Coral reef condition: A status report for the FLOWER GARDEN BANKS

NOAA
CORAL REEF
CONSERVATION PROGRAM

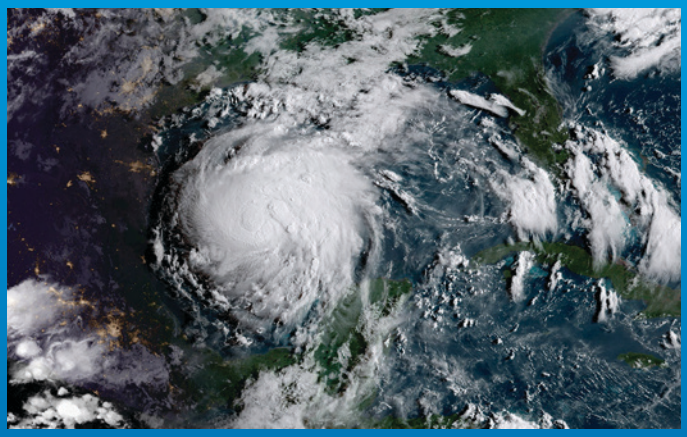
THE RESILIENCE OF ONE REEF IN A CHANGING WORLD

One hundred miles from the nearest beach in the Gulf of Mexico, Flower Garden Banks, a vast expanse of reef habitat, sits just below the ocean surface. These reefs are teeming with marine life and densely covered by large corals. Corals continue to thrive at Flower Garden Banks for three critical reasons:

1. Distance from the shore reduces some human impacts such as water quality degradation;
2. Its reefs sit in deeper, cooler waters than many coastal reefs, making corals less susceptible to events like coral bleaching; and,
3. The Flower Garden Banks are a designated national marine sanctuary, a status that offers additional protections to the benthic habitat such as enforcement of bans on anchoring, discharge, and bottom-impacting fishing activities.

While it benefits from isolation, this reef is not immune to the impacts other reefs across the globe experience today. Coastal runoff from extreme rain events, illegal fishing, and vessel anchoring still occur. Shifts in water temperature may induce bleaching events, and invasive species threaten the region's delicate food web dynamics. Yet, Flower Garden Banks has shown remarkable resilience to such impacts, and its protected status allows that resilience to endure.

Top: A school of Brown Chromis swim above a coral reef in Flower Garden Banks; Bottom: A diver collects coral reef monitoring photographs along transect tape.



Hurricanes help to shape the reefs on the Flower Garden Banks. Through direct observations after major hurricanes have passed close to the Flower Garden Banks National Marine Sanctuary, it is now generally acknowledged that these severe events are driving forces behind the general shaping of the reefs in the sanctuary. Mushroom heads are toppled, opening up reef space for recruitment, large barrel sponges are sheered, and yellow pencil coral fields that collapse in place recover over the subsequent years.

Left: ***A satellite image of Hurricane Harvey over the Gulf of Mexico in 2017. Photo: NOAA.***

BLUE = general historic/government events and governance

LIGHT BLUE = governance related to marine/reef management

1900's
Fishermen report the existence of the Flower Garden Banks.

1936
The U.S. Coast and Geodetic Survey confirms the existence of Flower Garden Banks.

1950
First contour map of FGB published.

1953
Oceanographer Henry Stetson discovers live corals on the banks.
Photo: Jan Hahn/Woods Hole Oceanographic Institution.

1960
First diving expedition.

1974
Bureau of Land Management sets up protection zones to shield FGB from direct impacts of oil and gas activity.

1976
Discovery of East Flower Garden Brine Seep.

1977
FGB nominated for sanctuary status.

1981
Oil and gas platform HIA-389-A constructed next to the East FGB.

1983
Region-wide die off of Long Spined Sea Urchins.

1984
FGB added to Site Evaluation List for sanctuary status after noted damage from anchored tug boat.

1985
Oil field service vessel anchored at bank; iconic book "Reefs and Banks of the Northwest Gulf of Mexico" published.

1988
Long-term reef monitoring begins on FGB, continues to this day.

1990
First mass spawning of corals reported at FGB; FGB's first recorded bleaching event occurs.

1992
NOAA designates the FGB National Marine Sanctuary.

REEFS ARE UNDER THREAT

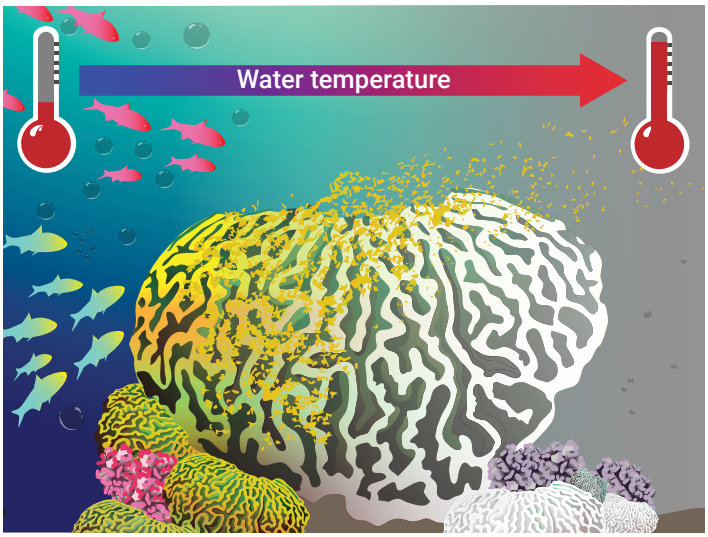
While relatively cooler waters and greater depth shield the reefs of Flower Garden Banks somewhat from human impacts, they are still subjected to stressors stemming from both climate change and invasive species.

Climate Change

Climate change is considered the greatest global threat to coral reefs. Human-induced greenhouse gas emissions are accelerating ocean warming, and as a result, mass coral bleaching events and disease outbreaks are becoming more frequent. Warmer oceans increase the likelihood of more frequent and intense hurricanes, which also amplifies impacts to reefs. Excess carbon dioxide absorbed by the oceans alters seawater chemistry by decreasing the pH, impacting the ability for corals to calcify and build reefs. Even with the remote location of Flower Garden Banks, coral bleaching and the spread of disease remain major management concerns. In 2005, 2010, and 2016, Flower Garden Banks suffered major bleaching, though without significant mortality. Fortunately, so far they have been spared a major disease outbreak.

Invasive Species

Several invasive species have been reported at Flower Garden Banks National Marine Sanctuary, including lionfish. Lionfish began appearing in the Gulf of Mexico in 2009, about 20 years after they entered the Atlantic as an invasive species. By July 2011, lionfish were observed on all three banks of the sanctuary. Lionfish have a voracious appetite, venomous spines, and reproduce rapidly. Without any natural predators in the region, lionfish can overwhelm native fish and invertebrate populations.



Healthy corals have a symbiotic relationship with microscopic algae called zooxanthellae that live in their tissue. These algae produce the coral's primary food source and give them their color. When ocean water is too warm, corals expel their algae, rendering the coral tissue translucent and making the animal's white skeleton clearly visible. These events are called coral bleaching because its now stark white appearance makes it look as though the coral has been "bleached" of color (in addition to having lost its main food source). Corals can survive a bleaching event and recruit new algae, but repeated events cause stress and decrease colony health, leading to coral death.

WHAT YOU CAN DO TO HELP

Flower Garden Banks is a treasure in the Gulf of Mexico. Here are things you can do to help protect this important place:

- **Educate yourself about coral reefs and the creatures they support.**
- **Support your local aquarium.**
- **Don't stand on or touch live coral. Don't take pieces of corals home with you.**
- **Support initiatives that preserve and protect coral reefs.**
- **Reduce energy use and your carbon footprint.**
- **Only catch enough fish for you and your family. If you don't fish, choose seafood that is sustainably harvested.**

PINK = social/economic **GREEN** = biology and hurricanes

1995 Oil spill notifications mandated following spill risk assessments.

1996 Stetson Bank added to FGB National Marine Sanctuary.

1997 A new species, the Mardi Gras Wrasse, is first observed.

1998 Coral bleaching and recovery occurs at FGBNMS.

2002 First observation of potentially invasive Orange Cup Corals.

2003 Live elkhorn coral is discovered at West Flower Garden.

2005 Coral bleaching and recovery; Hurricanes Katrina and Rita strike the Gulf of Mexico.

2006 Fossil Acropora reefs discovered below current coral cap.

2008 The research vessel Manta begins service; another coral bleaching event occurs.

2010 Extensive coral bleaching occurs at FGBNMS; though corals recover.

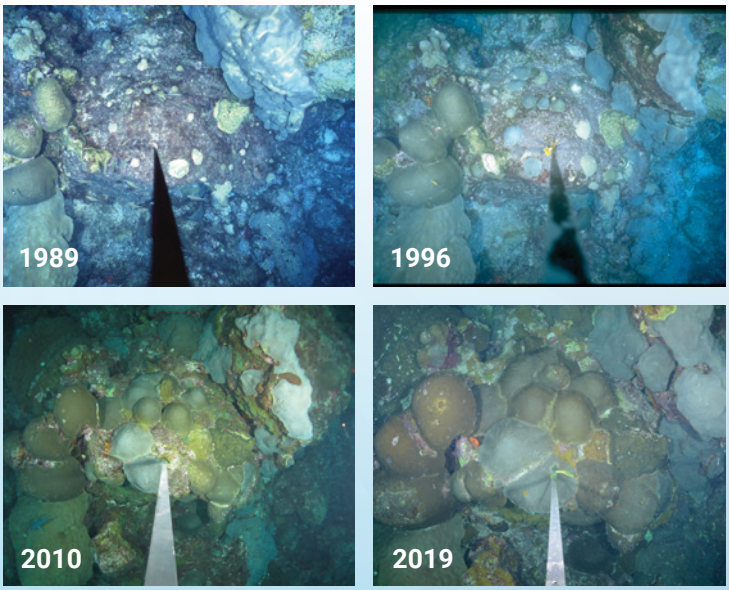
2011 Lionfish, an invasive species, first observed at FGBNMS.

2016 Localized mortality event occurs at East FGB; FGBNMS experiences coral bleaching and recovery.

2018 Upper 65ft of HI-A-389-A gas platform within boundaries of East FGB removed; the Regal Demoiselle, an exotic species, is sighted for the first time at FGBNMS.

TIME-LAPSE IMAGING HELPS MONITOR LONG-TERM CORAL GROWTH

Long-term coral reef monitoring was first established at Flower Garden Banks in 1988. Due to the close proximity of these reefs to oil and gas activity, the federal agency regulating this industry has been an active partner since monitoring began. In the subsequent three decades, regular and consistent monitoring shows that reefs within the selected one-hectare study sites have maintained high coral cover. This high coral cover continues to support relatively diverse and abundant fish populations in addition to a variety of other marine species. Within the long-term monitoring study sites, such as in the example provided to the right, permanent photostations have provided a time-lapse sequence of images from 1989 to 2019.



This series, taken from a photostation at East Flower Garden Bank, documents increasing coral cover over time. Images are from 1989 (top left), 1996 (top right), 2010 (bottom left), and 2019 (bottom right).

Top: A manta ray shows its distinct underbelly pattern; Bottom: A loggerhead sea turtle observed in the sanctuary.

GIANTS ROAM THE REEF

Flower Garden Banks is home to both year-round and seasonal megafauna—a category of large, charismatic animals that include sea turtles, manta rays, spotted eagle rays, and sharks. Loggerhead sea turtles (***C. caretta***) can often be spotted coming up for air or resting underneath complex coral structures. Approximately 20 species of sharks and rays can be found within the sanctuary as well. Schooling scalloped hammerhead sharks (***S. lewini***) and spotted eagle rays (***A. narinari***) are wintertime visitors, while summer months usually bring whale sharks (***R. typus***), the largest fish in the ocean with a typical length of over 30 feet (9m). Manta rays (***M. birostris***) that regularly frequent the sanctuary are easily identifiable via unique underbelly markings (think of it as a fish "fingerprint"). Approximately 100 individual manta rays observed within the sanctuary have been photographed and catalogued to date as part of an ongoing project, and both researchers and recreational SCUBA divers are encouraged to submit their images to help photo-tag and track manta rays roaming the national marine sanctuary.

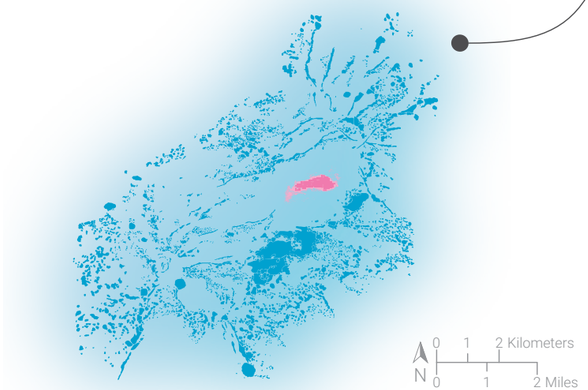
FLOWER GARDEN BANKS CORAL REEFS ARE IN **GOOD CONDITION**

The East and West Flower Garden Banks are submerged topographic features off the shores of Texas and Louisiana in the Gulf of Mexico. Rising from over 150 m depth to 17 m below the sea surface, they harbor relatively deep coral reef ecosystems. They were first discovered in the early 1900's and designated as part of the Flower Garden Banks National Marine Sanctuary in 1992. This report combines data collected from both East and West Flower Garden Banks and evaluates their condition for corals & algae, fish, and climate. Human Connection indicators were not assessed as Flower Garden Banks are not immediately adjacent to a permanent human population. Overall, coral reefs within Flower Garden Banks are in good condition (score: 89%), meaning the reefs are lightly impacted overall. Coral & algae are in very good condition. Fish and climate are in good condition overall, meaning fish and climate indicators are lightly impacted. Reef material growth is in very good condition.

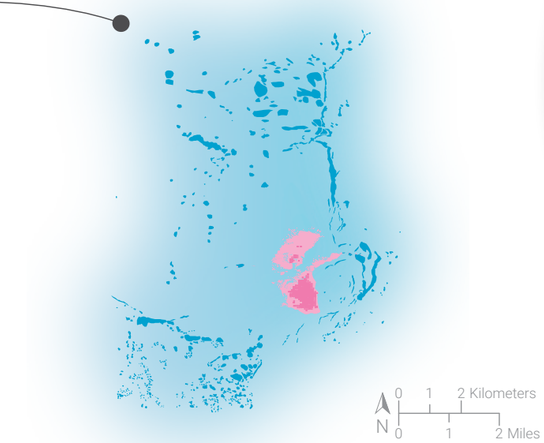
Since 1988, a complementary long-term monitoring program at the Flower Gardens National Marine Sanctuary has consistently tracked the status of these and other indicators. More information about the sanctuary itself and the data collected by sanctuary scientists can be found at https://flowergarden.noaa.gov/welcome.html.

Gulf of Mexico

WEST FLOWER GARDEN BANK



EAST FLOWER GARDEN BANK



What do the scores mean?

90–100% Very Good
All or almost all indicators meet reference values. Conditions in these locations are unimpacted, or minimally impacted or have not declined.

80–89% Good
Most indicators meet reference values. Conditions in these locations are lightly impacted or have lightly declined.

70–79% Fair
Some indicators meet reference values. Conditions in these locations are moderately impacted or have declined moderately.

60–69% Impaired
Few indicators meet reference values. Conditions in these locations are very impacted or have declined considerably.

0–59% Critical
Very few or no indicators meet reference values. Conditions in these locations are severely impacted or have declined substantially.

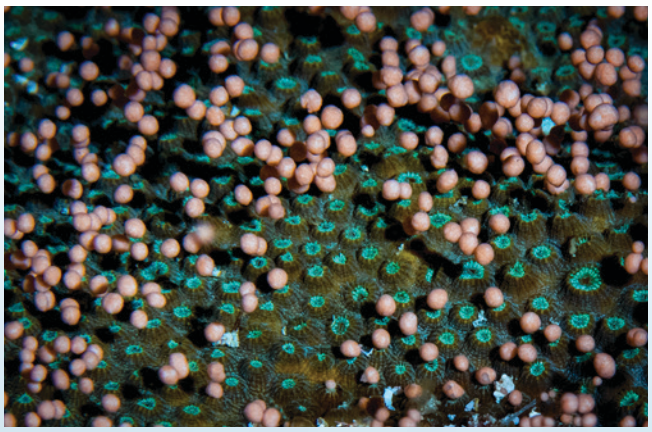
Insufficient Data
Not scored.

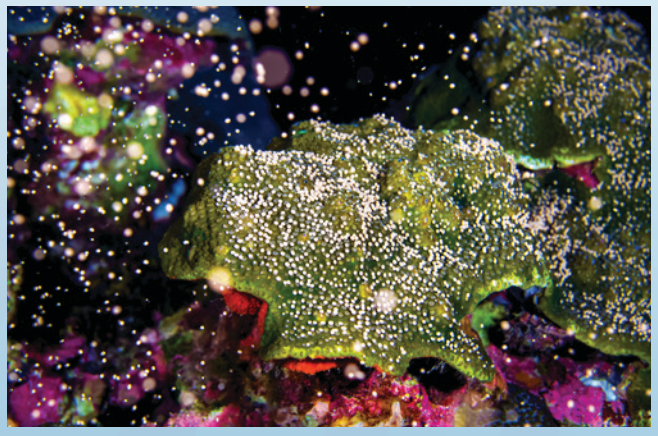
Whenever we conduct ecosystem assessments, we need to determine an appropriate baseline to make comparisons against current data. Ideally, we would assess the state of coral reef ecosystems by comparing current information to data collected before coral reefs were facing the impacts of climate change, overfishing, and pollution. Unfortunately for many reefs, data were only recently collected, and such comparisons cannot be made. Data used in this status report from 2014 to 2018, as well as information on reef conditions at Flower Garden Banks collected since the 1970's, suggest that with the exception of some fishing impacts, current reef conditions may largely reflect pre-industrial conditions. That scientists have to make several considerations before setting a historical baseline is reflective of the "Shifting Baseline" theory. Shifting baselines highlight the difficulty of interpreting change when we gauge the current state of an ecosystem against a prior baseline. There is the chance that the ecosystem we want to observe may have already changed, or "shifted", significantly between an earlier baseline and the one we have set. How far back we set our baseline depends on the amount of historical data available to make accurate comparisons.

HEALTHY CORALS SPAWN THE NEXT GENERATION

Each year, about 7–10 days after the August full moon, a massive coral spawning event occurs in Flower Garden Banks. Described as an upside down underwater snow storm, coral species will release their gametes in a synchronized display known as broadcast spawning. This, in addition to the sheer volume of gametes released, optimizes the likelihood of genetic diversity in the new generation of coral larvae. Some species release gamete bundles that encapsulate both egg and sperm, while other species have separate male and female colonies. Whether fledgling larvae disperse or settle near their parent reefs will depend on the direction and/or strength of the ocean current.

The cues that trigger coral spawning are not well understood, but it is fairly certain that the rhythm of the lunar and solar cycles, as well as changes in water temperature and ocean chemistry, play a role. Mass coral spawning was first observed at Flower Garden Banks in 1990. Since then, researchers have observed the event each year to collect more data on timing and species participation. Stressed corals do not have the energy to reproduce; so the presence of a predictable and abundant spawning event is a strong indicator of a healthy coral reef.





Top: An Orbicella star coral releases its gamete bundles during the mass spawning event; Bottom: Gamete bundles drift away from their parent corals.

KEY THEMES & INDICATORS

CORALS & ALGAE

Corals & algae make up the base of the coral reef ecosystem, providing food and shelter for fish, shellfish, and marine mammals. The indicators for corals & algae are:

- **Coral cover**, a measure of what percentage of the bottom (benthos) is living stony coral.
- **Macroalgae cover**, a measure of what percentage of the bottom (benthos) is macroalgae.
- **Crustose coralline algae (CCA) cover**, a measure of what percentage of the bottom (benthos) is crustose coralline algae.
- **Adult coral**, a measure of the density of reproductive age coral species.
- **Herbivory**, a measure of the level of grazing pressure by fish on corals and algae.
- **Mortality**, a measure of the amount of old dead coral skeleton exposed as scars on live coral colonies.
- **Diversity**, a measure of unique coral species present.

FISH

Coral reefs serve a vital ecological role for fish species. Fish are important to the ecology of the reef, the economy, and the livelihoods of local communities. The indicators for fish are:

- **Reef fish**, a region-specific measure of density for selected fish species.
- **Sustainability**, a measure of human-related fish mortality relative to natural fish mortality.
- **Diversity**, a measure of unique fish species present.

CLIMATE

Climate affects all components of a reef system. Climate change and ocean acidification influence reefs across the globe, but conditions vary at the regional and local level. The climate indicators are:

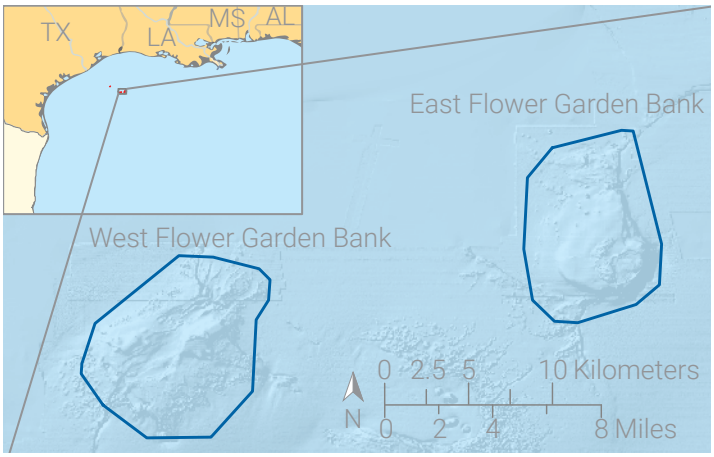
- **Temperature stress**, which evaluates the frequency and severity of high temperature events.
- **Ocean acidification**, which indicates if the water chemistry is suitable for the growth of corals and other calcifiers.
- **Reef material growth**, which is a calculated measurement of the yearly gain or loss of three-dimensional reef habitat.

THE SUCCESS OF NATIONAL MARINE SANCTUARIES

Flower Garden Banks National Marine Sanctuary was designated in 1992 to help protect the sanctuary's coral reef habitat and wildlife from adverse human impacts. The combination of location and geology makes Flower Garden Banks an extremely productive ecosystem. Salt domes push the seafloor up to within 17 meters (53ft) of the ocean surface. The sanctuary boundaries encompass a variety of habitats down to approximately 150 meters (500ft), and life flourishes at every depth, with a variety of reef fish, corals, and other marine invertebrates.

Massive boulders of brain and star corals flourish at Flower Garden Banks National Marine Sanctuary.

Despite a global decline in coral reef habitat, Flower Garden Banks continues to thrive thanks both to their remote offshore location and proximity to cooler waters from the deep. While these conditions shield this reef system somewhat from human impacts, Flower Garden Banks is not invulnerable. Therefore, continued observation and conservation of this habitat remains crucial as life on Flower Garden Banks still faces threats related to climate change, invasive species, water quality degradation, and unsustainable human activities.



NOAA is proposing to expand Flower Garden Banks National Marine Sanctuary to protect additional habitat in the northwestern Gulf of Mexico. Currently, the sanctuary protects three banks among dozens along the edge of the continental shelf. This expansion would help further conserve underwater habitat, endangered species, and nursery grounds for commercially viable fish.

WHY A STATUS REPORT?

Effective coral reef conservation cannot be accomplished without an informed and engaged public. This status report is part of an ongoing series of documents to track the status and trends of coral reefs across the U.S. and its territories. **The Flower Garden Banks coral reef status report is part of a larger effort to provide the public and decision-makers with information that helps us manage and conserve coral reef ecosystems.**

This status report provides a geographically specific assessment of Flower Garden Banks coral reef condition between 2014–2018. Data were collected by NOAA's National Coral Reef Monitoring Program. For more detailed information on methodologies, indicators, thresholds, and scoring, visit http://www.coris.noaa.gov (keyword: status reports).

Status report working group

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About this status report

This status report is a joint product of NOAA's Coral Reef Conservation Program (CRCP), Flower Garden Banks National Marine Sanctuary, and the University of Maryland Center for Environmental Science. Science communication, design, and layout by Nathan Miller, Caroline Donovan, Heath Kelsey, Max Hermanson, and Annie Carew. March 2020.

Acknowledgements

The CRCP supports effective management and sound science to preserve, sustain, and restore valuable coral reef ecosystems for future generations. For more information, visit coralreef.noaa.gov .All photos, from NOAA/Office of National Marine Sanctuaries/Flower Garden Banks National Marine Sanctuary unless specified otherwise. Cover photographed at East Flower Garden Bank in 2012 by George Schmahl.

Status report working group members at Flower Garden Banks National Marine Sanctuary offices in Galveston, TX.

The status report working group during the workshop in Silver Spring, MD in June 2019.

NOAA CORAL REEF CONSERVATION PROGRAM

University of Maryland CENTER FOR ENVIRONMENTAL SCIENCE