Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

STETSON BANK LONG-TERM MONITORING: 2018 ANNUAL REPORT

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Cover photo:
The regal demoiselle (*Neopomacentrus cyanomos*), seen here schooling around a vase sponge (*Callyspongia vaginalis*), is an exotic species newly documented in the sanctuary during the 2018 field season. Photo: G.P. Schmahl/NOAA

About the National Marine Sanctuaries Conservation Series

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Abstract

This document contains descriptions of the methods used, summaries of the field notes recorded, and highlights of significant observations made during the 2018 annual long-term monitoring efforts of fish and benthic communities at Stetson Bank, including the arrival of a new exotic species, *Neopomacentrus cyanomos*. Processed results and statistical analyses from this study will be reported in combination with the previous four years of data (2015 – 2018) in a synthesis report to follow. Stetson Bank is an uplifted claystone/siltstone feature located within Flower Garden Banks National Marine Sanctuary in the northwestern Gulf of Mexico, which supports a diverse benthic community of sponges and coral. Annual monitoring of the banks crest has been conducted since 1993. Surveys of the mesophotic zone surrounding the bank crest were added in 2015.

In 2018, several monitoring activities were not completed on the bank crest due to a reduced availability of divers. Bank crest and mesophotic repetitive photostations as well as random transects (both fish and benthic surveys) were completed. Three of the four quarterly water sampling cruises were completed. Autonomous instruments installed on the bank crest collected temperature data throughout the year. However, salinity and turbidity data on the bank crest were not collected in late 2017 due to instrument failure. Also, despite extensive searching, autonomous temperature loggers previously installed in mesophotic habitat were not located.

Keywords

Benthic community, fish community, Flower Garden Banks National Marine Sanctuary, long-term monitoring, mesophotic coral, Stetson Bank, and water quality.

Introduction

Stetson Bank, located in the Gulf of Mexico approximately 130 km southeast of Galveston, Texas, is an uplifted claystone feature associated with an underlying salt dome. The bank resides near the northern limit of coral community ranges and as such is exposed to "marginal" environmental conditions for coral reef development and growth due to varying temperature and light availability. However, Stetson Bank supports a well-developed benthic community that includes tropical marine sponges, corals, and other invertebrates.

Sponges, primarily *Neofibularia nolitangere*, *Ircinia strobilina*, and *Agelas clathrodes*, compose a large portion of the benthic biota. Long-term monitoring data have revealed that sponges have been in steady decline since 1999. The sponge *Chondrilla nucula* was historically prevalent on the bank, but underwent dramatic decline after 2005 following a coral bleaching event and is now almost absent. Similarly, the hydrozoan *Millepora alcicornis* historically dominated the benthic biota at Stetson Bank, but underwent rapid decline following 2005 due to bleaching and has not recovered to pre-2005 levels.

Twelve species of hermatypic corals have maintained low, but stable, cover over time at Stetson Bank, including *Pseudodiploria strigosa*, *Stephanocoenia intersepta*, *Madracis brueggemanni*, *Madracis decactis*, and *Agaricia fragilis*. The benthic cover of algae, predominantly *Dictyota* sp. and turf algae, is variable between years. Since the initiation of monitoring at Stetson Bank, a distinct shift has been documented from a benthic community characterized by *M. alcicornis* and sponges to an algal-sponge-dominated community (DeBose et al. 2013).

In 1993, an annual long-term monitoring program was initiated at Stetson Bank by the Gulf Reef Environmental Action Team (GREAT), and later conducted by Flower Garden Banks National Marine Sanctuary (FGBNMS). Monitoring was initially focused on the shallow reef habitat within non-decompression scuba diving limits (<33.5 m). While the designated boundaries were based on the best available data at that time, subsequent mapping and exploration led to the discovery of mesophotic reefs surrounding Stetson Bank that occur both inside and outside of the current sanctuary boundary (Figure I). In 2015, the Bureau of Safety and Environmental Enforcement (BSEE) and FGBNMS expanded monitoring at Stetson Bank to include both the historically monitored bank crest and the surrounding mesophotic reef habitat. Current sanctuary expansion efforts propose modification of Stetson Bank boundaries to include these known mesophotic reefs.

To date, the monitoring program at Stetson Bank comprises 26 years of continuous coral community monitoring efforts. As increasing anthropogenic stressors to marine environments are projected to continue, long-term monitoring datasets are essential to understanding community stability, ecosystem resilience, and responses to changing conditions. Additionally, as exotic species invade and establish, these long-term data sets are vital for documenting and tracking impacts on natural populations. Continuation and expansion of this extensive dataset will provide valuable insight for both research and management purposes. This report presents methods and notes from the 2018 monitoring period. Data were collected on eight cruises throughout the year (Table I).

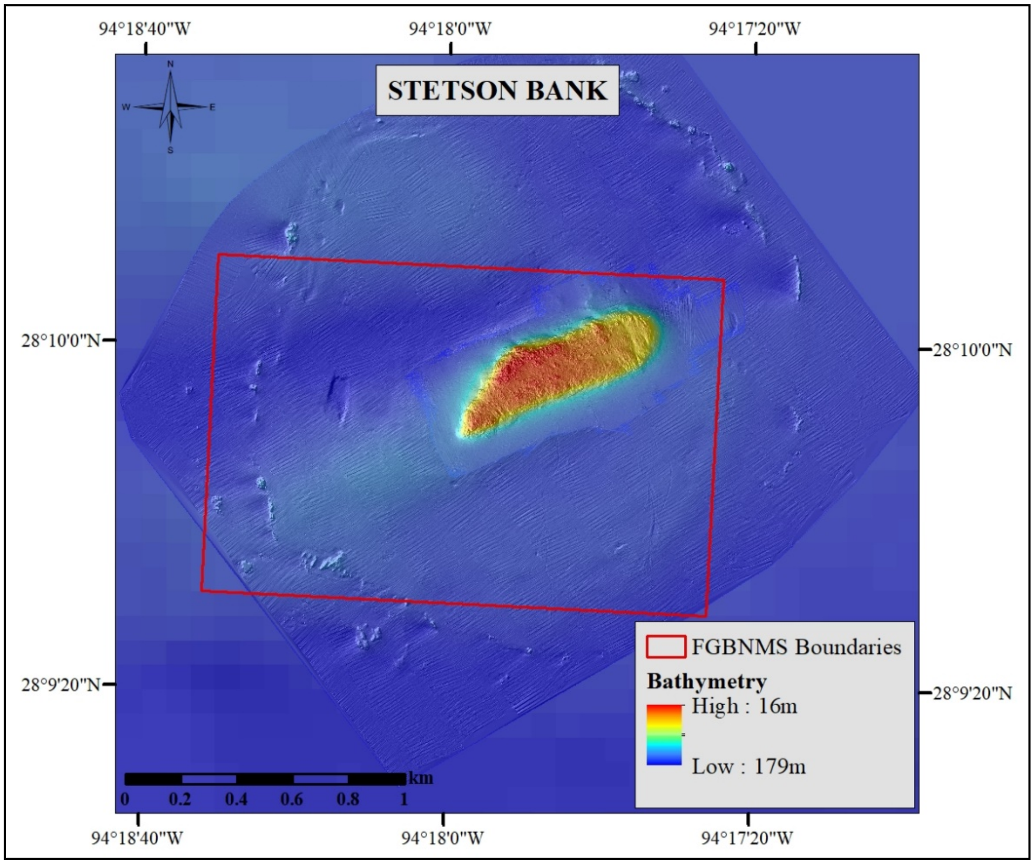


Figure I. Bathymetric map of Stetson Bank. Red lines indicate sanctuary boundary. Image: NOAA

Table I. 2018 Cruise information. Dates and primary tasks of data collection cruises at Stetson Bank for the 2018 monitoring period.

Date	Cruise Name and Monitoring Task	Participants
4/24/2018	Water quality: Sample collection (M/V *Hull Raiser*)	John Embesi, Buddy Guindon, Hans Guindon, James MacMillan, Marissa Nuttall
6/26/2018 – 6/29/2018	Water quality: Instrument download	Justin Blake, Karol Breuer, Cassidy Brown, Matthew Day, Ryan Hannum, Emma Hickerson, James MacMillan, Marissa Nuttall, Dustin Picard, G.P. Schmahl, Kate Thompson, Nick Zachar
7/15/2018 – 7/19/2018	Reef crest monitoring: benthic and fish community monitoring	Justin Blake, Karol Breuer, Cassidy Brown, Matthew Day, John Embesi, Emma Hickerson, James MacMillan, Marissa Nuttall, G.P. Schmahl
7/28/2018 – 7/31/2018	Mesophotic monitoring: benthic and fish community monitoring	Justin Blake, Joe Bosquez, Karol Breuer, Cassidy Brown, Jacque Cresswell, Matthew Day, Kelly Drinnen, Caroline Emery, Eric Glidden, Rebekah Hernandez, James MacMillan, Marissa Nuttall, Jason White
8/2/2018 – 8/4/2018	Mooring buoy installation: benthic and fish community monitoring	Justin Blake, Karol Breuer, Matthew Day, Kelly Drinnen, John Embesi, Eric Fisher, Gregg Gitschlag, Emma Hickerson, James MacMillan, Marissa Nuttall, G.P. Schmahl
8/21/2018 – 8/24/2018	East Flower Garden Bank long-term monitoring and water quality: sample collection and instrument download	Justin Blake, Joe Bosquez, Karol Breuer, Robert Brewer, Cassidy Brown, John Embesi, Jake Emmert, Emma Hickerson, Clayton Leopold, Sarah Linden, James MacMillan, Dustin Picard, Brian Zelenke
10/30/2018	Water quality: sample collection and instrument download	Justin Blake, Karol Breuer, Cassidy Brown, Nicole Cherichella, John Embesi, Jake Emmert, Emma Hickerson, James MacMillan, Marissa Nuttall
11/7/2018-11/8/2018	November reef crest monitoring: benthic and fish community monitoring	Justin Blake, Karol Breuer, Cassidy Brown, Nicole Cherichella, John Embesi, Vianne Euresti, James MacMillan, Marissa Nuttall, G.P. Schmahl

CHAPTER 1: REPETITIVE PHOTOSTATIONS

Repetitive photostation 19 captures a variety of sponges along with the stony coral *M. decactis*. Photo: Marissa Nuttall/NOAA

Introduction

Permanent photostations were installed at Stetson Bank in 1993. These stations were concentrated on the northwestern edge of the bank. Locations were selected along a series of high relief hardbottom features with a diverse benthic community. The stations were selected by scuba divers on biologically interesting locations and marked using nails or eyebolts and numbered tags. Initially, 36 permanent photostations were installed in 1993. Over time, many of these stations have been lost for a variety of reasons, and new stations have been established.

As of 2018, a total of 59 stations are located at Stetson Bank including 18 of the original stations installed in 1993. All of these photostations occur on hardbottom habitat and are accessible from permanent mooring buoys 1, 2, or 3 (Table 1.1, Figure 1.1). Each station is located by scuba divers using detailed maps (Figures 1.2 to 1.3), and photographed annually to monitor changes in the composition of benthic assemblages, presenting a time series of how the biota in the image have changed.

Table 1.1. Buoy locations. Coordinates and depths of buoys used to access repetitive photostations at Stetson Bank.

Buoy No.	Latitude (DMD)	Longitude (DMD)	Depth (m)
1	28 09.931	94 17.861	22.6
2	28 09.981	94 17.834	23.8
3	28 09.986	94 17.766	22.3

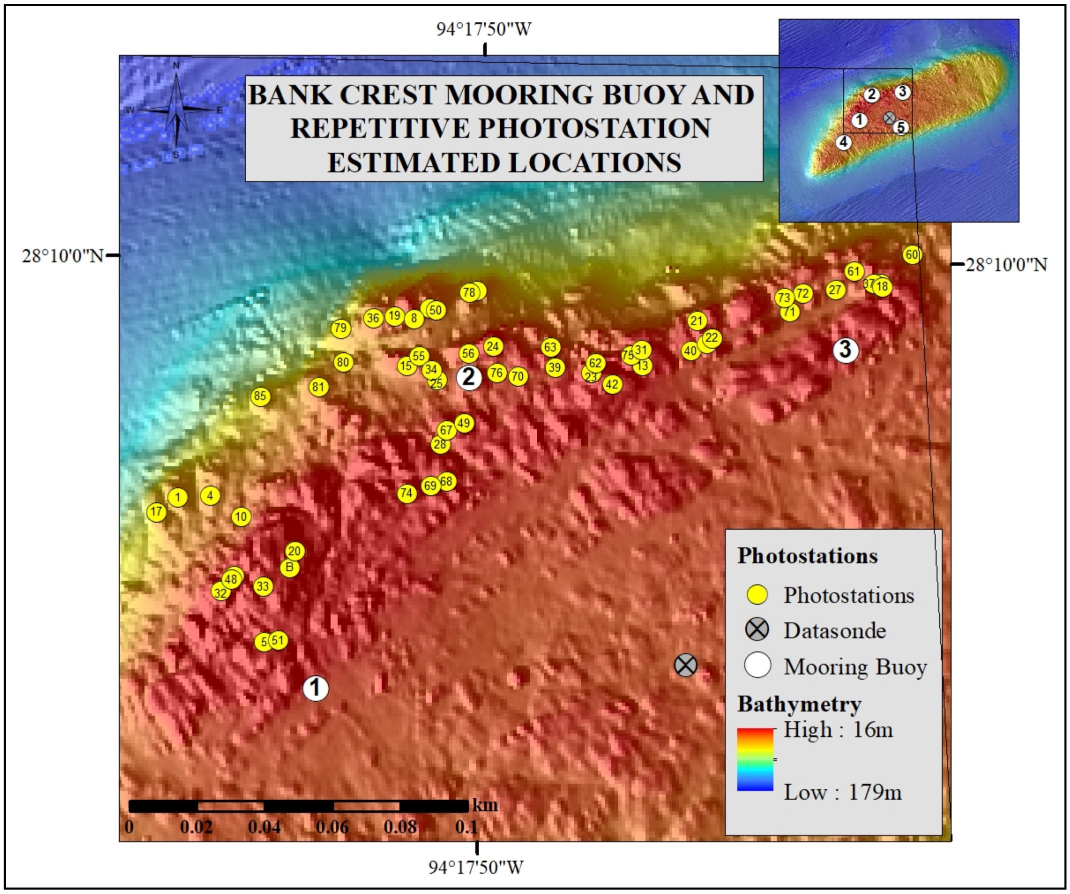
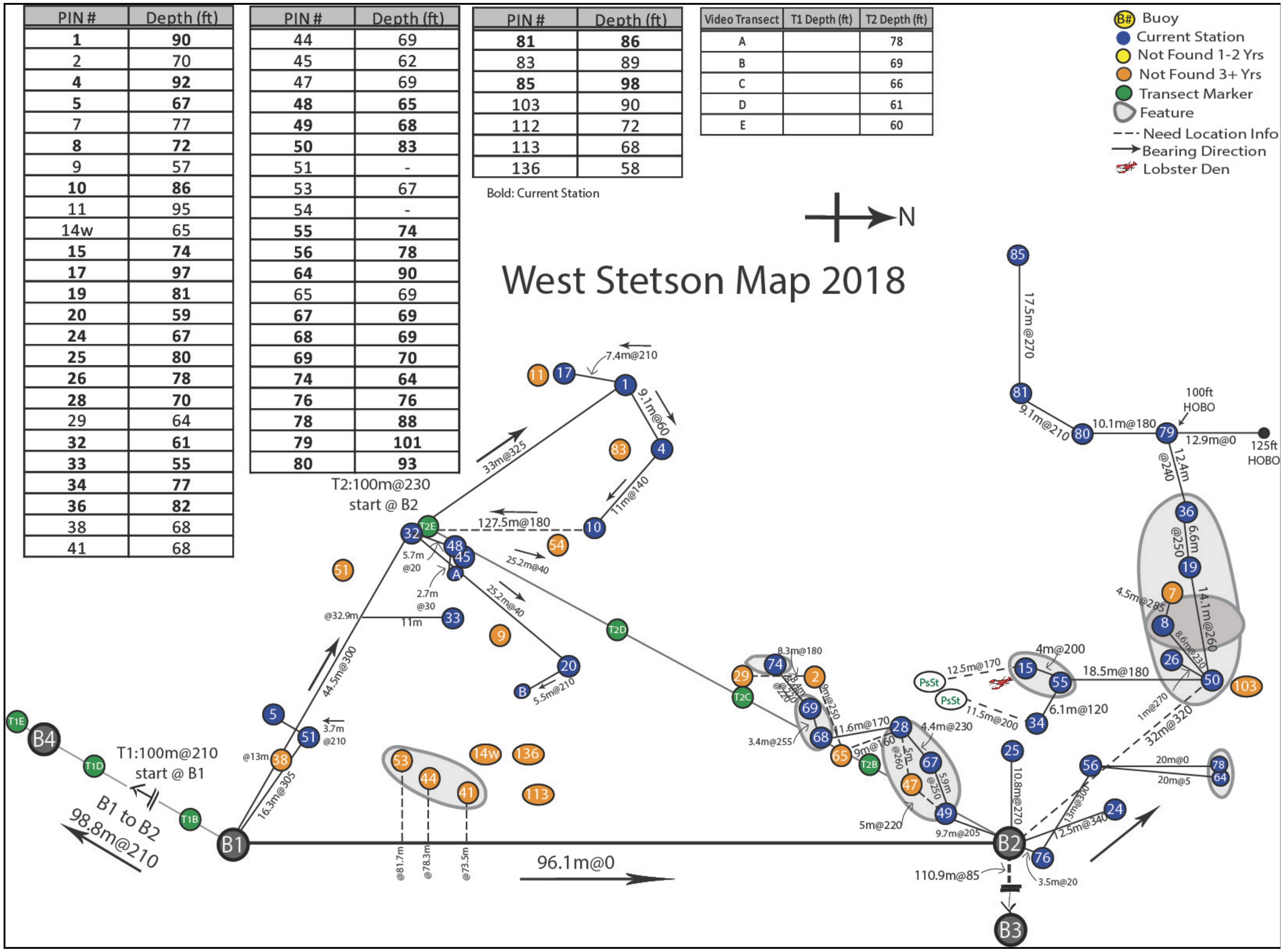


Figure 1.1. Stetson Bank site map. Seafloor topography with mooring buoy locations and approximate repetitive photostation locations. Image: NOAA



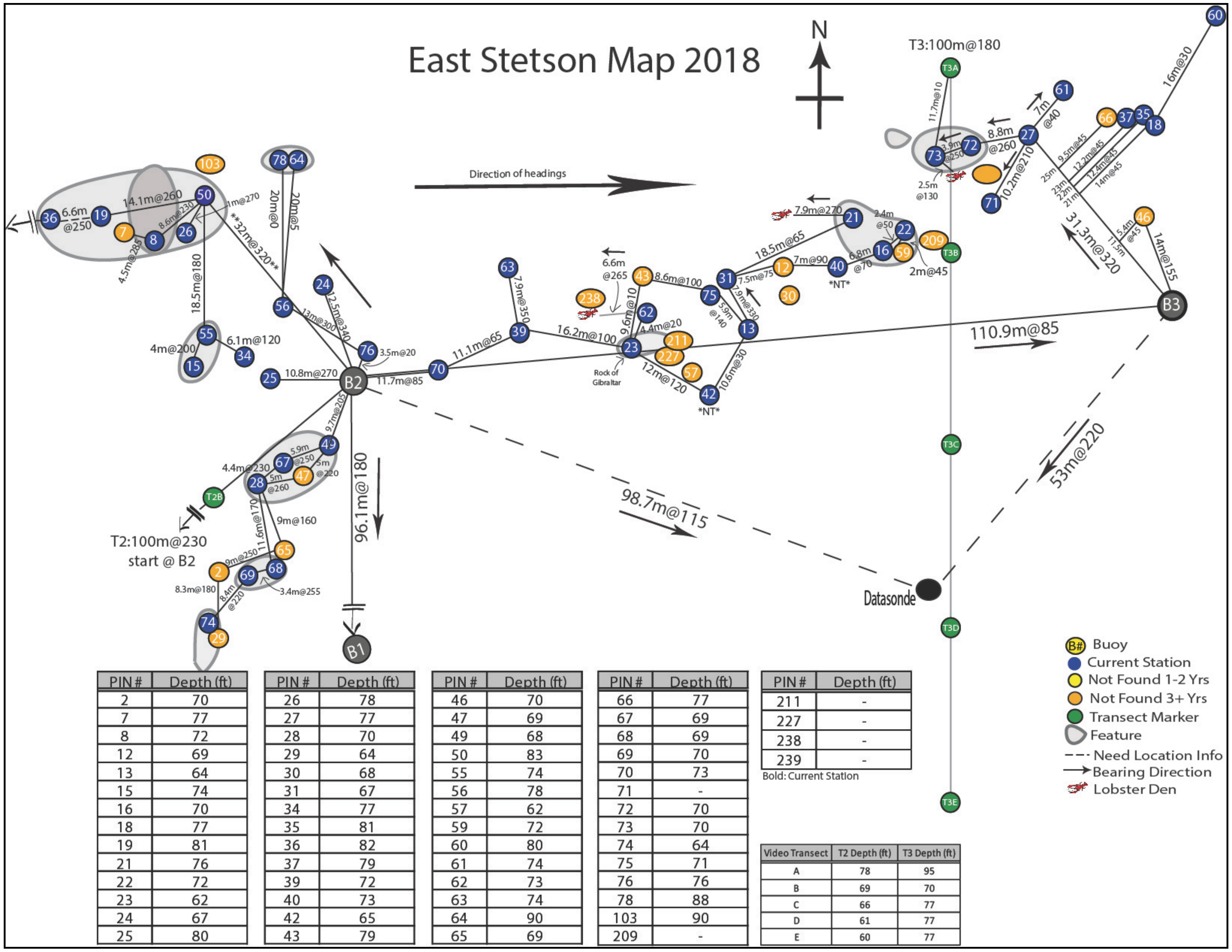
PIN #	Depth (ft)
1	**90**
2	70
4	**92**
5	**67**
7	77
8	**72**
9	57
10	**86**
11	95
14w	65
15	**74**
17	**97**
19	**81**
20	**59**
24	**67**
25	**80**
26	**78**
28	**70**
29	64
32	**61**
33	**55**
34	**77**
36	**82**
38	68
41	68

PIN #	Depth (ft)
44	69
45	62
47	69
48	**65**
49	**68**
50	**83**
51	-
53	67
54	-
55	**74**
56	**78**
64	**90**
65	69
67	**69**
68	**69**
69	**70**
74	**64**
76	**76**
78	**88**
79	**101**
80	**93**

PIN #	Depth (ft)
81	**86**
83	89
85	**98**
103	90
112	72
113	68
136	58

Video Transect	T1 Depth (ft)	T2 Depth (ft)
A		78
B		69
C		66
D		61
E		60

Figure 1.2. West Stetson map, used by divers to locate the repetitive photostations in the study site. Image: NOAA



PIN #	Depth (ft)
2	70
7	77
8	72
12	69
13	64
15	74
16	70
18	77
19	81
21	76
22	72
23	62
24	67
25	80

PIN #	Depth (ft)
26	78
27	77
28	70
29	64
30	68
31	67
34	77
35	81
36	82
37	79
39	72
40	73
42	65
43	79

PIN #	Depth (ft)
46	70
47	69
49	68
50	83
55	74
56	78
57	62
59	72
60	80
61	74
62	73
63	74
64	90
65	69

PIN #	Depth (ft)
66	77
67	69
68	69
69	70
70	73
71	-
72	70
73	70
74	64
75	71
76	76
78	88
103	90
209	-

PIN #	Depth (ft)
211	-
227	-
238	-
239	-

Video Transect	T2 Depth (ft)	T3 Depth (ft)
A	78	95
B	69	70
C	66	77
D	61	77
E	60	77

Figure 1.3. East Stetson map. Used by divers to locate the repetitive photostations in the study site. Image: NOAA.

Methods

Field methods

Repetitive photostations were located using detailed maps and marked by scuba divers with floating plastic chains attached to small weights. Divers with cameras then photographed each station. In 2018, images were captured using a Sony A6500 digital camera in a Nauticam NA-A6500 housing with a Nikkor Nikonos 15 mm underwater lens. The camera was mounted onto a T-frame, set at 1.75 m from the substrate, with two Inon® Z240 strobes set 1.2 m apart (Figure 1.4). A compass and bubble level were mounted to the center of the T-frame in order for images to be taken in a vertical and northward orientation, and to standardize the area captured. Images were corrected as necessary in Adobe Photoshop® CS2 with no cropping to maintain 1.6 m^2 coverage.

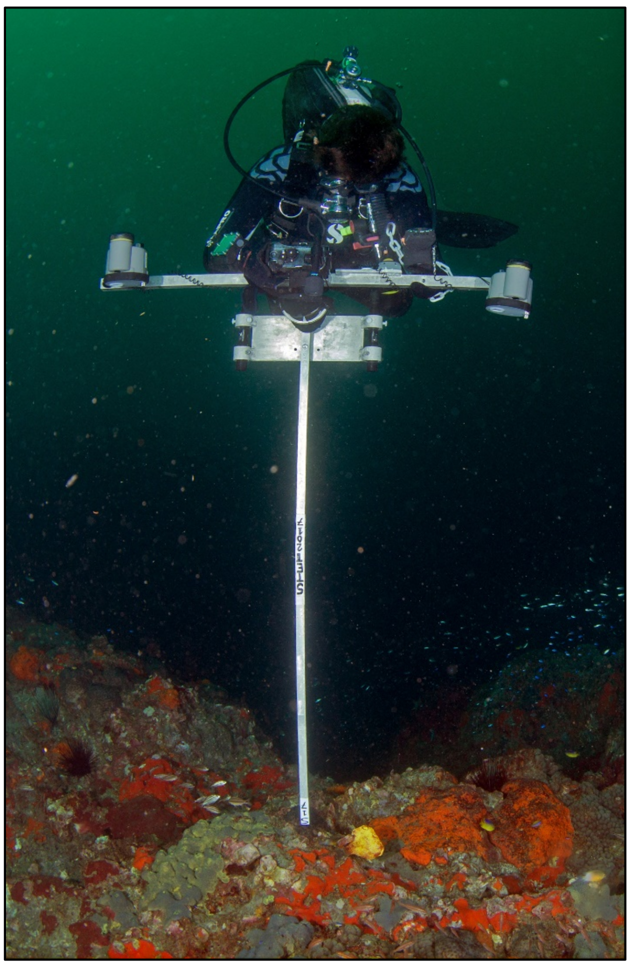


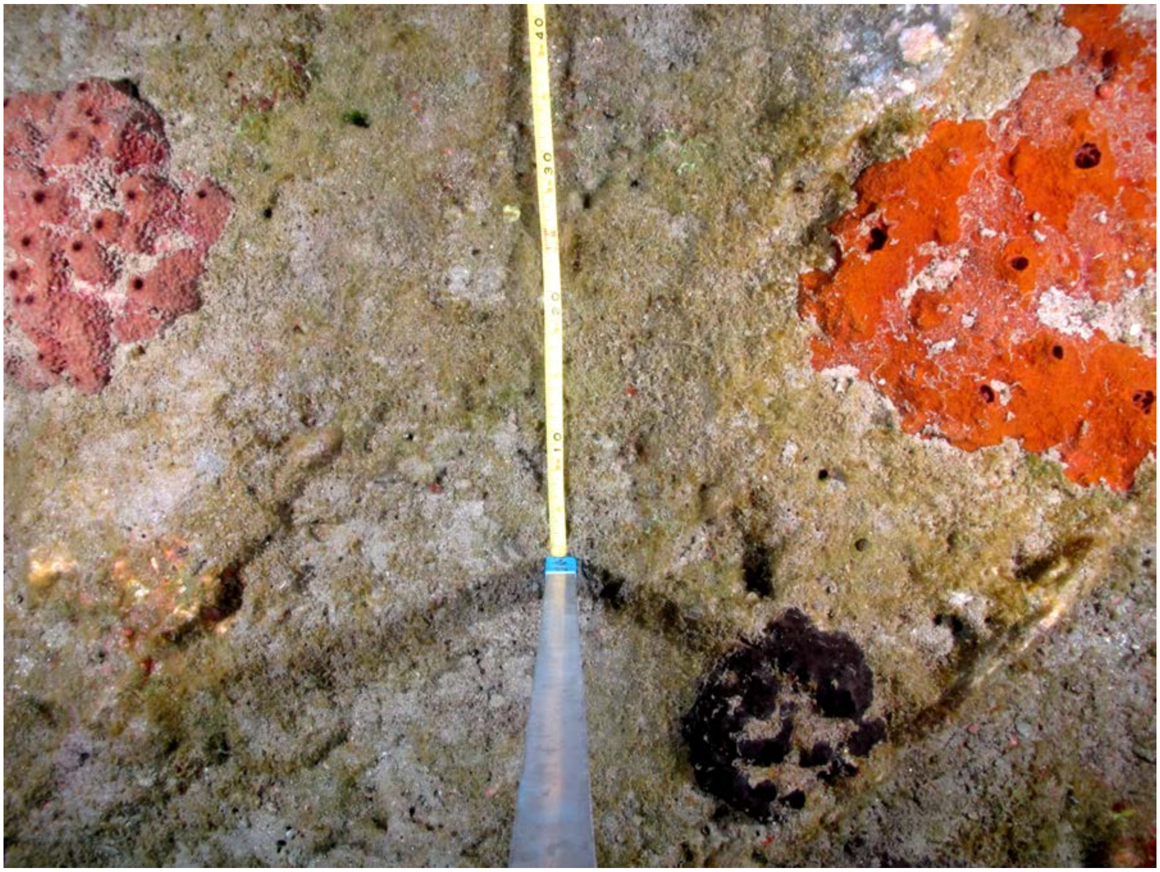
Figure 1.4. T-frame configuration. Photo: G.P. Schmahl/NOAA

In 2018, no new repetitive photostations were installed. All 59 current stations were located and photographed. Seven required refurbishment.

Challenges and resolutions

- A change in camera system occurred in 2018.
    - Images were previously collected using a 1.25 m T-frame pole length with a Canon G11 in a FIX housing and fish eye port. In 2018, two setups were evaluated: 1) a 1.5 m pole length with a Sony A6500 in a Nauticam housing with a 16 mm lens and N85 dome port and 2) a 1.75 m pole length with a Sony A6500 in a Nauticam housing with Nikkor Nikonos 15 mm wet lens (the same lens used from 1993 to 2007). Despite requiring a longer pole length, the second setup (Nikkor Nikonos 15 mm lens) was able to capture the coverage area without the need for cropping or distortion correction. Due to the reduced processing time required by this setup, all stations in 2018 were photographed with the Sony A6500 in a Nauticam housing with Nikkor Nikonos 15mm lens.

CHAPTER 2: RANDOM TRANSECTS



A random transect image shows sponges and macroalgae. Photo: Marissa Nuttall/NOAA

Introduction

Transect tapes were positioned at random locations within high and low relief habitat on Stetson Bank in order to estimate and compare the areal coverage of benthic components such as corals, sponges, and macroalgae, and to provide information on the sessile benthic community of the entire bank.

Methods

Field methods

Transect sites were selected in a stratified random design (Figure 2.1). Habitat was defined using 1 m^2 resolution bathymetric data. Range (minimum to maximum depth) was calculated from the bathymetry data using the focal statistics tool in ArcGIS® (5 m x 5 m rectangular window calculating range). This layer was reclassified to define low relief habitat (<1 m range) and high relief habitat (>1.1 m range). A 33.5 m contour was used to restrict the extent of the range layer, limiting surveys to within non-decompression diving limits. Area was calculated for each habitat type in ArcGIS® to distribute transect start points equally by area. Total area available for conducting surveys was 0.12 km^2: 0.08 km^2 low relief habitat and 0.04 km^2 high relief habitat. Thirty surveys were distributed among habitat types: 20 in low relief habitat and 10 in high relief habitat. Points representing the start location of a transect were generated using the ArcGIS® random point tool with a minimum of 15 m between sites (Figure 2.1). One transect was completed at each random point perpendicular to the random heading of the paired fish survey. However, surveyors were instructed to remain within the assigned habitat type and modify headings if needed. Where this was not possible, habitat type encountered was recorded and noted in the database.

Each transect was designed to capture at least 8 m^2 of benthic habitat. A still camera, mounted on a 0.65 m T-frame with bubble level and strobes, was used to capture non-overlapping images of the reef. Each image captured approximately 0.8 x 0.6 m (0.48 m^2), requiring 17 images to obtain the desired coverage (8.16 m^2). Spooled fiberglass 15 m measuring tapes, with 17 pre-marked intervals (every 0.8 m), were used to provide guides for the camera T-frame, providing a 0.2 m buffer between each image to prevent overlap. A Canon Power Shot® G11 digital camera in an Ikelite® housing with a 28 mm equivalent wet mount lens adaptor and two Inon® Z240 strobes set 1.2 m apart on the T-frame was used.

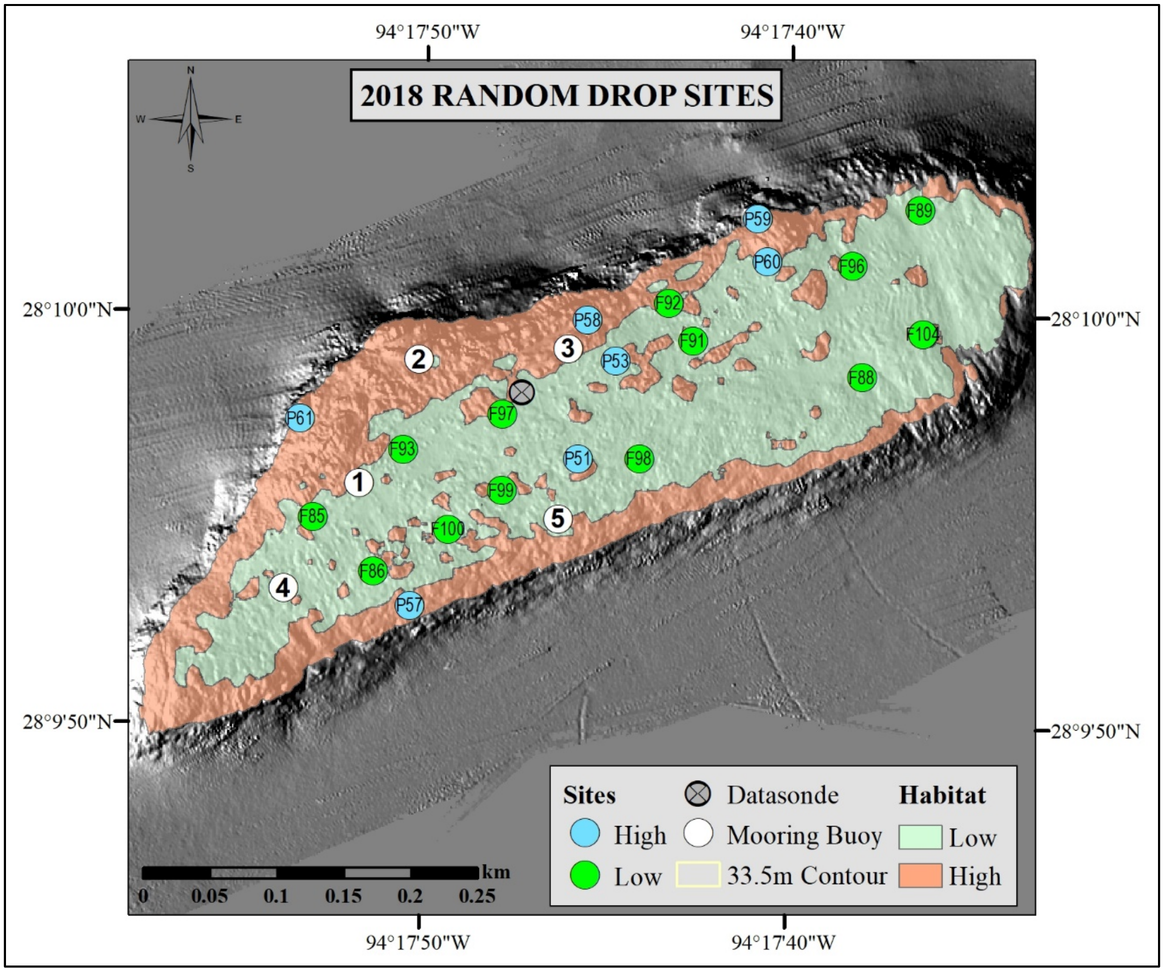


Figure 2.1. 2018 Random drop sites. Blue points denote high relief sites and green points denote low relief sites. Image: NOAA

In 2018, twenty random transects were conducted: 13 in low relief habitat and seven in high relief habitat.

Challenges and resolutions

- Only 20 of the 30 random transect were collected.
    - Limited diver availability during the shallow monitoring cruise reduced capacity to collect surveys in 2018. Additional transects were collected on subsequent water quality cruises to meet minimum sample size (Table 2.1).

Table 2.1. Additional 2018 cruise information. Cruise names and dates on which random transect samples were collected.

Date	Cruise Name: Random Transect Samples
7/15/2018 – 7/19/2018	Reef Crest Monitoring: 11 Samples
7/28/2018 – 7/31/2018	Mesophotic Monitoring: 2 Samples
8/2/2018 – 8/4/2018	Mooring Buoy Installation Cruise: 2 Samples
11/7/2018 – 11/8/2018	November Reef Crest Monitoring: 5 Samples

CHAPTER 3: FISH SURVEYS

Gray snapper, *Lutjanus griseus*, school at Stetson Bank. Photo: G.P. Schmahl/NOAA

Introduction

Modified Bohnsack and Bannerot (1986) stationary visual fish censuses were conducted in conjunction with reef-wide random transects to examine fish populations and composition and temporal changes (annually). Reef-wide surveys were conducted at stratified random locations in both low relief and high relief habitats.

Methods

Field methods

Scuba divers, using the modified Bohnsack and Bannerot (1986) stationary visual fish census technique, restricted observations to an imaginary cylinder with a radius of 7.5 m, extending from the seafloor to the surface. All fish species observed within the first five minutes of the survey were recorded as the diver slowly rotated in place above the bottom. Immediately following this five-minute observation period, one rotation was conducted for each species noted in the original five-minute period to record abundance (number of individuals per species) and fork length (within size bins). Size was binned into eight groups; <5 cm, ≥5 cm to <10 cm, ≥10 cm to <15 cm, ≥15 cm to <20 cm, ≥20 cm to <25 cm, ≥25 cm to <30 cm, ≥30 cm to <35 cm. If fish were noted to be >35 cm each individual's size was recorded based on visual estimation by divers. Divers carried a 1 m PVC pole marked in 10 cm increments to provide a reference for size estimation.

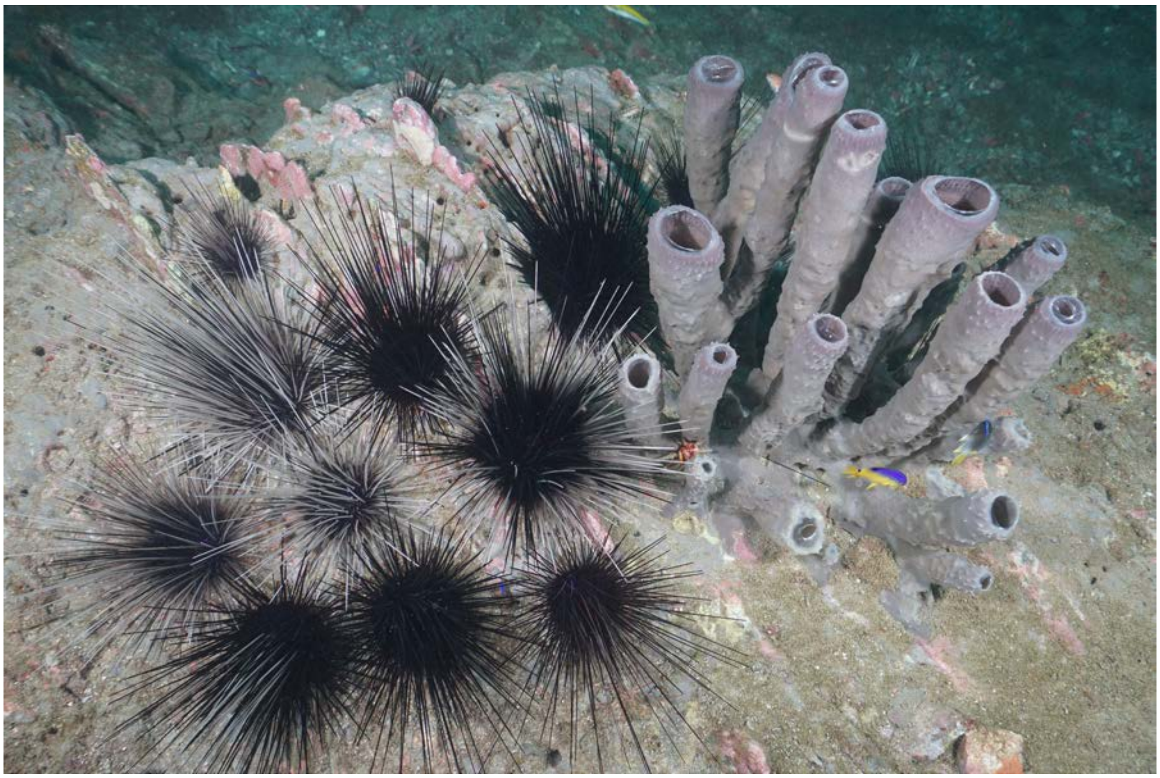
Each survey required at minimum 15 minutes to complete. Transitory or schooling species were counted and measured at the time the individuals moved through the cylinder during the initial five-minute period. Surveys began in the early morning (after sunrise), and were repeated throughout the day until dusk. Each survey represented one sample.

Surveys were paired with benthic random transects, with location selected randomly in two habitat types defined by relief: low and high (see Chapter 2 Methods). One diver from the dive team conducted the fish survey along a random heading while the other diver conducted the benthic photo transect perpendicular to the fish survey area. In 2018, 20 random fish surveys were conducted: 13 in low relief habitat and seven in high relief habitat (Chapter 2, Figure 2.1).

Challenges and resolutions

- As these surveys are paired with random transects, similar issues were encountered. Only 20 of the 30 random transect were collected.
    - See Chapter 2 Challenges and resolutions for resolution details.

CHAPTER 4: SEA URCHIN AND LOBSTER SURVEYS



Long-spined sea urchin, *Diadema antillarum*, gather at Stetson Bank. Photo: G.P. Schmahl/NOAA

Introduction

Surveys of several important and conspicuous invertebrates are made during the monitoring efforts on Stetson Bank. The long-spined sea urchin (*Diadema antillarum*) were an important herbivore on coral reefs throughout the Caribbean until the 1980s. Between 1983 and 1984, an unknown pathogen decimated populations throughout the region, including FGBNMS. Since then, irregular limited recovery has been documented in the region (Edmunds and Carpenter 2001). Additionally, commercially-important lobster and slipper lobster population dynamics throughout this region are not well understood. These surveys are used to document the abundance of the long-spined sea urchin and multiple lobster species at Stetson Bank.

Methods

Field methods

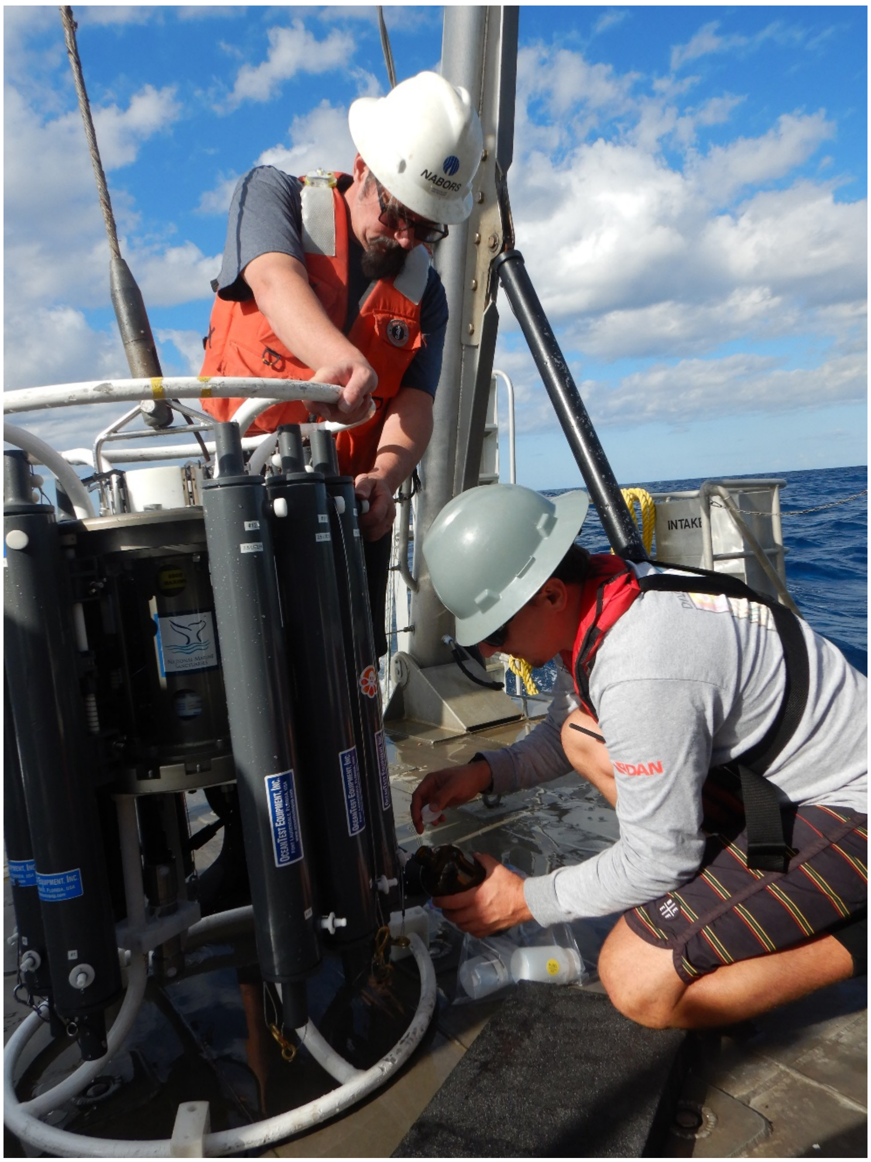
Sea urchin counts were conducted on both repetitive photostation images and random transect images, both collected during daylight hours (sunrise to sunset). The abundance of long-spined sea urchin, Caribbean spiny lobster (*Panulirus argus*), spotted spiny lobster (*Panulirus guttatus*), and slipper lobster species (Scyllaridae) was recorded at each photostation or transect and saved in a database.

In 2018, 59 repetitive photostations (covering 94.4 m^2) and 20 random benthic transects (covering 163.2 m^2) were processed for invertebrate counts.

Challenges and resolutions

- No night surveys were conducted in 2018.
    - Due to limited diver availability during the shallow long-term monitoring cruise, tasks were prioritized. From data in previous years, day and night surveys for sea urchin density have yielded similar results, and therefore, these activities were determined to be low priority and, ultimately, not completed.

CHAPTER 5: WATER QUALITY



Water samples are collected for nutrient analyses from the sampling carousel aboard the R/V *Manta*. Photo: NOAA

Introduction

Several water quality parameters were continually or periodically recorded at Stetson Bank from October 2017 through October 2018. Salinity, temperature, and turbidity were recorded every hour by data loggers permanently installed on the crest of Stetson Bank at a depth of 24 m. Additionally, temperature was recorded every hour at 30 m and 40 m stations.

Water column profiles recording, temperature, salinity, pH, turbidity, fluorescence, and dissolved oxygen (DO) were paired with water sampling, when possible. Water samples were collected each quarter and analyzed by an Environmental Protection Agency (EPA) certified laboratory for select nutrient levels (chlorophyll-*a*, ammonia, nitrate, nitrite, and total nitrogen). Ocean carbonate samples were sent to a university laboratory for measurement of total pH, alkalinity, and total dissolved CO_2 (DIC), from which *in situ* pH and pCO2 were calculated.

Methods

Field methods

Temperature and salinity loggers

The primary instrument for recording salinity, temperature, and turbidity was a Sea-Bird® Electronics, *16plus* V2 CTD (SBE 16*plus*) with a WET Labs ECO NTUS turbidity meter, deployed at a depth of 24 m. The logger was installed on a large railroad wheel, situated on a low relief surface of the bank crest, in the midsection of the bank (Figure 5.1). The instrument recorded temperature, salinity, and turbidity hourly throughout the year. Each quarter year, the instrument was exchanged by scuba divers for downloading and maintenance. It was immediately exchanged with an identical instrument to avoid any gaps in the data collection. Prior to re-installation, all previous data were removed from the instrument and battery life checked. Maintenance and factory service of each instrument were performed at annual intervals.

Onset® Computer Corporation HOBO® Pro v2 U22-001 (HOBO) thermographs were used to record temperature on an hourly basis. These instruments provide a highly reliable temperature backup for the primary logging instrument at the 24 m station. In addition, one of these loggers was deployed at a 30 m station and one at a 40 m station to record temperature hourly (Figure 5.1). The loggers were also downloaded, maintained, and replaced on a quarterly basis. The instruments were either attached directly to the primary instrument at the 24 m station or to eyebolts at the 30 m and 40 m stations. Prior to re-installation, all previous data were removed from the instrument and battery levels were checked.

Data from 24 m station concludes on October 30th, 2018, with the last data collection cruise of 2018. Additionally, data from the 24 m SBE 16plus recorded between August 3, 2017, and November 07, 2017, were found to be erroneous. Data from the 30 and 40 m deep stations concludes on June 26, 2018, as these instruments were not recovered before the close of the 2018 field season.

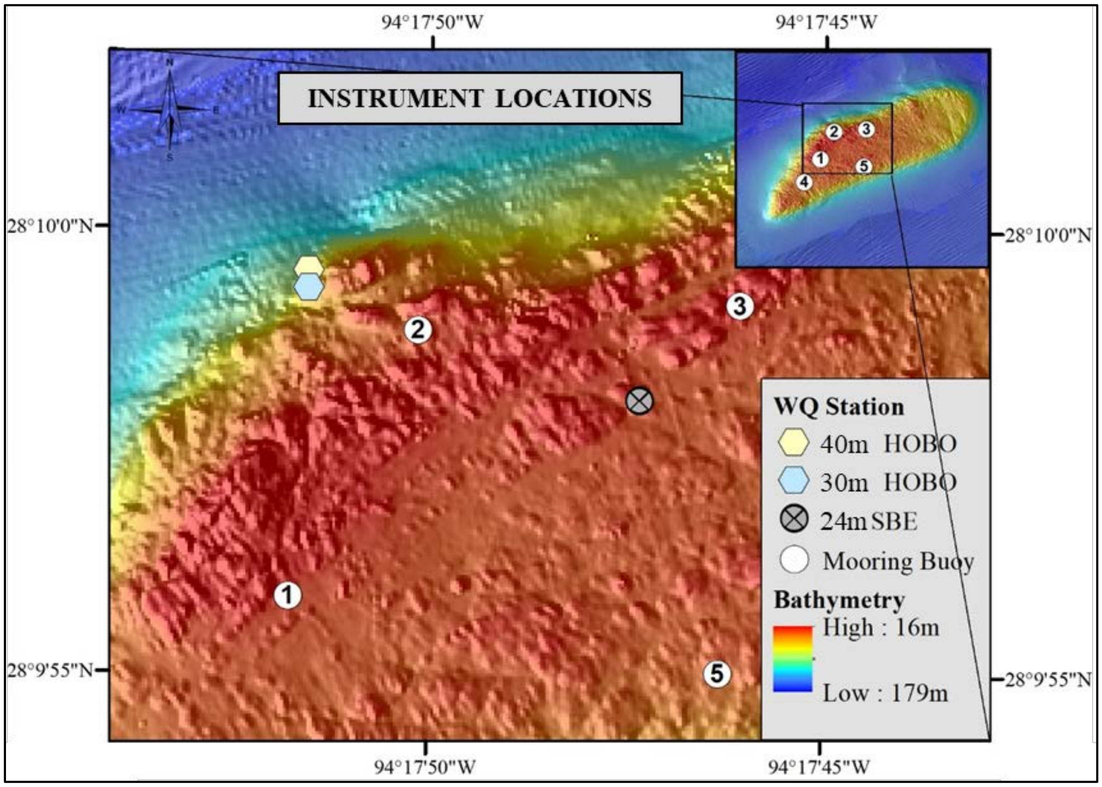


Figure 5.1. Water quality instrumentation locations. Image: NOAA

Water column profiles

Water column profiles are typically taken quarterly in conjunction with the collection of water samples; however, due to extended vessel maintenance, only three sampling events occurred during the 2018 study period. During one of these events, the water samples were collected with manual Niskin sampler and no water column profile was obtained. A Sea-Bird® Electronics *19plus* V2 CTD recorded temperature, salinity, pH, turbidity, fluorescence, and DO every ¼ second. Data were recorded following an initial soaking period, on the upcast phase of each deployment, while the CTD was brought to the surface at a rate <1 m/sec. Table 5.1 details the instruments used to collect each parameter.

Table 5.1. Sensors for water column profiles. Sensors are added to SBE 19*plus* V2 CTD.

Sensor	Parameter Measured
SBE-18	pH
SBE-19	Depth, Salinity, Temperature
SBE-43	Dissolved oxygen
WET Labs ECO-FLNTUrtd	Fluorescence and Turbidity

Profiles containing temperature, salinity, pH, dissolved oxygen, turbidity, and fluorescence were collected on August 17 and October 22, 2018.

Water samples

Water samples were collected each quarter using a sampling carousel equipped with a Sea-Bird® Electronics *19plus* V2 CTD and twelve OceanTest® Corporation 2.5 l Niskin bottles. The carousel was attached to the vessel with a scientific winch cable that allows activation of the sampling bottles at specific depths from the shipboard wet lab. A total of six nutrient and four carbonate samples were collected each quarter. Three Niskin bottle samples were collected near the bank crest (approximately 20 m depth), three mid-water (10 m depth), and four near the surface (1 m depth). An additional blind duplicate water sample was taken at one of the sampling depths for each sampling period. One sampling event (April 2018) used an eight liter handheld General Oceanics Niskin Sampling Bottle (Model 1010).

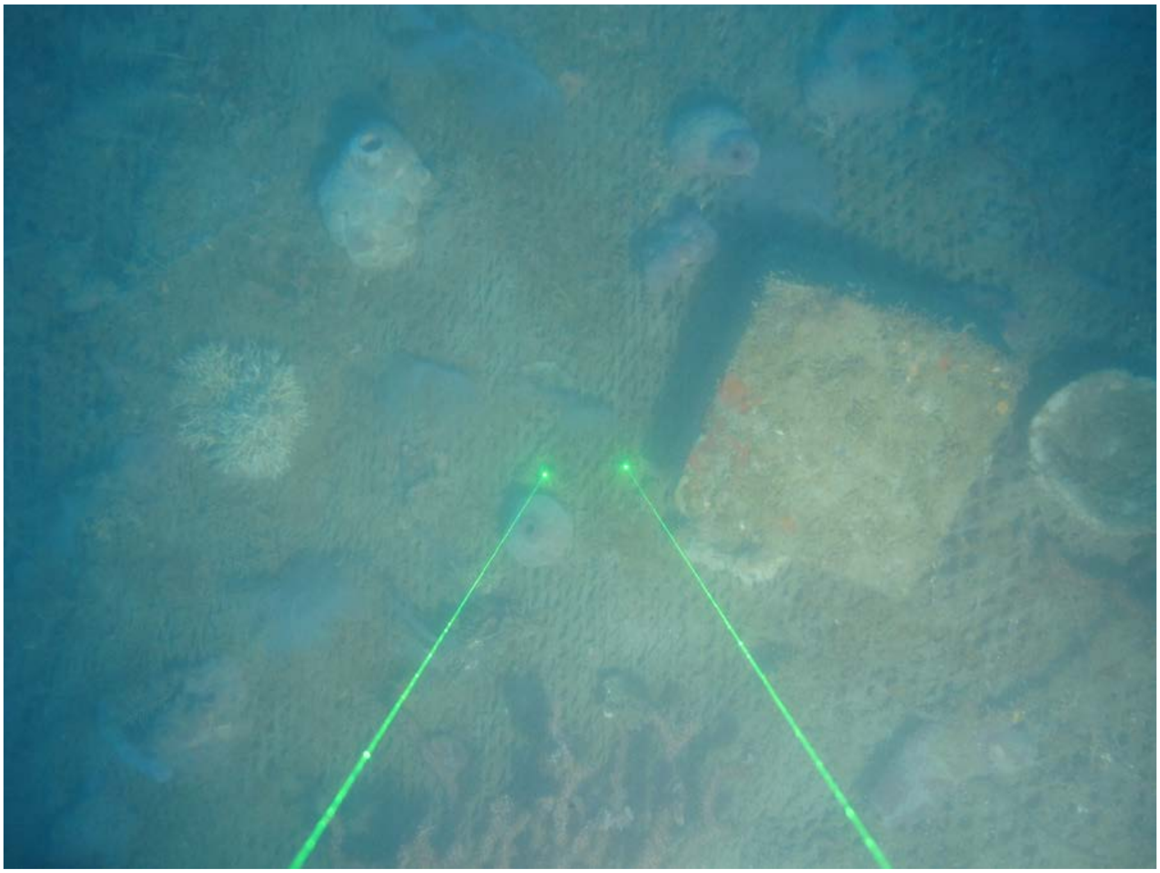
One sample bottle from each depth was distributed among three containers for nutrient analysis: chlorophyll-*a* samples were distributed to 1000 ml glass containers with no preservatives; samples for reactive soluble phosphorous were distributed to 250 ml bottles with no preservatives; and ammonia, nitrate, nitrite, and total nitrogen samples were distributed to 1000 ml bottles with a sulfuric acid preservative. Immediately after sampling, labeled sample containers were stored on ice and maintained at or below 4° C, and a chain of custody was initiated for processing at an EPA certified laboratory. The samples were transported and delivered to A&B Laboratories in Houston, Texas, within 24 hours of being collected. Each sample was analyzed for chlorophyll-*a* and nutrients (ammonia, nitrate, nitrite, phosphorous, and total nitrogen). In 2018, water samples were obtained on April 24, August 17, and October 22.

Water samples for ocean carbonate measurements were collected following methods requested by the Carbon Cycle Laboratory (CCL) at Texas A&M University – Corpus Christi (TAMU-CC) from one sample bottle at each depth, with two replicate samples taken near the surface (1 m). Samples were distributed to Pyrex 250 ml borosilicate bottles with glass stoppers using a 30 cm plastic tube that connected to the lower spout of the Niskin bottle. Sample bottles were rinsed three times using the sample water, filled with the plastic tube at the bottom of the bottle to reduce bubble formation, and overflowed by at least 200 ml before 100 µl of $HgCl_2$ was added to each bottle. Stoppers were sealed with Apiezon grease and secured with a rubber band and mixed vigorously. Samples were then stored at 4° C. Samples and CTD profile data were sent to CCL TAMU-CC. Samples were obtained on April 24, August 17, and October 22, 2018.

Challenges and resolutions

- Three of four quarterly water samples were conducted
    - Due to a combination of poor weather and limited vessel availability from February to May 2018, the first scheduled quarterly water cruise did not occur. The first water collecting cruise occurred in April aboard a fishing vessel without diving and scientific winch capabilities, therefore only water samples were collected. Following April, the remaining two quarterly water quality cruises occurred as scheduled in August and October.
- No data were recorded on the SBE *16plus* between August 03, 2017, and November 07, 2017.
    - An issue with the configuration file used to set up the SBE *16plus* for this deployment resulted in erroneous data. Additional training in the proper setup, assessment, and evaluation of configuration files for new staff is essential and was conducted during October 2018.
- The SBE *16plus* backup HOBO thermistor deployed in October 2017 failed, resulting in a data gap between November 09, 2017, and June 26, 2018.
    - In addition to thoroughly examining thermistors for physical damage and verifying adequate battery life before deployment, units can be returned to manufacturer to determine remaining working life and potentially retrieve any stored, but inaccessible, data. New thermistors are being put in service as older models are identified and phased out.

CHAPTER 6: MESOPHOTIC REPETITIVE PHOTOSTATIONS



Mesophotic repetitive photostation M03 was placed atop a high relief outcropping entombed in fishing net. Photo: NOAA/UNCW-UVP

Introduction

Seven permanent photostations were established on the mesophotic reefs surrounding Stetson Bank in 2015. Locations of biological interest were selected along the hard bottom reef features and markers were deployed by remotely operated vehicle (ROV). Their latitude and longitude were recorded using the navigation system on the ROV (Figure 6.1). In 2018, all seven stations were located and photographed. While the majority of key features at each station were captured in the images, the images are not identical between years.

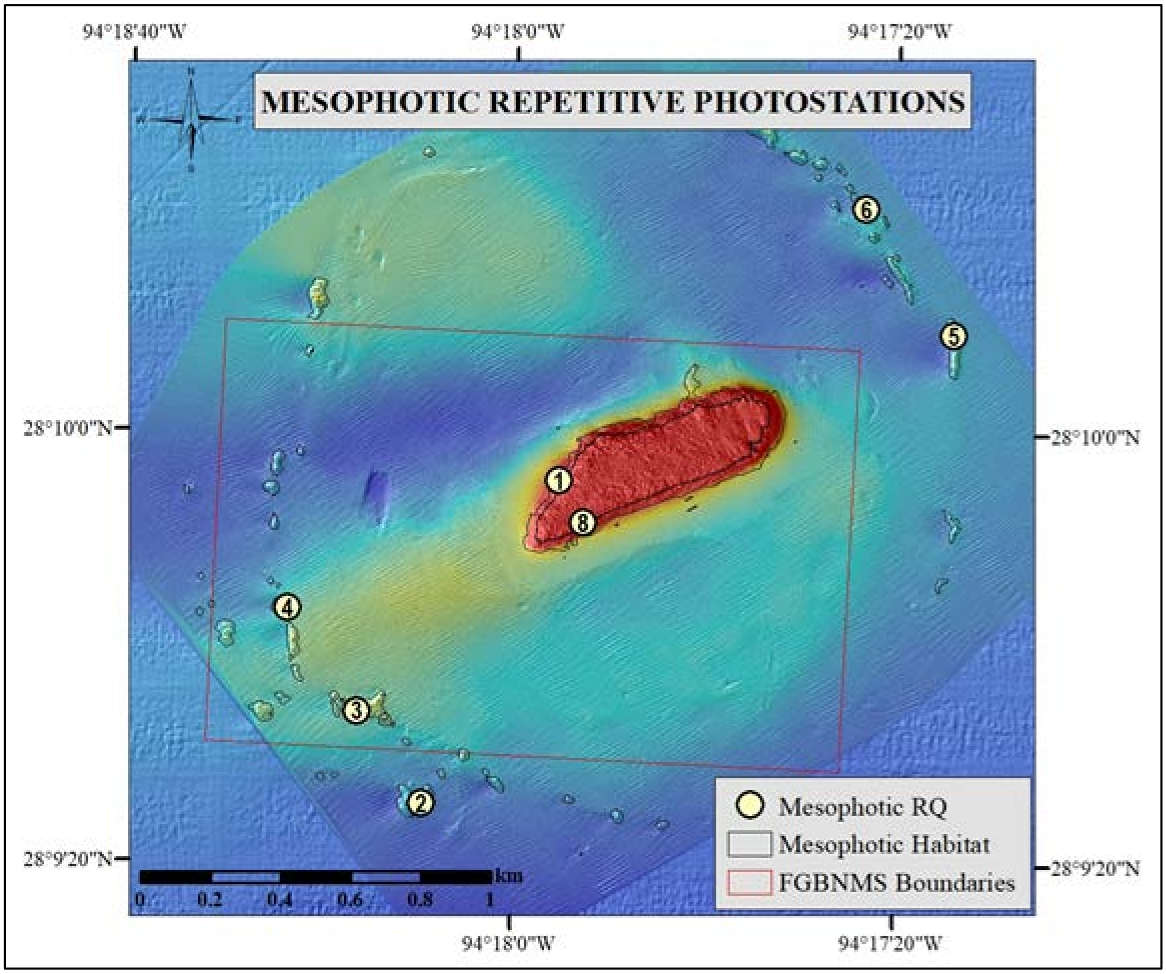


Figure 6.1. Mesophotic repetitive photostation locations. Image: NOAA

Methods

Field methods

Seven repetitive photostations, marked with concrete blocks, were located and photographed by ROV using recorded latitude and longitude overlaid into the ROV navigation system. A repetitive heading assigned to each station was used to guide collection of high definition video imagery of the site and old photographs were used to ensure all key features were observed in the video. Still frames for each repetitive station were extracted from the high definition video feed and a downward facing photograph of each station was also captured, with the ROV positioned directly above the station marker, approximately 1 m above the bottom.

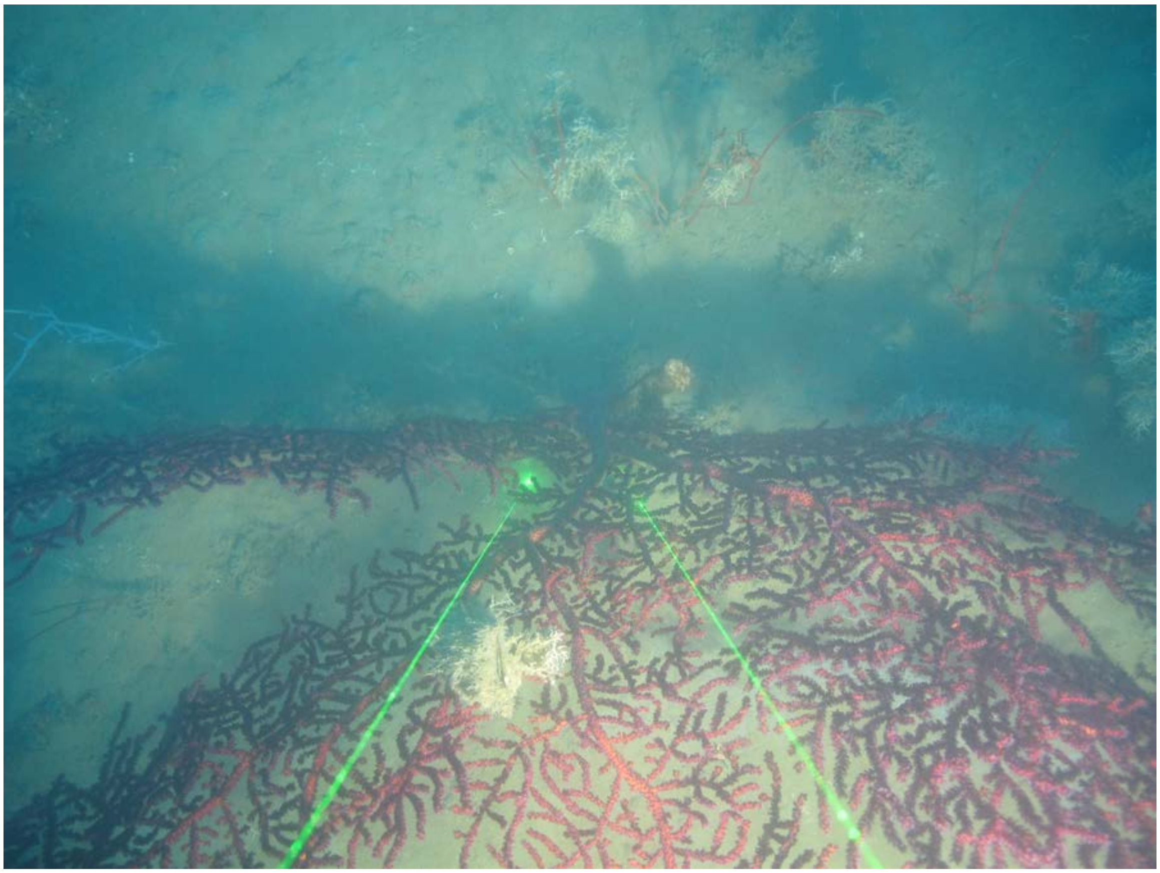
In 2018, a SubAtlantic Mohawk 18 ROV, owned by the National Marine Sanctuary Foundation and FGBNMS and operated by University of North Carolina at Wilmington - Undersea Vehicle Program (UNCW-UVP), was used. The ROV was equipped with an Insite Pacific Mini Zeus II HD video camera with two Deep Sea Power & Light 3100 LED lights, a tool skid with an ECA Robotics five-function all-electric manipulator, and two parallel spot lasers set at 10 cm in both the video and the still camera frames for scale.

All seven sites were located and photographed. Five of the seven sites were photographed with both forward facing and downward images. Site M02 was only photographed with downward facing images and site M05 was only photographed with forward facing images.

Challenges and resolutions

- Some sites were difficult to locate.
    - While all sites were found, poor visibility due to heavily silted water, combined with markers overgrown by hydroids, made locating markers difficult in 2018. Multiple ROV dives were conducted searching for markers. It was determined that dives conducted early in the morning had better visibility.

CHAPTER 7: MESOPHOTIC RANDOM TRANSECTS



A red *Hypnogorgia* octocoral in the deep reef habitat grows on patch reefs surrounding the main feature at Stetson Bank. Photo: NOAA/UNCW-UVP

Introduction

A minimum of 15 random transects are conducted annually using a stratified random sampling design. Sites were selected on potential mesophotic habitat identified using bathymetric data. Transects were conducted using a downward facing still camera mounted to the ROV. The transects will be analyzed to assess community composition and coral density.

Methods

Field methods

Bathymetric data was processed in Esri's ArcGIS® to highlight potential mesophotic reef habitat. Two meter resolution bathymetry raster was imported into ArcMap® and focal statistics calculated for range (minimum to maximum depth) within a 2 x 2 cell rectangle. Cells with a range >1 m were identified as potential habitat. Area shallower than 33.5 m was removed. The raster was then converted to a polygon feature.

Two habitats were identified in 2015: coralline algae reef and deep reef. In 2018, a total of 30 surveys (15 in each habitat) were randomly distributed within the polygon defining habitat. Each point, representing the start location of transects, was generated using the tool "create random points," with a minimum of 30 m between sites (Figure 7.1). However, transects were not conducted at all sites if transects overlapped or environmental conditions resulted in poor quality data.

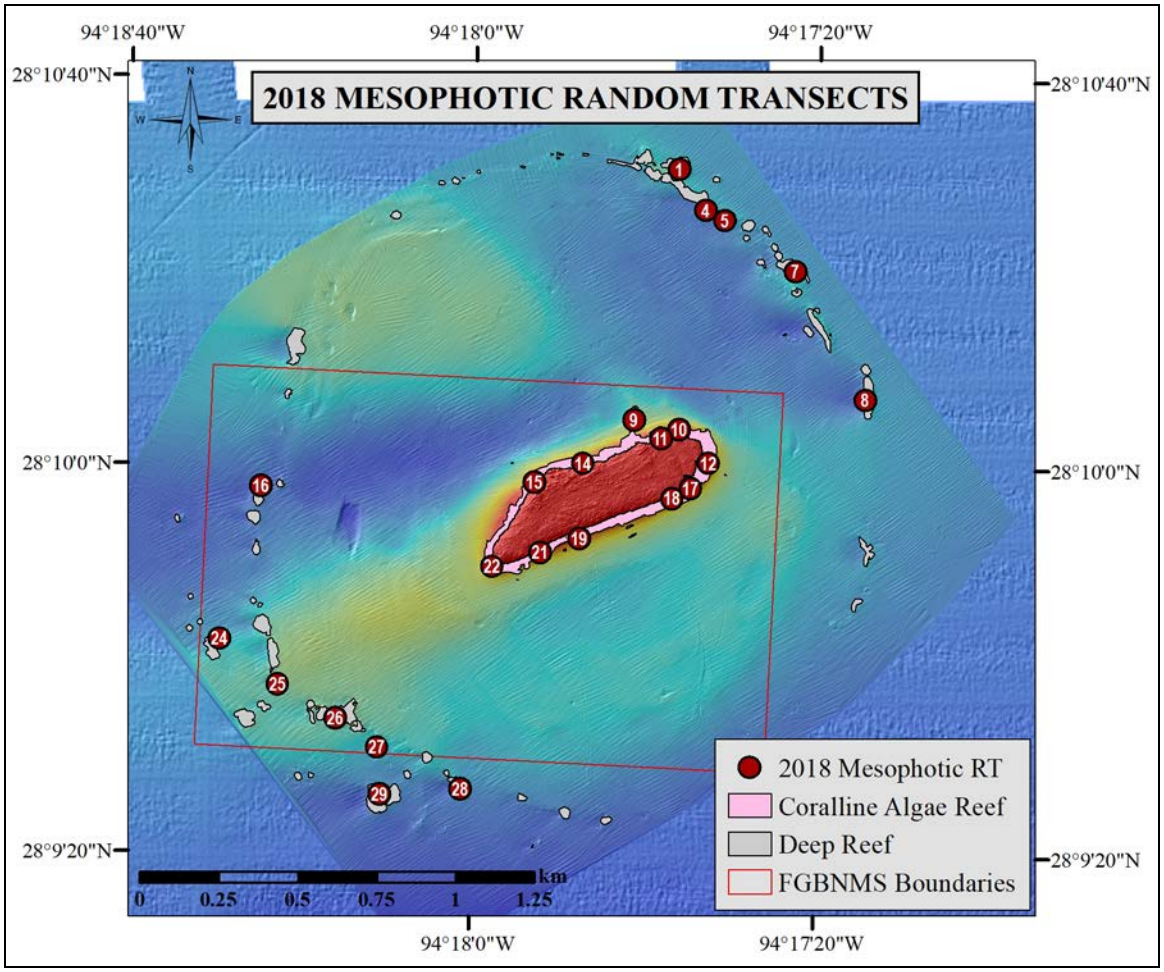


Figure 7.1. 2018 Mesophotic random transect locations. Image: NOAA

Surveys were conducted using the ROV with a downward facing still camera and two lasers for scale. Transects started at each of the random drop sites and continued for 10 minutes along hard bottom habitat. The ROV traveled at 1 m above the bottom, at a speed of 1 knot, taking downward facing still images every 30 seconds during the transect.

In 2018, the same ROV system as described in Chapter 6 Methods was used. The ROV was also equipped with a Kongsberg Maritime OE14-408 10 mp digital still camera, OE11-442 strobe, and two Sidus SS501 50 mW green spot lasers set at 10 cm in the still camera frame for scale.

Twenty-three transects were conducted in 2018, with 11 in coralline algae reef habitat and 12 in deep reef habitat.

Challenges and resolutions

No problems were encountered in the 2018 field season.

CHAPTER 8: MESOPHOTIC FISH SURVEYS

A lionfish swims in deep reef habitat on the patch reefs surrounding the main feature at Stetson Bank. Photo: NOAA/UNCW-UVP

Introduction

Belt transect visual fish censuses were conducted at random locations in the mesophotic habitat surrounding Stetson Bank, in conjunction with mesophotic random transects, to examine fish community composition and temporal changes (annually). These surveys will be used to characterize and compare fish assemblages.

Methods

Field methods

Fishes were visually assessed by ROV using forward facing video footage obtained from belt transects discussed in Chapter 7 Methods. Observations of fishes were restricted to the field of view of the ROV's forward facing high definition video camera. All fish species observed were recorded, counted, and sized. Size estimates, based on fork length, were made using mounted scale lasers in the field of view of the ROV for reference and binned into eight groups: <5 cm, ≥5 cm to 10 cm, ≥10 cm to 15 cm, ≥15 cm to 20 cm, ≥20 cm to 25 cm, ≥25 cm to 30 cm, ≥30 cm to 35 cm, and ≥35 cm. Each survey required 10 minutes to complete. Surveys began in the early morning (after sunrise), and were repeated throughout the day until dusk. Each survey represented one sample.

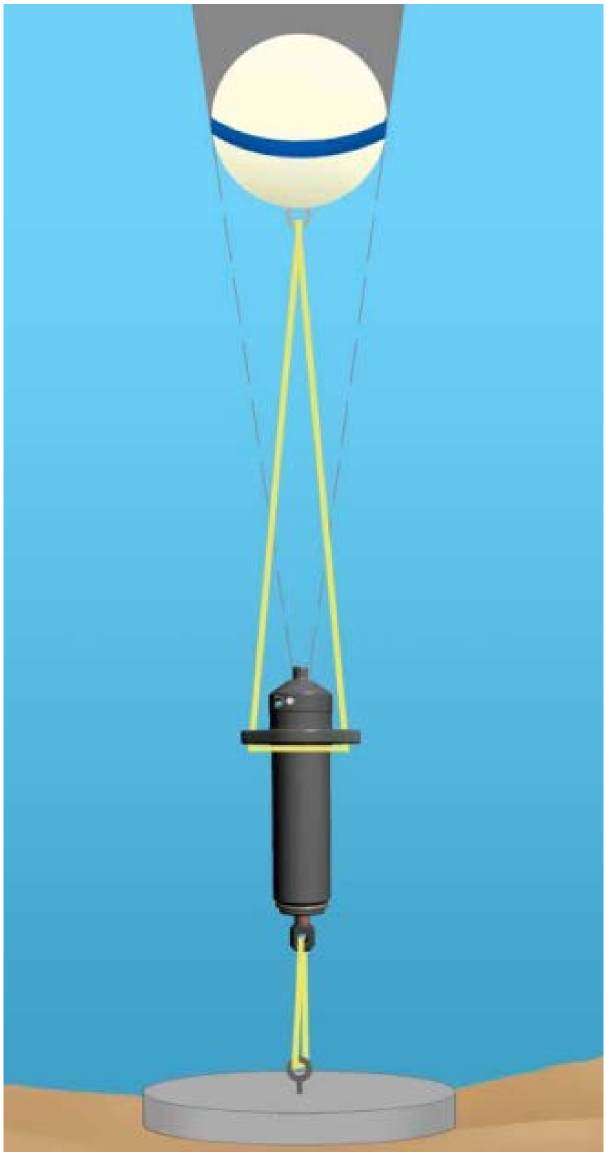
The surveys were conducted in conjunction with mesophotic random transects, where the survey starting location was selected using a stratified random sampling design (see Chapter 7 Methods). A minimum of 15 surveys are conducted annually. During the 2018 sampling period, 23 fish surveys were completed.

In 2018, the same ROV system described in Chapter 6 Methods was used. This ROV was also equipped with an ORE transponder to collect ROV position information with ORE TrackPoint II. A separate set of paired lasers, set at 10 cm apart, was used to size fish.

Challenges and resolutions

- Random fish surveys were challenging in low visibility habitats, as fish hid before coming into the field of view and the lack of water clarity made observation and species identifications difficult.
    - In 2017, a minimum field of view of 3 m was used to determine sufficient visibility for the survey. This field of view threshold was applied to surveys conducted in 2018.

MESOPHOTIC WATER TEMPERATURE



VEMCO acoustic release system setup. Image: VEMCO

Introduction

Water temperature loggers were deployed at Stetson Bank in July 2015 to collect water temperature data every hour. Two instruments were deployed on a single acoustic release system, one at 54 m and one at 44 m (Figure 9.1).

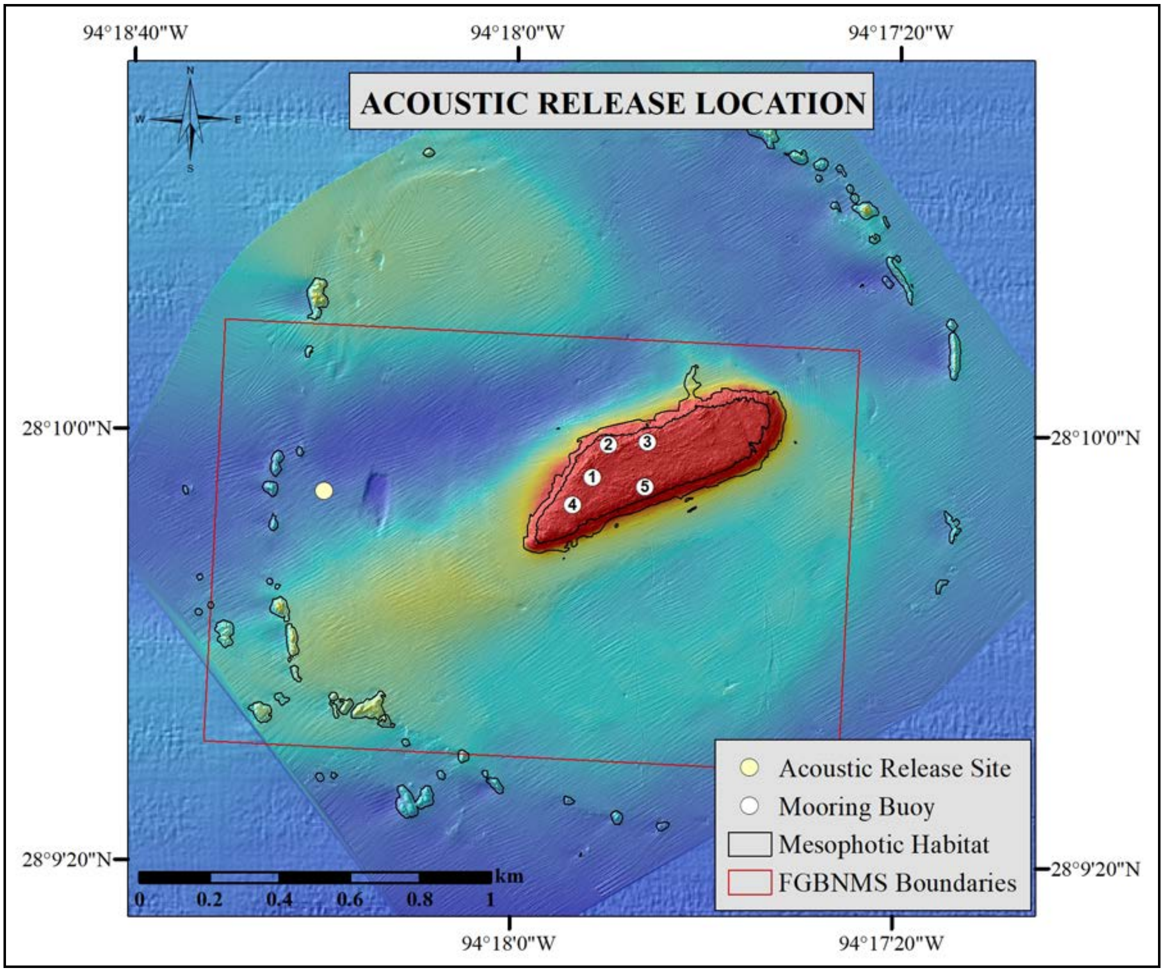


Figure 9.1. Location of the acoustic release system. The system holds instruments at 54 m and 44 m to record water temperature every hour. Image: NOAA

Methods

Field methods

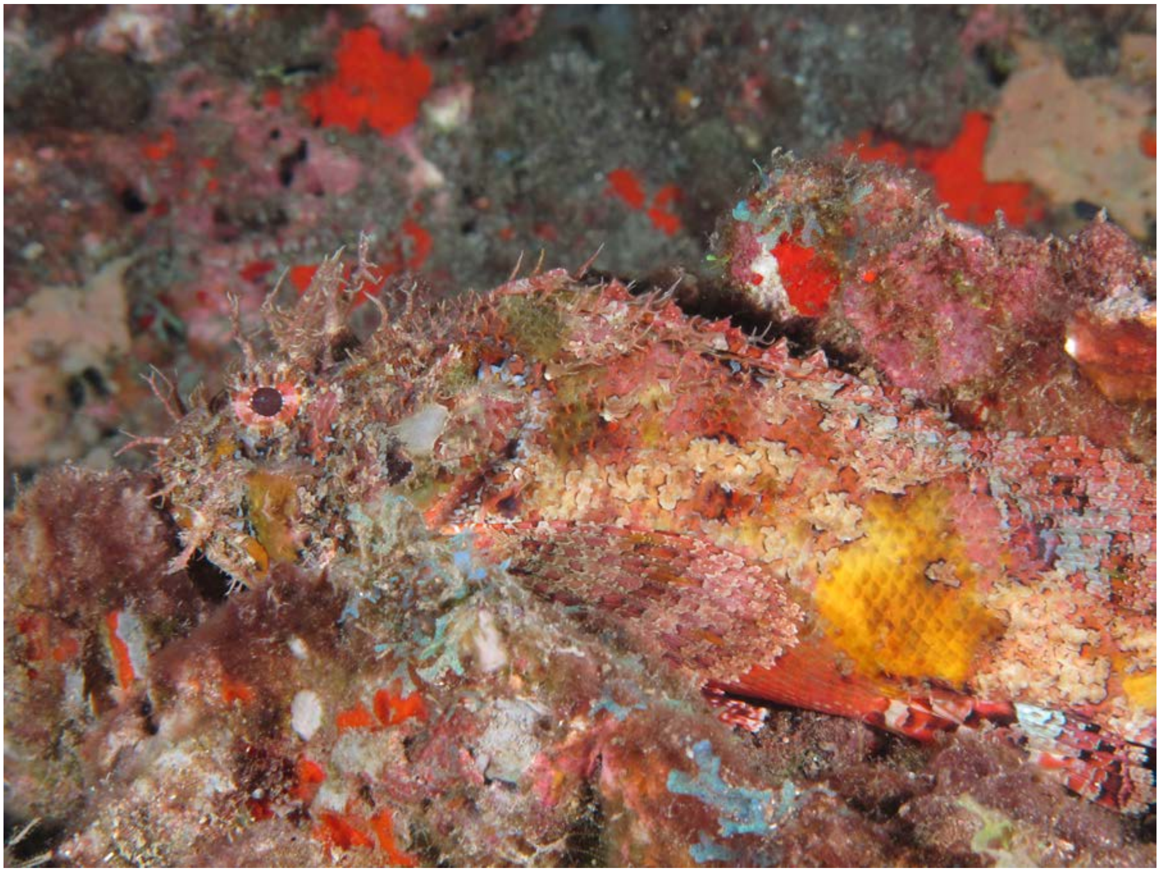
A VEMCO VR2AR acoustic release system with Onset® Computer Corporation HOBO® Pro v2 U22-001 thermographs were deployed as described in Nuttall et al. (2017).

Challenges and resolutions

- Instrument could not be relocated.

- Two ROV dives were conducted in an attempt to locate and recover the instrument because the acoustic release system failed. Comprehensive search patterns were completed but the effort was unsuccessful in locating the instrument.

VIDEO OBSERVATIONS, NOTES, AND OTHER RESEARCH



A spotted scorpionfish, *Scorpaena plumieri*, hides at Stetson Bank. Photo: Marissa Nuttall/NOAA

Introduction

Permanent video transects locations were established on the bank crest, covering both low relief and high relief features, in addition to locations of high coral cover. As time permitted, video transects were conducted in the mesophotic habitat, traversing the extent of the bank and associated patch reef features. These transects were conducted for general condition observations.

Methods

Field methods

Bank crest video transects

Three 100 m permanent transects were installed at Stetson Bank in 2015. Each transect was marked using 30 cm stainless steel eyebolts drilled and epoxied into the reef at 25 m increments along the transect. Each eyebolt was labeled with a cattle tag denoting the transect number and the eyebolt position along the transect. Transect start locations are available on the site maps (Chapter 1, Figures 1.2 and 1.3). Before recording video, a line was stretched between the eyebolts to mark the transect. Video was recorded using a Sony® Handycam® HDR-CX350 HD video camera in a Light and Motion® Stingray G2® housing.

A two-meter-long plumb bob was secured to the front of the camera housing. The diver swam along the transect line, following the line with the plumb bob. The camera was maintained at a 45^{o} angle to the reef during filming.

In 2018, two of three video transects were completed (T2 and T3).

Mesophotic video transects

None completed in 2018.

General observations

General observations were recorded throughout the field work. Biological and geological observations, and sighting of marine debris, were noted on each transect. The details and order of field operations were continuously recorded.

In 2018, interesting observations included the presence of the exotic regal demoiselle (*Neopomacentrus cyanomos*), native to the Indo-west Pacific, and a tiger shark (*Galeocerdo cuvier*) with a metal ring entangled around its body forward of the pectoral fins (Figure 10.1).

Figure 10.1. Video observations showed marine debris impacts at Stetson Bank. A tiger shark, *Galeocerdo cuvier*, was seen with a metal band forward of the pectoral fins. Photo: Marissa Nuttall/NOAA

Other Research

1. Thirty samples of the regal demoiselle, a recently observed exotic fish species, were collected from Stetson Bank and provided to Dr. Ron Eytan at Texas A&M University at Galveston for further analysis.
2. A note on the presence of the regal demoiselle was distributed to the Coral Listserv and observations were submitted to the United States Geological Survey (USGS) nonindigenous aquatic species database (https://nas.er.usgs.gov/default.aspx).
3. Ocean carbonate data at FGBNMS were published by Dr. Xinping Hu at TAMU-CC CCL.
    a. Hu, X., Nuttall, M.F., Wang, H., Yao, H. Staryk, C. J., McCutcheon, M.R., Eckert, R.J., Embesi, J.A., Johnston, M.A., Hickerson, E.L., Schmahl, G.P., Manzello, D., Enochs, I.C., DiMarco, S., and Barbero, L. Seasonal variability of carbonate chemistry and decadal changes in waters of a marine sanctuary in the Northwestern Gulf of Mexico. Marine Chemistry. Volume 205, 20 September 2018, Pages 16-28. https://doi.org/10.1016/j.marchem.2018.07.006

4. Texas Lionfish Control Unit completed two removal cruises in 2018. The June and August cruises removed 83 and 41 lionfish, respectively, from Stetson Bank.
5. Publication of historical manta ray observations at FGBNMS in Marine Biology journal.
    a. Stewart, J.D., Nuttall, M., Hickerson, E.L., Johnston, M.A. 2018. Important Juvenile Manta Ray Habitat at Flower Garden Banks National Marine Sanctuary in the Northwestern Gulf of Mexico. Marine Biology 165:111. Doi.org/10.1007/s00227-018-3364-5
6. NOAA Fisheries Southeast Area Monitoring and Assessment Program (SEAMAP) continued with the deployment of baited camera arrays and plankton sampling, led by Kevin Rademacher.

Conclusions

This report summarizes field efforts for the annual monitoring conducted at Stetson Bank in 2018. Both bank crest and mesophotic habitat were surveyed in this study period.

The bank crest of Stetson Bank has been monitored for over 20 years. While repetitive photostations do not capture the entire reef community, this form of benthic monitoring has been conducted annually on the reef since 1993, and documented a significant shift in the benthic community. In addition to repetitive photostations, random transects (for benthic and fish communities) on the bank crest were completed in 2018 and will be processed to provide a more comprehensive picture of the community by habitat. Similarly, repetitive photostations and random transects (for benthic and fish communities) were completed in 2018 in mesophotic habitats.

Water temperature data were collected throughout the year on the bank crest. The thermistors located in mesophotic depths were not found after extensive searching using an ROV in 2018. Salinity and turbidity levels were recorded on the bank crest for the majority of the year, but some data gaps occurred in late 2017 due to equipment failure. Only three quarterly water samples were collected in 2018 due to poor weather conditions and limited vessel access. Water column profile data were not collected on one of the sampling periods due to the limited capabilities of the vessels utilized.

Observations of an additional exotic fish species, the regal demoiselle, occurred on June 26, 2018. Schools of regal demoiselle (*Neopomacentrus cyanomos*), each containing hundreds of small fish (5-10 cm), were observed over many pinnacles on the bank and within vertical sponges. These schools often included other reef fish, including brown chromis (*Chromis multilineata*).

To date, this monitoring program represents one of the longest running monitoring efforts of a northern latitude coral community. An ongoing monitoring program at Stetson Bank is essential to monitor the drivers of ecosystem variation and change in the northern Gulf of Mexico. Sustained monitoring will continue to document changes in the species composition and general condition of the bank, which will guide research and management decisions in the future.

Literature Cited

Bohnsack JA, Bannerot SP. 1986. A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. NOAA Technical Report NMFS 41. 15pp.

Edmunds PJ and Carpenter RC. 2001. Recovery of *Diadema antillarum* reduces macroalgal cover and increases abundance of juvenile corals on a Caribbean reef. Proceedings of the National Academy of Sciences 98:5067–5071.

Nuttall MF, Sterne TK, Eckert RJ, Hu X, Sinclair J, Hickerson EL, Embesi JA, Johnston MA, Schmahl GP. 2017. Stetson Bank Long-Term Monitoring: 2015 Annual Report. Marine Sanctuaries Conservation Series ONMS-17-06. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Flower Garden Banks National Marine Sanctuary, TX. 98pp.

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Glossary of Acronyms

BSEE – Bureau of Safety and Environmental Enforcement
CCL – Carbon Cycle Laboratory
CTD – conductivity, temperature, and depth
DIC – total dissolved CO_2
DO – dissolved oxygen
EPA – Environmental Protection Agency
FGBNMS – Flower Garden Banks National Marine Sanctuary
GREAT – Gulf Reef Environmental Action Team
LTM – long-term monitoring
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
ROV – remotely operated vehicle
SEAMAP – Southeast Area Monitoring and Assessment Program
TAMU-CC – Texas A&M University – Corpus Christi
TAMUG – Texas A&M University at Galveston
UNCW-UVP – University of North Carolina at Wilmington - Undersea Vehicle Program
USGS – United States Geologic Survey

National Marine Sanctuaries

America's Underwater Treasures