Mid Channel Reef	3	1	2	
	Offshore Patch Reef	1			1
	Forereef	6	3	1	2
Middle Keys	Inshore Reef	1	1		
	Mid Channel Reef	3	3		
	Offshore Patch Reef	1	1		
	Forereef	6	6		
Lower Keys	Inshore Reef	3	3		
	Mid Channel Reef	12	12		
	Offshore Patch Reef	6	5	1	
	Forereef	8	6	1	1
Dry Tortugas	Lagoon	10	1	9	
	Forereef	40	4	32	4
Total		195	77	90	28

Disease prevalence at each DRM site was assigned to one of three categories: low (0-5%), medium (5-10%), and high (>10%) (**Figure 3; Table 3**). Across the 195 sites surveyed, 148 sites were recorded with low disease prevalence, 32 sites with medium disease prevalence and 15 sites with high disease prevalence. Pooled by subregion-zone, the Upper Keys Mid Channel reef was the only zone to experience >10% disease prevalence. This was mainly driven by disease observed on *Siderastrea siderea* (**Figure 4**) which was also the most abundant coral in that zone constituting of > 50% of the corals surveyed in 2018. Medium disease prevalence was observed in the southern area of the Mid-Upper Keys Transition Inshore Reef and the Middle Keys Offshore Patch Reef. However, results from these zones with medium disease prevalence were only based on a single survey site.

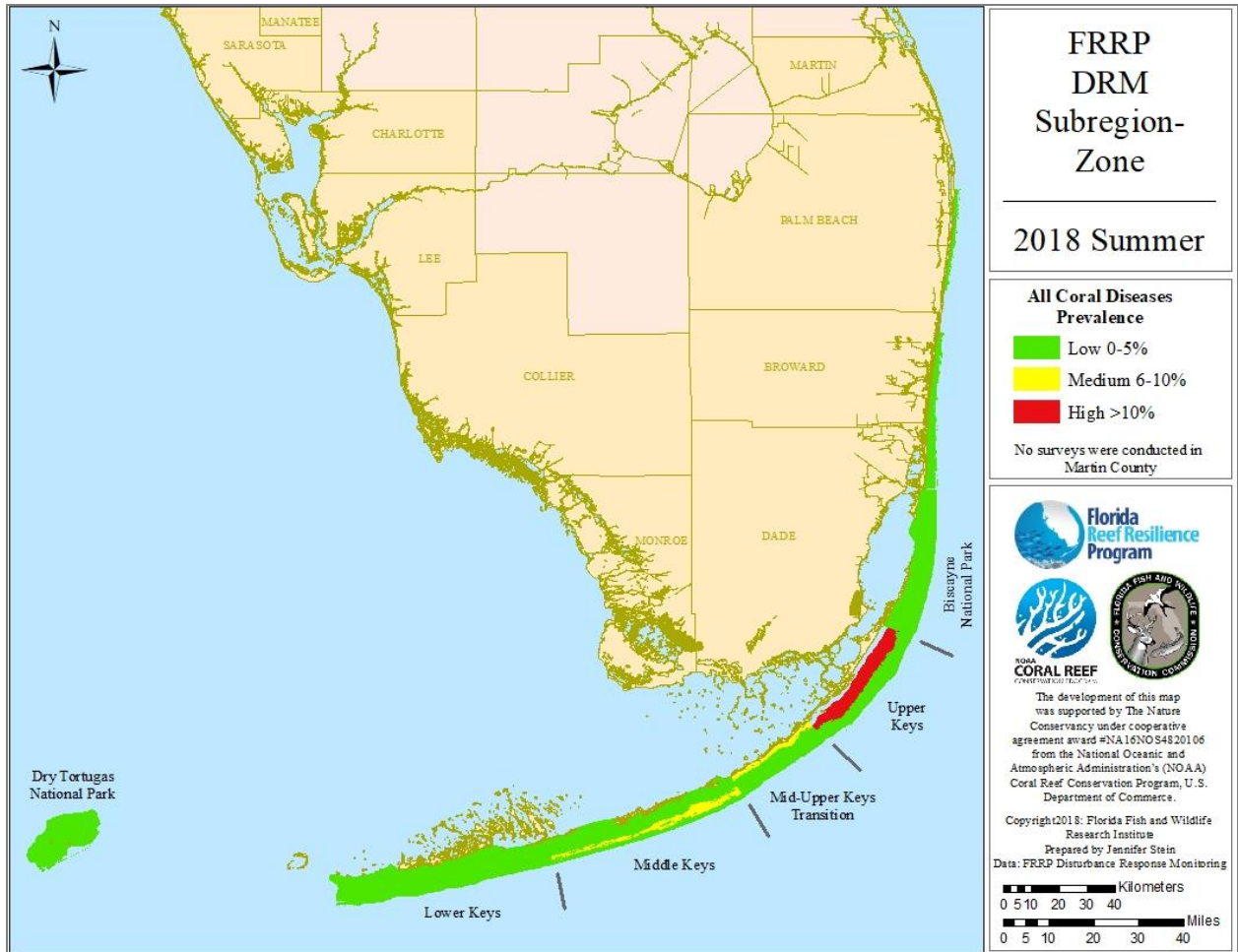


Figure 3: Disease prevalence of surveyed coral colonies by subregion-zone.

Table 3: Total number of sites within each subregion-zone recorded with low, medium or high disease prevalence.

Subregion	Zone	Total Sites	All Coral Disease Prevalence		
			Low 0-5%	Medium 6-10%	High >10%
Palm Beach	Undetermined	3	3		
Broward-Miami	Inshore Reef	22	15	2	5
	Inner Reef	8	6	2	
	Middle Reef	13	11	1	1
	Undetermined	4	3	1	
Biscayne	Inshore Reef	2	2		
	Mid Channel Reef	12	11		1
	Offshore Patch Reef	1	1		
	Forereef	7	7		
Upper Keys	Mid Channel Reef	7	1		6
	Offshore Patch Reef	9	8	1	
	Forereef	6	6		
Mid-Upper Keys Transition	Inshore Reef	1		1	
	Mid Channel Reef	3	1	1	1
	Offshore Patch Reef	1	1		
	Forereef	6	5	1	
Middle Keys	Inshore Reef	1	1		
	Mid Channel Reef	3	2	1	
	Offshore Patch Reef	1		1	
	Forereef	6	4	2	
Lower Keys	Inshore Reef	3	3		
	Mid Channel Reef	12	11	1	
	Offshore Patch Reef	6	6		
	Forereef	8	8		
Dry Tortugas	Lagoon	10	10		
	Forereef	40	37	2	1
Total		195	163	17	15



Figure 4. Images of coral disease on *Siderastrea siderea* in the Upper Keys subregion. Photo credit: FWRI Coral Program.

Focusing on the SCTLD outbreak, the Upper Keys Mid Channel reef was the only subregion-zone with >5% prevalence (**Figure 5**). Across the seven survey sites sampled in the Upper Keys Mid Channel reef (**Table 4**), 52 corals were recorded with lesions associated with SCTLD representing 13% prevalence across this zone. This was the highest frequency of corals observed with SCTLD among all subregion-zones.

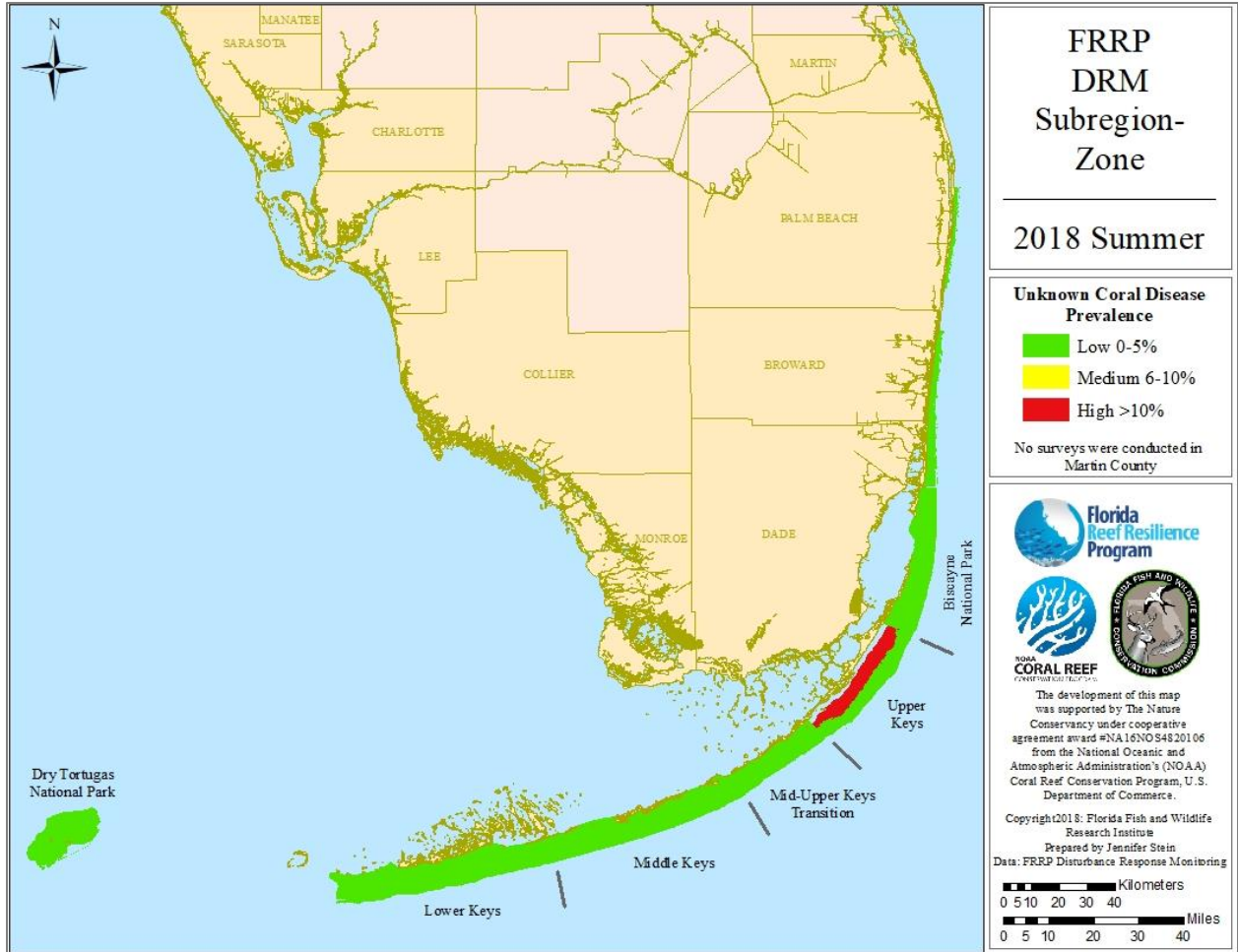


Figure 5. SCTL D prevalence of surveyed coral colonies by subregion-zone.

Table 4: Total number of sites within each subregion-zone recorded with low, medium or high SCTL D prevalence.

Subregion	Zone	Total Sites	Unknown Tissue Loss Disease Prevalence		
			Low 0-5%	Medium 6-10%	High >10%
Palm Beach	Undetermined	3	3		
Broward-Miami	Inshore Reef	22	17	2	3
	Inner Reef	8	5	3	
	Middle Reef	13	12		1
	Undetermined	4	2	2	
Biscayne	Inshore Reef	2	2		
	Mid Channel Reef	12	11		1
	Offshore Patch Reef	1	1		
	Forereef	7	7		
Upper Keys	Mid Channel Reef	7	2	1	4
	Offshore Patch Reef	9	9		
	Forereef	6	6		
Mid-Upper Keys Transition	Inshore Reef	1	1		
	Mid Channel Reef	3	1	1	1
	Offshore Patch Reef	1	1		
	Forereef	6	5	1	
Middle Keys	Inshore Reef	1	1		
	Mid Channel Reef	3	3		
	Offshore Patch Reef	1	1		
	Forereef	6	6		
Lower Keys	Inshore Reef	3	3		
	Mid Channel Reef	12	11	1	
	Offshore Patch Reef	6	6		
	Forereef	8	8		
Dry Tortugas	Lagoon	10	10		
	Forereef	40	38	2	
Total		195	172	13	10

Although the prevalence values pooled across the subregion-zones showed <5% SCTL D prevalence, there are several sites above and below the Upper Keys subregion with >10% SCTL D prevalence (**Table 4**). The Broward-Miami subregion had four sites with >10% SCTL D prevalence and seven sites with >5% SCTL D prevalence. Biscayne subregion had one site with >10% SCTL D prevalence and the Mid-Upper Keys Transition subregion had one site with >10% and 2 sites with >5% SCTL D prevalence.

At the time the 2018 DRM Season concluded, the results confirmed that the progression SCTL D had not reached west of the Lower Keys subregion. Since the nomenclature for the outbreak disease had not been established at the time of the survey, surveyors were told to record outbreak symptoms as ‘unknown’ coral tissue loss disease. In the Dry Tortugas subregion, which is ~70 miles west of Key West, there were two sites that were recorded with >5% ‘unknown’ coral

tissue loss disease prevalence in 2018 (**Table 4**). The majority of the observations were on *Orbicella franksi* and *O. faveolata*. These species are known to be affected by SCTLD but show symptoms much later than other highly susceptible species such as *Colpophyllia natans*, *Meandrina meandrites*, and *Dichoceonia stokesi*. None of the known highly susceptible SCTLD species were observed with >5% disease prevalence at any site in the Dry Tortugas subregion making the connection between unknown coral tissue loss disease and SCTLD at these two sites unlikely.

During several roving diver surveys in the Dry Tortugas conducted in the area surrounding the DRM transects, several *Orbicella* spp. were photographed with White Plaque disease which has been documented in previous years in the Dry Tortugas by the DRM program as well as other long-term monitoring programs. Therefore, the records of ‘unknown’ coral tissue loss disease or SCTLD in the Dry Tortugas, were plausibly the beginning phases of White Plaque disease misidentified due to similar initial symptoms. Additional surveys were conducted in the Dry Tortugas in early 2019 by FWRI and The Nature Conservancy to look for SCTLD however, no corals were observed with the disease which further confirmed the misidentification of SCTLD during the DRM surveys in 2018.

Among the corals recorded with SCTLD, the average percentage of recent mortality on the colonies affected was calculated for each subregion-zone (**Table 5**). This calculation was used to determine where the tissue loss associated with SCTLD lesions was most active. Mean (\pm SD) percent recent mortality was low in the Palm Beach and Broward-Miami subregions (**Table 5**). The mean recent mortality at Biscayne Inshore reef and Mid Channel reef was much higher than in the Palm Beach and Broward-Miami Dade subregions, however, the Biscayne Inshore reef percentage was calculated from only one coral with 50% recent mortality. Mean recent mortality was around or below 20% in the subregion-zones to the south with the exception of the Middle Keys Forereef (29%) and the Lower Keys Mid Channel reef at (32%). Only three corals were recorded with 100% recent mortality from disease across all sites. All three corals were located at one site in the Lower Keys Mid Channel (DRM Site ID 1177). The species included were *Dichoceonia stokesi*, *Colpophyllia natans*, and *Mycetophyllia* sp. Site 1177, located approximately three miles NNE of Looe Key Reef, had the highest disease prevalence (8%) among all sites surveyed in the Lower Keys subregion.

Table 5. Average percent recent mortality of corals recorded with SCTLD calculated by subregion-zone.

Subregion	Zone	Total Corals	Total Corals with Recent Mortality from Disease	Mean (\pm SD) % Recent Mortality of Diseased Corals
Palm Beach	Undetermined	12		
Broward-Miami	Inshore Reef	276	11	7 \pm 5
	Inner Reef	254	6	9 \pm 6
	Middle Reef	195	5	12 \pm 16
	Undetermined	45	1	5
Biscayne	Inshore Reef	150	1	50
	Mid Channel Reef	976	15	27 \pm 27
	Offshore Patch Reef	30		
	Forereef	218		
Upper Keys	Mid Channel Reef	504	64	11 \pm 12
	Offshore Patch Reef	519	7	18 \pm 12
	Forereef	403		
Mid-Upper Keys Transition	Inshore Reef	33	2	21 \pm 28
	Mid Channel Reef	119	11	5 \pm 7
	Offshore Patch Reef	2		
	Forereef	126	4	14 \pm 18
Middle Keys	Inshore Reef	27		
	Mid Channel Reef	449	8	21 \pm 27
	Offshore Patch Reef	51	5	22 \pm 16
	Forereef	213	7	29 \pm 29
Lower Keys	Inshore Reef	76	1	10
	Mid Channel Reef	1827	20	32 \pm 38
	Offshore Patch Reef	911	12	19 \pm 32
	Forereef	294	1	1
Dry Tortugas	Lagoon	746	5	13 \pm 12
	Forereef	2583	38	8 \pm 6

2018 was a mild to moderate bleaching year (**Figure 1**), however, when combined with paling corals, bleaching and paling prevalence values are moderate to severe in the Upper Keys and Mid-Upper Keys transition subregions (**Figure 2**). Moderate bleaching and paling were observed along the outer reefs of the Biscayne subregion and through all zones of the Broward-Miami subregion. High prevalence values of paling however, could be due to the discoloration at the onset of SCTLD. When compared across the years, bleaching prevalence was higher than the past two years but still lower than conditions found during the more severe bleaching years of 2014 and 2015 (**Table 6**). Although 2018 represented only a mild to moderate bleaching season, a higher prevalence of coral disease continues to persist in the Broward-Miami subregion and the Upper and Middle Keys due to SCTLD (**Table 3**). High disease prevalence in the Mid Channel

reefs of the Upper Keys was driven by a high disease prevalence in *Siderastrea siderea*, which also makes up over 50% of the coral population in that zone. The prevalence of SCTLD was highest in the Upper Keys subregion but still persists in the Broward-Miami subregion and continues to move south through the Mid-Upper Keys Transition subregion (**Table 4**). Observations of SCTLD in the Dry Tortugas however, were presumably the initial phases of White Plaque disease.

Table 6. Number of subregion-zones recorded with mild, moderate, or severe bleaching prevalence and bleaching and paling prevalence for each DRM summer survey event.

*2017 does not include data from the IRMA rapid response effort.

DRM Summer Survey	Bleaching Prevalence			Bleaching and Paling Prevalence			Total Subregion-Zones Sampled
	Mild 0-20%	Moderate 21-50 %	Severe >50%	Mild 0-20%	Moderate 21-50 %	Severe >50%	
2005	9	6	1	1	10	5	16
2006	20			16	4		20
2007	27	1	1	16	12	1	29
2008	21			17	4		21
2009	23	2		9	16		25
2010	22			15	7		22
2011	20	5		7	16	2	25
2012	23	1		21	3		24
2013	23			16	7		23
2014	7	13	8	2	9	17	28
2015	14	14	1	4	14	11	29
2016	28			13	14	1	28
2017*	12			6	6		12
2018	24	2		9	14	3	26

North of the Palm Beach subregion, no surveys were completed along the northern portion of the reef system. Therefore, the results of this report do not reflect conditions experienced in the Martin County subregion during the 2018 bleaching season.

For more information about FRRP and its DRM effort see the website

<http://ocean.floridamarine.org/FRRP/>. For more information about the Summer 2018 DRM results contact Jennifer Stein at Jennifer.Stein@MyFWC.com or at (305) 676-3252.