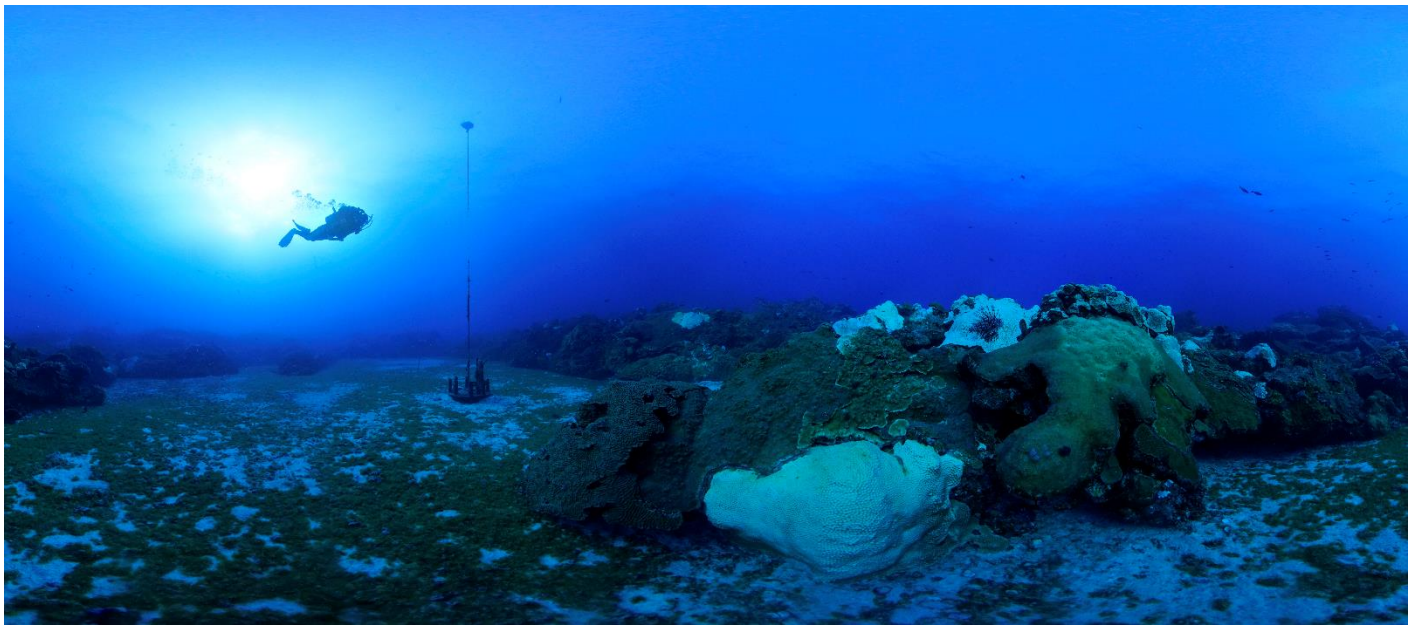
Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY

2016 RESEARCH AND MONITORING REPORT



April 2017

The purpose of this document is to report the activities of the Flower Garden Banks Research Team during FY2016.

National Oceanic and Atmospheric Administration

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Cover photo: The corals of East Flower Garden Bank and West Flower Garden Bank endured a bleaching event in 2016. This photograph was taken at West Flower Garden Bank near buoy #2 at the peak of the event. Since then, the corals have recovered well.
Cover Photo Image credit: FGBNMS/Emma Hickerson

Overview

The Flower Garden Banks National Marine Sanctuary (FGBNMS) research team was involved in 13 research cruises and expeditions during the 2016 field season. The *R/V MANTA* was utilized by the research team for a total of 40 days to conduct operations. A pool of 31 FGBNMS NOAA divers, scientists, and reciprocity divers conducted 856 SCUBA dives; reciprocity divers conducted 22.8% of the dives. Activities included biological surveys and sample collection, response to a mass die-off of invertebrates at East Flower Garden Bank (EFGB), response to a bleaching event, removal of invasive species, equipment maintenance, image collection, and dive safety training. Six sanctuary permits were processed, and an additional five were/are ongoing.

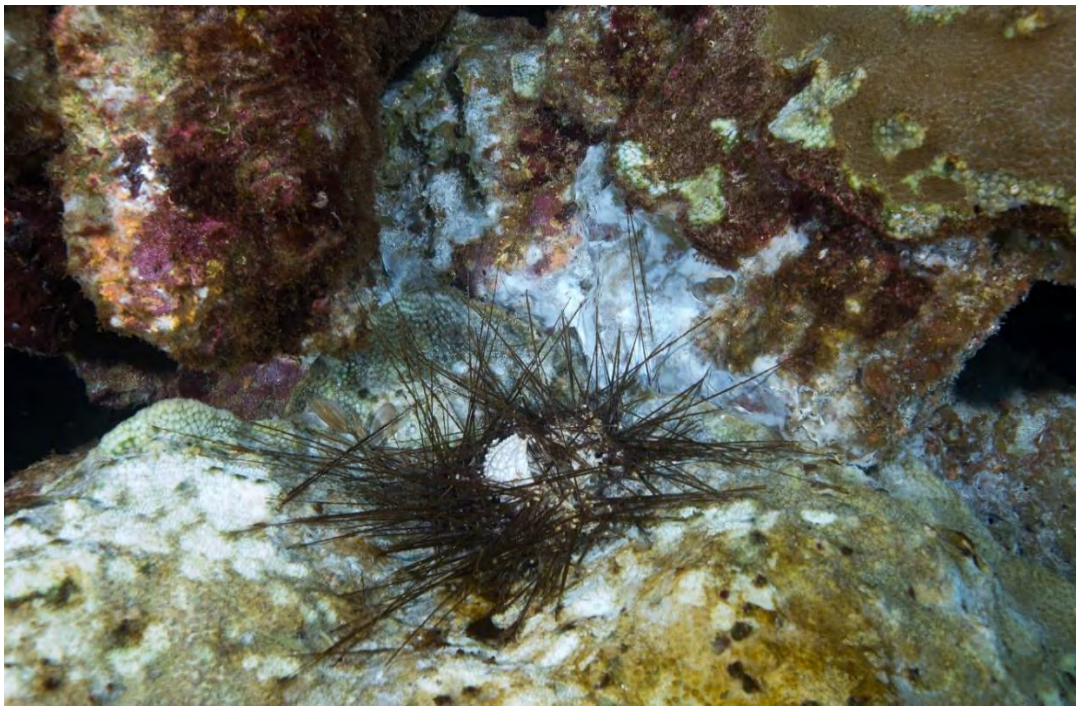
A mixed school of gray snapper, creole fish, and vermillion snapper swim over a siltstone outcropping colonized by sponges, algae, and *Madracis decactis* coral on the pinnacles at Stetson Bank.
Image credit: FGBNMS/G.P. Schmahl

FY 2016 HIGHLIGHTS

East Flower Garden Bank Invertebrate Die-Off Event

On July 25, 2016 a mortality event was reported at East Flower Garden Bank to the FGBNMS research team by recreational divers and crew aboard the *M/V FLING* following a dive on buoy #4. The event was confirmed and subsequently a response was launched by the FGBNMS and partners including University of South Florida (USF), Texas A&M University (TAMU), Rice University, University of North Carolina - Chapel Hill (UNCW-CH), University of Houston (UH), Baylor University, Texas General Land Office (TX GLO), and University of Texas-Dallas (UT-D).

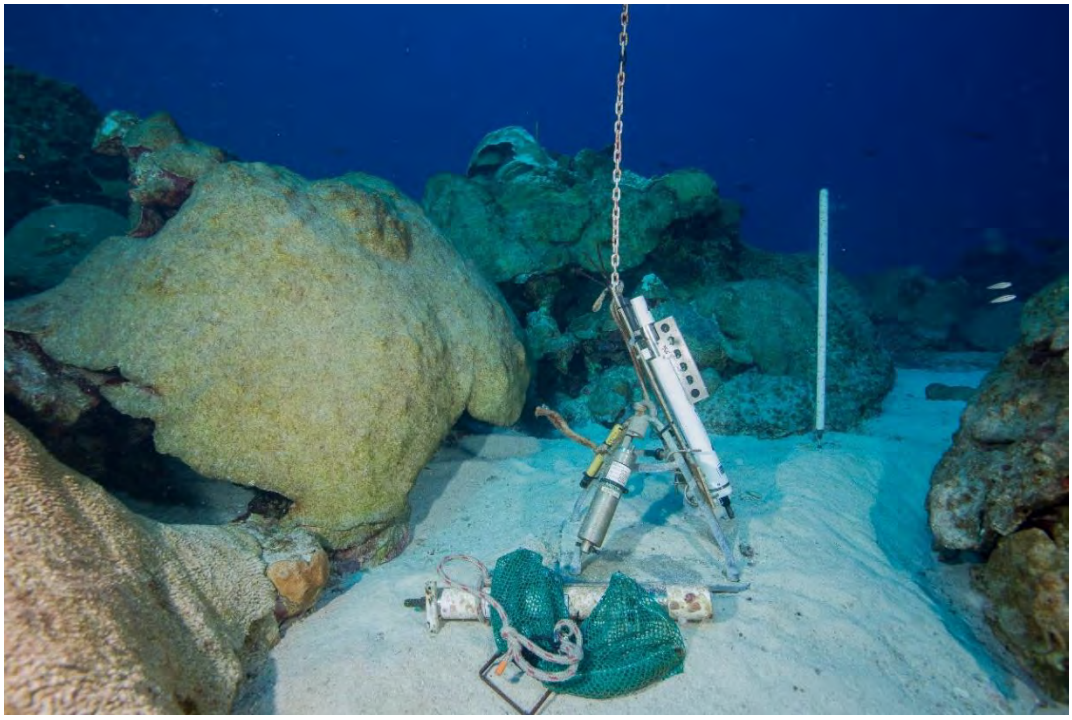
USF led an effort to analyze satellite imagery showing chlorophyll levels – an indicator of freshwater events from land. Imagery was analyzed from June to the time of the event. Imagery confirmed that freshwater outflow had been persistent in the area of Flower Garden Banks for weeks. A response cruise that focused on water collection and CTD casts measuring primarily temperature and salinity was conducted by Texas A&M University from July 30 – August 2, 2016. Water samples were collected at locations throughout and between sanctuary waters. Initial observations confirmed that freshwater was reaching the sanctuary, and also suggested an upwelling event brought in decreased levels of oxygen to the sanctuary.



Countless invertebrates died during the localized mortality event at EFGB. Here, the spines fall off a dead *Diadema* sea urchin. A white bacterial mat covers a sponge, and dead coral. Image credit: FGBNMS/Schmahl.

The second of two response cruises returned August 7, 2016 with observations that the event appeared to be inactive except for some discrete areas. Based on the limited surveys conducted, it was determined that approximately 6.5 acres of the coral reef had greater than 15% of the coral affected by the mortality event, with a maximum of 70% affected corals in localized areas. The 6.5 acres represents around 1% of the coral reefs within the sanctuary. During the second cruise, divers from FGBNMS and UNC – Chapel Hill conducted 23 photo transects, scooter surveys, and collected over 300 samples of corals and sponges, both affected and unaffected, as well as directed water samples in discrete areas on the impacted reef. These samples are currently being analyzed to look at the micro-organism communities, and also genetic markers that may indicate specific types of stress. TAMU deployed a glider that ran transects throughout the area to continue characterizing the water column. The glider was retrieved in early September 2016.

Additional observations were made, during the coral spawning cruise (August 25-28, 2016) on the flanks of EFGB around buoy #1 and also nearby at the HIA389A and HI376A platforms, that indicated there may have been a more widespread event than just the localized hotspot initially surveyed on the reef crest. Sponge mortality was observed on the reef and on both of the platforms. Follow up surveys were conducted during October 2016.



Water quality instrumentation deployed at “ground zero” within the mortality zone at East Flower Garden Bank. The majority of the corals in this image died during the event. Image credit: FGBNMS/Schmahl

Coral Bleaching Event

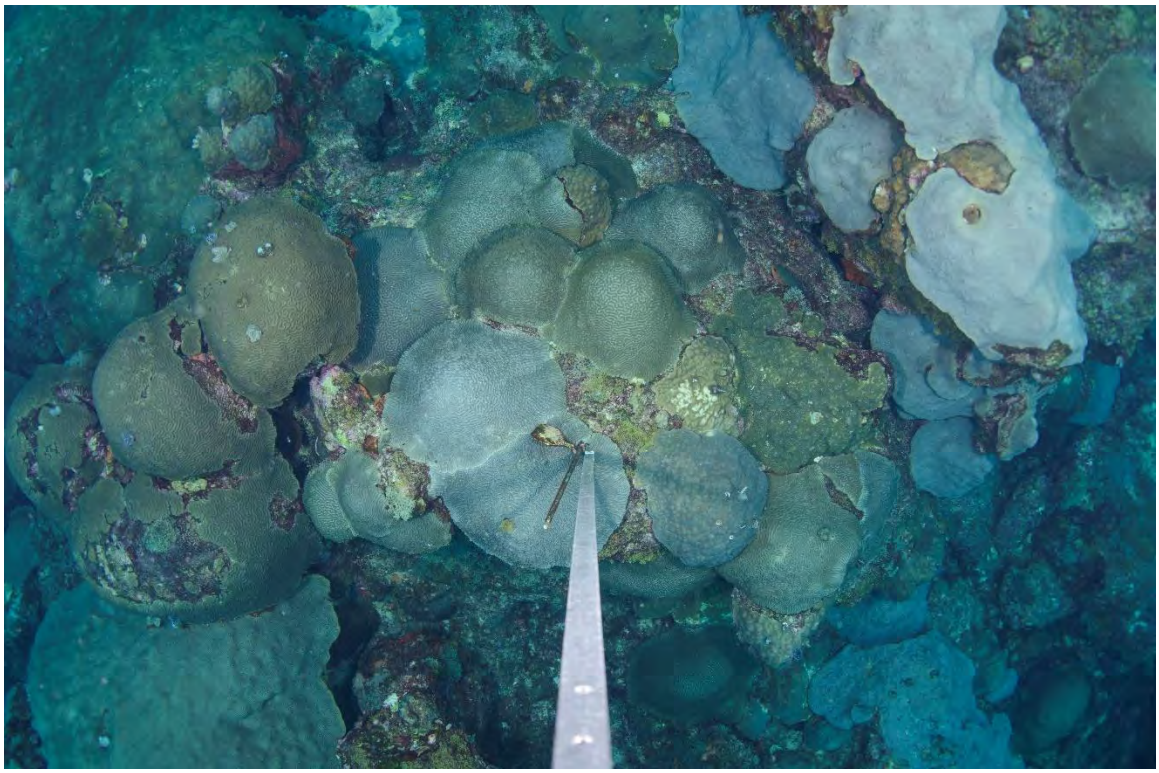
A diver swims over bleached coral at East Flower Garden Bank. Image credit: FGBNMS/Hickerson

Water temperatures were consistently elevated during the months of August and September 2016. The first signs of bleaching were observed during the annual coral spawning and Sanctuary Advisory Council cruises in August. Response cruises were conducted during October 2016 and February 2017 to collect photographs at the repetitive photostations at EFGB and West Flower Garden Bank (WFGB) to monitor the event.

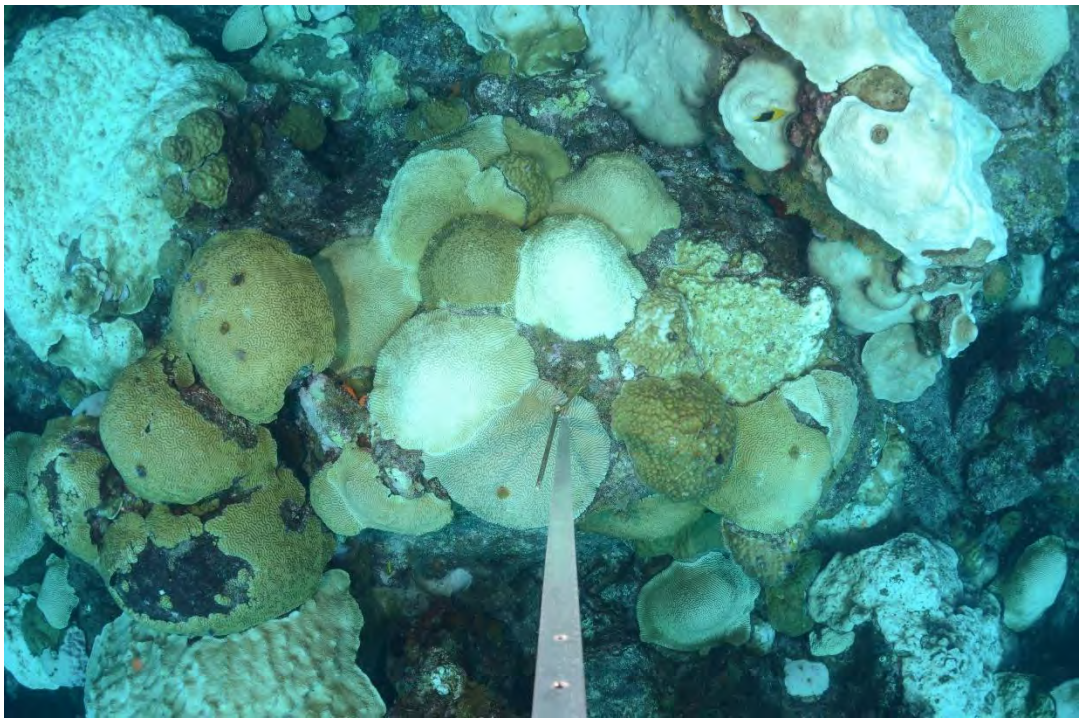
Water temperature data downloaded from the Texas Automated Buoy (TABS) buoy at the surface revealed that 85 days between June 1 and October 5, 2016 were above 30°C, the accepted threshold for coral bleaching. On the reef crest of EFGB, water quality instruments recorded 36 days over 30°C, and 21 days over 30°C on WFGB in 2016 (30 days at EFGB, and 18 days at WFGB during the June-October time period reflected in the TABS buoy data). This difference in the number of days over the threshold between the two banks is likely driving the results shown below, as EFGB sustained more days of temperature stress.

In October, 46% of the colonies exhibited bleaching or paling in the EFGB long-term monitoring shallow repetitive photostations (around 70ft depth), and 20% of the deep photostations (between 100ft and 130ft). In contrast, 24% of the colonies exhibited bleaching or paling in the WFGB long-term monitoring shallow repetitive photostations, and 15% of the deep photostations.

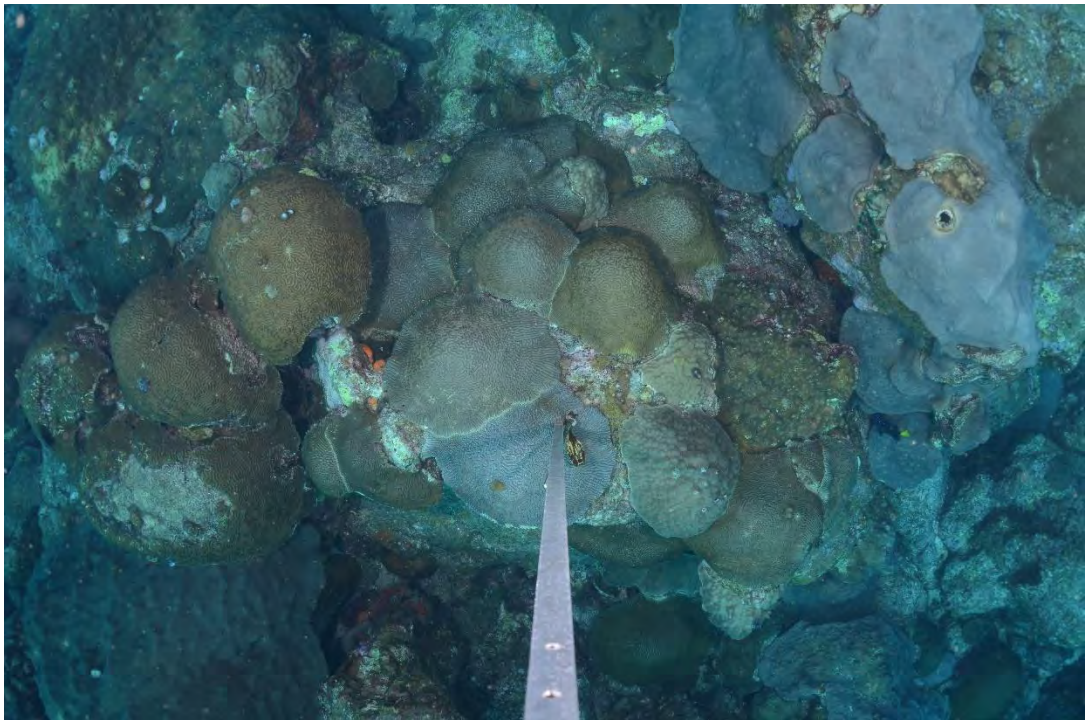
A follow-up cruise was conducted in February 2017, and documented significant recovery of the coral colonies within the repetitive photostations with less than 10% of the corals still impacted on the shallow sites within the long-term monitoring study site at EFGB, and 5% of the coral colonies in the deep stations.



Repetitive photostation 102 at EFGB – July 2016. Healthy corals. Image credit: FGBNMS



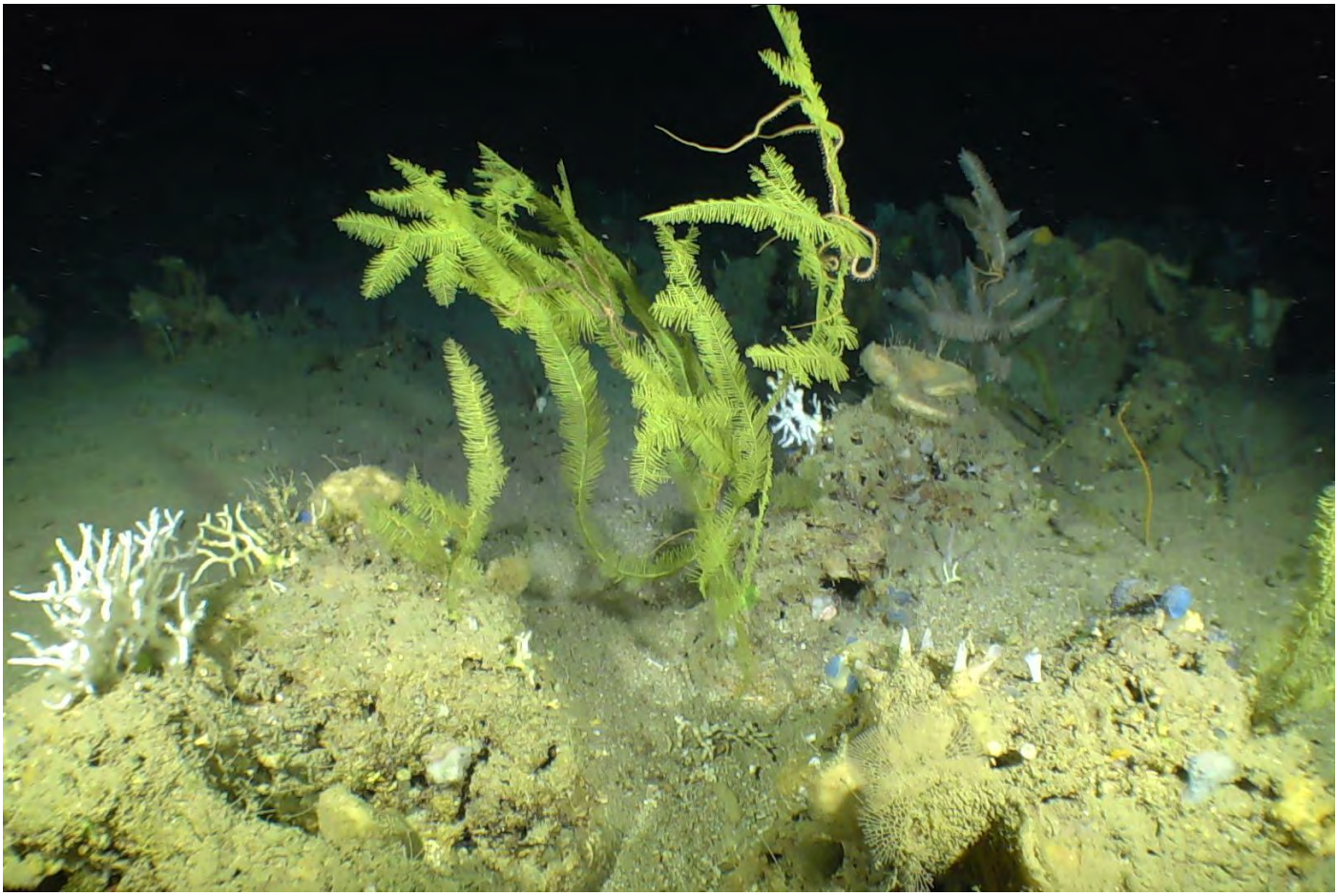
Repetitive photostation 102 at EFGB – October 2016. Bleached corals. Image credit: FGBNMS



Repetitive photostation 102 at EFGB – February 2017. The corals have re-recruited their symbiotic algae and made a recovery. Image credit: FGBNMS

Northwest Gulf of Mexico ROV Cruise

The FGBNMS conducted the 30th Deep Fish Habitat (DFH) cruise to survey mesophotic habitats at Parker, Rezak, Sidner, Bryant, Bouma, Tressler, and Elvers Banks in September 2016 . Participants from City University of New York (CUNY) and University of Texas Rio Grande Valley (UTRGV) joined FGBNMS and UNCW-Undersea Vehicle Program on the cruise. A total of 68 transects were completed during 28 dives – over 27 hours of video and 2800 images were collected. Twenty black coral and three octocoral samples were opportunistically collected. A potentially new species of black coral was documented at Elvers Bank. The sanctuary will work with Drs. Dennis Opresko and Mercer Brugler to confirm this. It will be targeted for collection during 2017 ROV operations. The cruise was supported in part by NOAA's Deep Sea Research and Technology Program, and the National Marine Sanctuary Foundation.



A potentially undescribed species of black coral was photographed at Elvers Bank during DFH30. Samples will be collected during 2017 ROV activities. Image credit: FGBNMS/UNCW-UVP

Women Divers Hall of Fame Coral Spawning Trip

The FGBNMS hosted an extraordinary group of divers from the Women Divers Hall of Fame (WDHoF) on board the M/V FLING, to witness the annual mass coral spawning event (August 25-28, 2016). FGBNMS Research Coordinator, Emma Hickerson, was inducted into the WDHoF in 2014, and invited the members to the sanctuary to showcase the stunning reefs. The divers visited all three banks (EFGB, WFGB, and Stetson Bank) within the sanctuary, as well as HIA389A - the platform at East Flower Garden Bank, and HI376A platform just outside the sanctuary boundaries. The corals spawned, and four mantas visited. Other sightings included spotted eagle rays, sandbar sharks, silky sharks, and a tiger shark. This experience was generously co-sponsored by the National Marine Sanctuary Foundation (NMSF) and Harte Research Institute (HRI). It was truly a privilege for the FGBNMS to host this wonderful group of women (and some men) - as a group of divers they have amassed an awesome number of close to 44,000 dives.

LIONFISH UPDATE

Table 1. Priority activities currently conducted by staff and partners at the Flower Garden Banks National Marine Sanctuary.

Category	Focus Area/Project	Brief Description
Monitoring	CRCP NCRMP	National Coral Reef Monitoring Program. Lionfish abundance and size conducted along reef-wide random belt transects.
	FGB Long-Term Monitoring	Lionfish abundance and size documented on Bohnsack fish surveys within study sites.
	Stetson Monitoring	Lionfish abundance and size documented on Bohnsack fish surveys within study sites.
	Citizen science reporting	Lionfish sightings reported to the Sanctuary through an online report form.
Control	Identify Priority Areas	Priority areas for lionfish control include buoyed areas on the FGBNMS reef cap.
	Permitting Mechanisms	Select individuals are authorized via a permit and letter of authorization to remove lionfish from priority areas.
	Targeted Removals	Staff and permitted volunteers are trained and issued permits to safely remove lionfish.
Research	Diet	Stomach contents analyzed from all lionfish fish removed from the FGBNMS.
	Ciguatera	Partner with NOAA, NCCOS, and FDA to test lionfish for ciguatera fish poisoning.
	Mercury	Lionfish screened for mercury levels at the FGB.

Category	Focus Area/Project	Brief Description
	Habitat Utilization	Collect data on density, distribution, and habitats utilized on shallow and deep reefs through diver surveys and ROV surveys.
	Age and Growth	Partner with NOAA, NCCOS, TAMU-CC, and TAMUG for otolith analysis.
	Tissue collection	Partner with TAMU-CC and UTB for genetic analysis and gene mapping.
	Gulf Mapping	Partner with TNC for GIS analysis and map products documenting a time series of the Gulf of Mexico invasion.
Education & Outreach	Training and Handling Workshops	Partner with REEF, Houston Zoo, and Texas State Aquarium to host lionfish safe handling workshops.
	Lionfish messaging	Development of messages and facts incorporated in presentations given to dive clubs and community organizations. Work with local schools on "Host a Lionfish" in your classroom week.
	Partnerships	Key partners to date have included Fling Charters, REEF, NOAA NCCOS, TX State Aquarium, TAMU-CC, TAMUG, UTB, The Nature Conservancy, the FDA, Haven, and The Houston Zoo.
	Special Events	Host Ocean Discovery Day and partner with Houston restaurants to hold special lionfish dinner events.
	Outreach Materials	Develop facts sheets and sighting forms. Partner with Moody Gardens on aquarium exhibits.

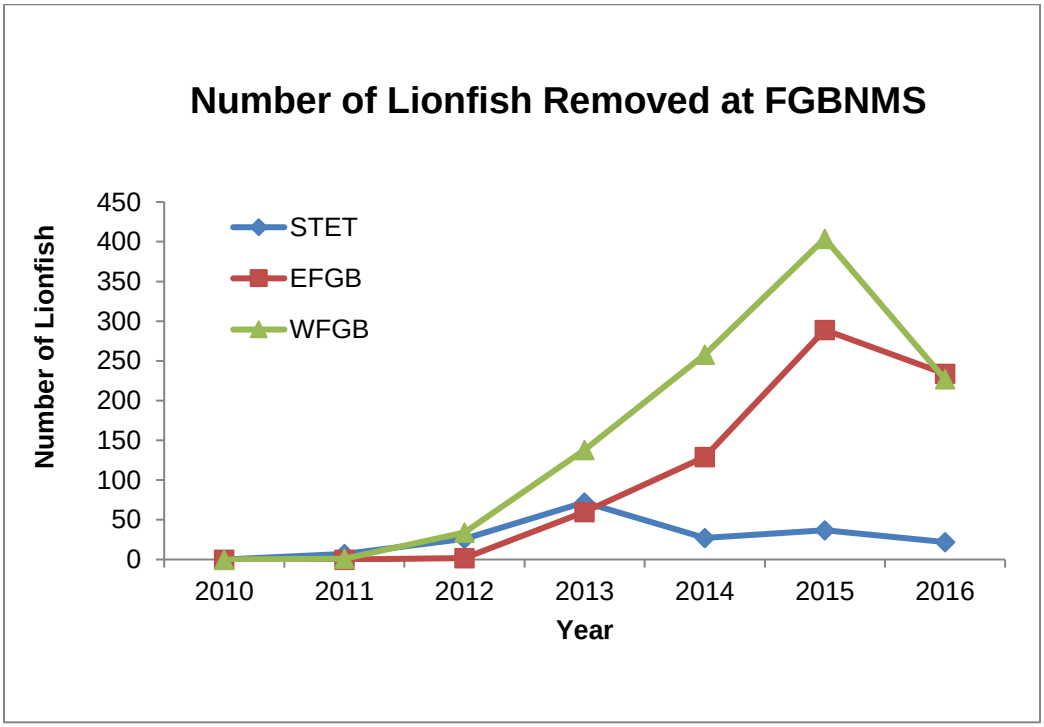
Lionfish were first observed in the FGBNMS in 2011. Since that time, researchers have been studying lionfish diet through stomach content analysis and providing data and samples for age/growth, genetic, and ciguatera studies (Table 1) as part of the FGBNMS Lionfish Program. While fish biomass at FGBNMS remains high, the invasion is still in the early stages, and negative impacts on the reef community may not be seen for several years.

FGBNMS currently works to remove lionfish when possible, and the second annual FGBNMS Lionfish Invitational was held on board the *M/V FLING* in partnership with Reef Environmental Education Foundation (REEF), the National Marine Sanctuary Foundation, Fling Charters, Ripley's Aquarium, and Oregon State University (OSU). The Lionfish Invitational used trained volunteer divers to help conduct research and remove invasive lionfish within the marine sanctuary on August 29– September 1, 2016. Collection permits were issued for 30 divers participating in the four-day lionfish

research cruise. Reef fish surveys were conducted and lionfish were removed and dissected as part of the on-going lionfish research and management program at NOAA. The skilled group of divers removed a total of 396 lionfish despite rough conditions offshore, helping to protect and save 1-2 million native reef fish that would have been prey for lionfish within the next year at FGBNMS. More research and management strategies are needed to control the population and to understand control targets and other effective control mechanisms that would minimize ecosystem-level impacts. To date, approximately 2,000 lionfish have been removed from sanctuary waters. The most common identifiable gut contents include crustaceans (46%), wrasses (8%), blennies (3%), and damselfishes (3%). Samples from removal cruises have helped determine through genetic analysis that lionfish at FGBNMS are of the species *Pterois volitans* (Johnson et al. 2016).

Sanctuary staff are tracking the invasion at FGBNMS and surrounding banks by documenting the locations of lionfish removals and observations. These observations include sightings using SCUBA and during ROV surveys in deep water habitat. Lionfish sighting forms (on the FGBNMS website) are available for recreational divers to report sightings and submit pictures.

More about Lionfish: http://flowergarden.noaa.gov/education/invasivelionfish.html



Number of lionfish removed from each bank within the FGBNMS between 2010 and 2016. Credit: FGBNMS/Johnston

CRUISES and EXPEDITIONS

11/3-4/15 Water Quality - instrument change out
2/16-17/16 Water Quality - instrument change out
5/31-6/2/16 HIA389A - Fish Densities – Bioacoustics with NCCOS
6/6-10/16 Stetson Bank Long-Term Monitoring - repetitive photostations, random benthic and fish surveys, video surveys, water quality instrument change out sampling
7/25-28/16 East FGB Long-Term Monitoring - repetitive photostations, random benthic and fish surveys, video surveys, water quality instrument change outs
7/31-8/2/16 EFGB Mortality Event Rapid Response - random benthic and fish surveys, water quality instrument installation, biological sampling
8/11-12/16 WFGB Long-Term Monitoring - repetitive photostations, random benthic and fish surveys, video surveys, water quality instrument change outs
8/25-26/16 Coral Spawning, Marine Biological Observation Network ops. Water sampling, biological sampling
8/31-9/1/16 Lionfish Invitational – M/V FLING
9/4-8/16 DFH30 – NWGOM ROV
9/11-15/16 DFH31 – E&W and SB Mesophotic Monitoring

FGBNMS Divers participated in the following projects and cruises:
8/25-28/16 WDHoF Coral Spawning Cruise – M/V FLING
9/10-11/16 Sanctuary Advisory Council Cruise – M/V FLING

R/V MANTA. Image credit: FGBNMS/Schmahl

ADDITIONAL *R/V MANTA* CRUISES

The *R/V MANTA* was chartered by several different user groups during the 2016 research season.

5/3-7/16 CIOERT Technical Diving I
5/22-28/16 UTIG
7/17-21/16 SCRIPPS Acoustic Research Cruise
9/19-21/16 NRL Mooring Recovery
9/26-30/16 CIOERT Technical Diving II

Texas A&M University deployed and recovered several Slocum Gliders over the course of the year. Image credit: FGBNMS/Schmahl

ADDITIONAL SCIENCE ACTIVITIES

1. Deployment of Sound Trap
2. Development of Draft Environment Impact Statement
3. Permitting
4. Scheduling of *R/V MANTA*
5. Coordination of SCUBA operations
6. Coordination of shipboard research equipment and activities
7. Submitted NOAA fleet shiptime requests and needs
8. Regional GIS support
9. Science presence at SAC meetings
10. Participation in NOAA Coral Collaboration calls
11. Participation in NOAA Deep Sea Coral calls

Spawning *Diadema antillarum*. Image credit: FGBNMS/Schmahl

SCIENTIFIC INTERPRETATION/OUTREACH

2016 original 12'x6' mural by Jacqui Stanley– Shallow reefs of the FGBNMS. 2016 Final mural – Shallow reefs of the FGBNMS. Ocean Discovery Day participants replicated a portion of the original mural.

1. Ocean Discovery Day – Shallow Reefs of the FGBNMS
2. Contribution to digital slide catalog/library
3. Contribution to video library, including annotations
4. Development of PowerPoint presentations for various events
5. Facebook postings
6. Web-based research reports and blogs
7. Response to "Into the Sea" mail (Hickerson)
8. Collection of 360 degree imagery (Hickerson)
9. Presentations include Seaside Chats and lionfish dissections

2016 Final mural – Shallow reefs of the FGBNMS. Ocean Discovery Day participants replicated a portion of the original mural on an 8"x8" canvas – a total of 162 individuals, mostly children, contributed a square to create this 12'x6' mural.

CONFERENCES, MEETINGS, PRESENTATIONS, TRAINING, ETC.

1. Deep Coral Southeast Region Initiative – Scoping. Emma Hickerson, St. Petersburg, FL. November 18-20, 2015
2. Primer Statistics training – January, 2016. Marissa Nuttall, Michelle Johnston, John Embesi
3. NOAA DiveMaster Training – January, 2016. Marissa Nuttall
4. TX LoneStar Lionfish Symposium – Feb 3-4, 2016. Michelle Johnston, Corpus Christi
5. TX Invasive Species Conference – Mar. 10, 2016. Michelle Johnston, Sam Houston State University
6. Joint Ocean Initiative Cooperative – New Orleans, LA – May, 2016. Emma Hickerson
7. 13th International Coral Reef Symposium – June 19-24, 2016. Michelle Johnston. Honolulu, Hawaii
8. 6th International Deep Sea Coral Symposium – September 11-16, 2016. Emma Hickerson. Boston, MA
9. NOAA Deep Sea Coral Research and Technology Program SE Region Planning Meeting – September 27-28, 2016. Emma Hickerson, G.P. Schmahl. Charleston, SC
10. 69th Gulf and Caribbean Fisheries Institute Conference – November 7-11, 2016. Raven Walker presented poster for Michelle Johnston. Grand Cayman.

ABSTRACTS AND PUBLICATIONS

Barfield, S., Aglyamova, G.V. and Matz, M.V. 2016. Evolutionary origins of germline segregation in Metazoa: evidence for a germ stem cell lineage in the coral *Orbicella faveolata* (Cnidaria, Anthozoa) *Proc. R. Soc. B 283: 20152128* http://dx.doi.org/10.1098/rspb.2015.2128

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Johnston MA, Eckert RJ, Sterne TK, Nuttall MF, Hu X, Embesi JA, Hickerson EH, Schmahl GP. 2016. Long-Term Monitoring at East and West Flower Garden Banks: 2015 Annual Report. U.S. Marine Sanctuaries Conservation Series ONMS-16-02. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Flower Garden Banks National Marine Sanctuary, Galveston, TX. 86 pp.

Johnston MA, Lemm A, Hogan D, Nuttall MF, Walker R, Hickerson EH, Schmahl GP. 2016. The Effects of Lionfish at Flower Garden Banks National Marine Sanctuary in the Northwest Gulf of Mexico. 69th GCFI. Grand Cayman.

Johnson JE, Bird CE, Johnston MA, Fogg AQ, Hogan JD. 2016. Regional genetic structure and genetic founder effects in the invasive lionfish: comparing the Gulf of Mexico, Caribbean and North Atlantic. Marine Biology. 163: 216.

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Munoz, R., Clark, R., Hickerson, E.L. Fish community structure from shallow and upper mesophotic zones of Flower Garden Banks National Marine Sanctuary (FGBNMS), a remote US coral reef. 13th International Coral Reef Symposium. Honolulu, HI. June, 2016.

Munoz, R., Clark, R., Hickerson, E.L. Fish community structure from shallow and upper mesophotic zones of Flower Garden Banks National Marine Sanctuary (FGBNMS), a remote US coral reef. 13th International Coral Reef Symposium. Honolulu, HI. June, 2016.

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Sammarco PW, Nuttall MF, Beltz D, Hickerson EL, and Schmahl GP. 2016. Patterns of Mesophotic Benthic Community Structure on Banks Off vs Inside the Continental Shelf Edge, Gulf of Mexico. Gulf of Mexico Science, 2016(1): 77-92

Schmahl, G.P., Benson, K., and Hickerson, E.L. The identification and use of marine protected areas for conservation, management and restoration of coral reefs and coral communities in the northern Gulf of Mexico. 13th International Coral Reef Symposium. Hololulu, HI. June, 2016.

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Brittlestar arms draped over a tube sponge at Stetson Bank. Image credit: FGBNMS/Nuttall

FUNDING

Seabird Instruments – Damage Assessment Funds - $36,483.89
East and West FGB LTM – BOEM - $152,000
HIA389A – BSEE - $229,117
SBLTM – BSEE - $247,497
NOAA Deep Sea Coral Research and Technology Program (DSCRTP) - $35,000 – NWGOM Habitat Characterization maps – Travis/Marissa
NOAA DSCRTP - $28,000 – NWGOM ROV Cruise
ONMS Headquarters – OAR Funds - $10,000 Mortality Event Response
NOAA Regional Office - $7,500 Mortality Event Response
Ripley's Aquarium - $5,000 Lionfish Invitational Cruise
National Marine Sanctuary Foundation (NMSF) – CSL Maritime SA - $5,000 Long Term Monitoring Supplies
NMSF – CSP Gulfstolt - $30,140 - East and West FGB Long-Term Monitoring
NMSF – CSP Gulfstolt - $9,500 – Women Divers Hall of Fame Coral Spawning Cruise
NMSF – CSP Gulfstolt - $40,925 – Northwestern Gulf of Mexico ROV cruise
NMSF – Chandris - $14,570 – East and West FGB LTM Deep ROV Surveys
NMSF – Rowan - $5,116 – Long-Term Monitoring Water Quality Analysis

NEW SANCTUARY BIOLOGICAL RECORDS

Mithrodia clavigera – Stetson Bank, Brandi and Steve Miller

First record of *Mithrodia clavigera* at FGBNMS. Image credit: Brandi and Steve Miller

2016 PERMITS ISSUED and permit activity

FGBNMS-2011-002 Ken Bush (M/V FLING) – removal of lionfish

FGBNMS-2014-001 G.P. Schmahl (FGBNMS) – removal of invasive species, sample collection for mortality event response, long-term monitoring activities, placement of water quality instruments, installation of acoustic receivers and soundtraps

FGBNMS-2014-014 Dr. Josh Voss (Florida Atlantic University) - Characterization of mesophotic corals through genetic connectivity assessment and a reciprocal transplant experiment

FGBNMS-2015-001 Josh Stewart (SCRIPPS) - Manta tissue sampling
FGBNMS-2016-001 Kevin Rademacher (NMFS Pascagoula) SEAMAP 2016. Drop camera, vertical long line sampling.

FGBNMS–2016–002 Dr. Adrienne Simoes-Correa (Rice University) - Assessment of the distribution of two common bioeroders in the northwest Gulf of Mexico.

FGBNMS-2016-003 Dr. Benjamin Titus (Ohio State University) - Abundance and distribution of sea anemone symbioses on the coral reefs of the Flower Garden Banks.

FGBNMS–2016–004 Dr. Joe Kuehl (Baylor University) – Micro-movement of water at the FGBNMS, deployment of tilt current meters.

FGBNMS-2016-005 Dr. Frank Muller-Karger (University of South Florida) – Marine Biodiversity Observing Network – collection of coral spawn.

FGBNMS–2016–006 REEF – removal of lionfish during Lionfish Derby on MV FLING

An octopus (*Octopus vulgaris*) and midden. Image credit: FGBNMS/Schmahl

2016 RESEARCH STAFFING

1. Ryan Eckert, Research Assistant (left staff in December, 2016)
2. John Embesi, HIA389A Project Manager, Research Assistant
3. Emma Hickerson, Research Coordinator
4. Michelle Johnston, FGBLTM Project Manager
5. Marissa Nuttall, Stetson Bank Project Manager
6. G.P. Schmahl, Sanctuary Superintendent
7. Travis Sterne, Research Assistant
8. Raven Walker, Research Assistant (joined staff in 2016)

R/V MANTA core crew –services provided by Shetler Marine, Inc., owned and operated by Captain Michael Shetler, and Cardinal Point Captains.

1. Captain Michael Shetler/Captain Seth Leo
2. First Mate Michael Allison
3. Deck Brett Mayberry/Gerry Amador
4. Galley multiple personnel

FGBNMS NOAA Divers:

1. Adrienne Simoes-Correa (NOAA diver training - September, 2016)
2. Kelly Drinnen
3. Ryan Eckert (left unit in December, 2016)
4. John Embesi
5. Emma Hickerson (Unit Diving Supervisor)
6. Michelle Johnston
7. Marissa Nuttall
8. Dustin Picard
9. G.P. Schmahl
10. Michael Shetler (left unit in June, 2016)
11. Raven Walker (NOAA diver training – September, 2016)

The NOAA Dive Program supports our research and science interpretation efforts through access to training, equipment, and leadership.

A loggerhead sea turtle (*Caretta caretta*) rests on a sand patch within the mortality zone at the E FGB. Image credit: FGBNMS/Hickerson

For more information contact:
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