Bahamas Coral Reef Report Card

Volume 2: 2015-2019

Andros, Abaco, Grand Bahama, New Providence & Rose Island, Bimini, Eleuthera, Exumas, Cat Island, Cocneption Island, Long Island

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On the Cover

Photo of a coral reef at John Miller's Blue Hole.

Coral reefs provide a crucial source of food and income for people around the world.

Coral reefs are home to the highest biodiversity in The Bahamas.

Executive Summary

Coral reefs are home to the greatest diversity of life in the Bahamian archipelago and provide **critical ecosystem services that support a vibrant economy,** including tourism, fisheries and protection from coastal erosion. These reefs owe much of their value to the corals themselves, which are the architects and engineers of the reef, building reef structure that protects shorelines and provides habitat to marine life. Despite their inherent value for the ecology and economy of The Bahamas, coral reefs here have dramatically declined over the last 50 years as corals have been faced with increased threats that have local, national, regional and global impacts. The reduction of key species due to disease, fishing, and habitat loss have altered the function of marine ecosystems, weakening the resilience of coral reefs and preventing their recovery from hurricanes, bleaching events and damage from other threats.

The first steps to helping reefs recover is to assess their status; see how various threats have led to declines; and how protection and restoration can reduce or even reverse the decline of coral reefs. This report card examines these factors for Bahamian coral reefs over the past 5 years, from 2015 to 2019. When possible we compare current data with past information from the previous coral reef report card to see how reefs have changed over the past 5-10 years. While this report card really just scratches the surface regarding coral reef health in The Bahamas, we believe it provides a good overview to inform management decisions in a way that is accessible to experts and non-experts alike.

Perry Institute for Marine Science Executive Director, Dr. Craig Dahlgren, conducting a fish survey.

Introduction to Indicators

To better manage and protect Bahamian coral reefs, we must first understand how reef condition varies over space, time and under different threat levels. For the past decade, we have assessed the health of reefs throughout The Bahamas using Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocols, and have analyzed the data to look at specific indices of reef health, grading reef health on a scale from poor to good for each index and for a combined Bahamian Reef Health Index (BRHI). We also present case studies to: 1) show the impact of various threats to coral reef health, 2) highlight some of the strategies that have proven successful to improve reef health, and 3) inform some of the challenges facing The Bahamas moving forward.

Measures of Coral Reef Health

Benthic Index
The Benthic Index compares the proportion of a reef covered by live coral and organisms that promote reef growth versus the amount of reef covered by organisms that overgrow or kill corals.

Coral Condition Index
When a coral suffers natural stresses or human impacts, parts of the colony may die, or the entire colony may die. This index compares the average percentage of live coral tissue on colonies to dead coral on colonies >25 cm.

Coral Disease Index
Coral diseases are a major cause of coral loss on reefs. This index examines the prevalence of various diseases on coral reefs through belt transect surveys. Sites with the lowest percentage of disease-infected corals are the healthiest.

Coral Recruitment Index
Recruitment is measured as the number of new corals on a reef. While coral size varies among species, for this index recruits are considered as any coral <4 cm in diameter. Coral recruitment is crucial, as reef sites need to be replenished with new coral recruits to replace corals that die off.

Large Parrotfish Index
In The Bahamas, several parrotfish species (*Sparisoma spp.*) are the main grazers of seaweeds on coral reefs since the die-off of longspined urchins. This index examines the biomass of these parrotfish on reefs at each site.

Grouper Index
Large groupers are among the most important fishery species on reefs, and play an important role as predators, controlling populations of species that harm corals. This index examines grouper abundance at sites, with greater values assigned to larger fish (>40 cm) that can reproduce.

Bahamian Reef Health Index (BRHI)
The scores from the other indicators are combined to calculate the BHRI by assigning the grades of the other indicators a numberic score of 1-4 (Poor to Good), and averaging that score. This index is only calculated for sites with at least 5 of the other 6 indicators calculated.

Reef Scores

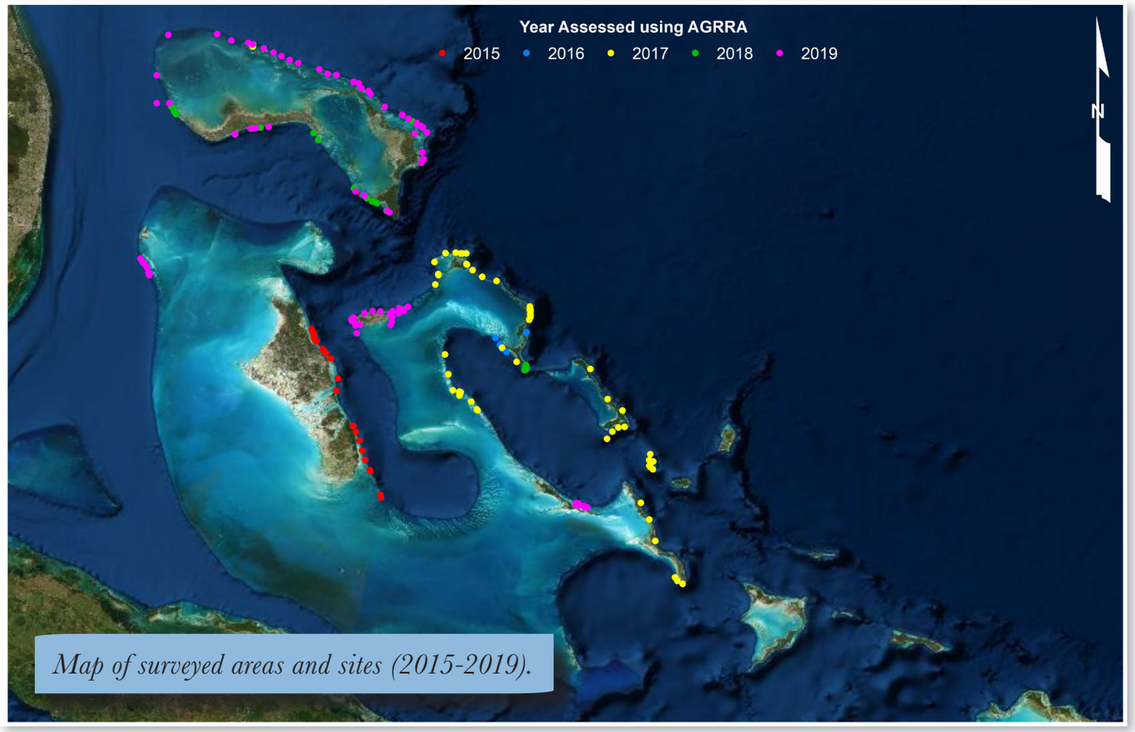
For each geographic area surveyed, index scores are displayed on maps using color-coded, circular graphs to show the proportion of reefs that received each score. The average score is depicted by the colour of the centre of the circle.

Evaluating Reef Health

Grading Scale

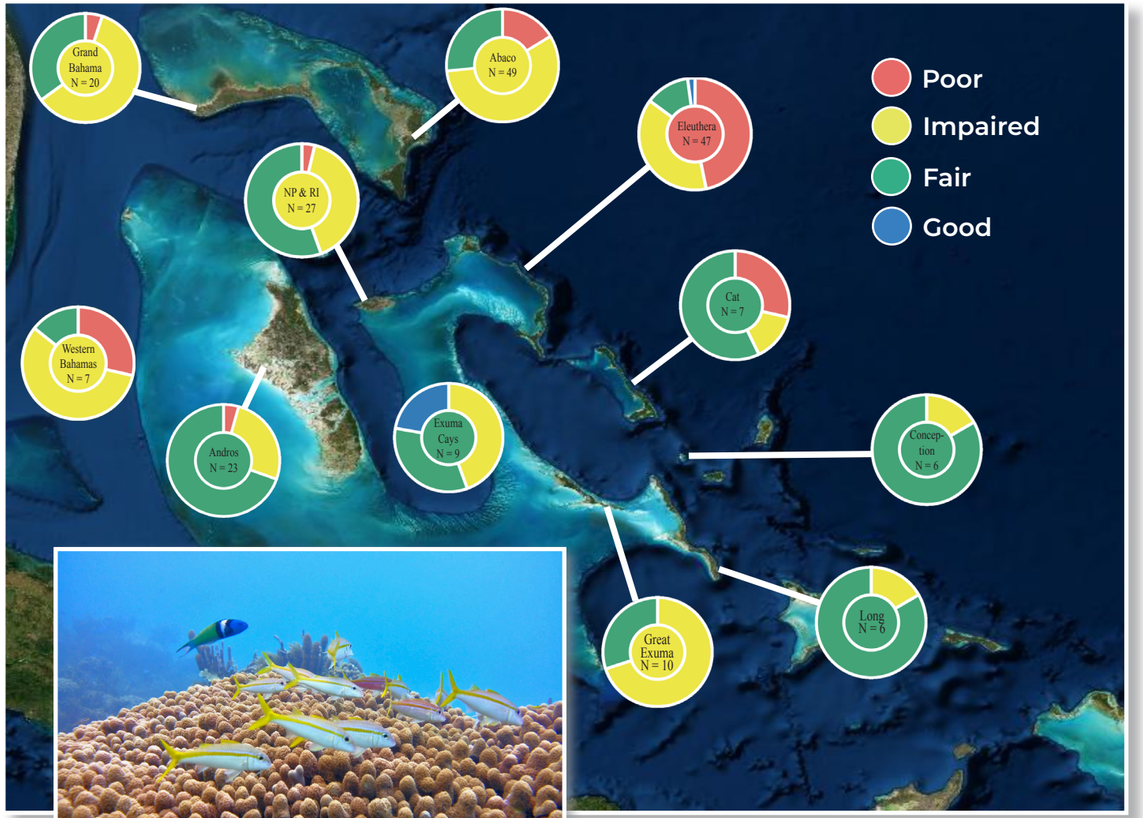
INDICATOR	POOR	IMPAIRED	FAIR	GOOD
Benthic Index	1	1.5–2	2.5–3	3.5-4
Coral Condition (% alive)	< 40	40–59	60–79	80–100
Coral Disease (% colonies)	> 5	5–2.5	< 2.5	0
Recruit Density (no./m^2)	< 4.0	4.0–7.9	8.0–11.9	12+
Large Parrotfish Biomass (g/100m^2)	0–500	501–1000	1001–500	>1500
Grouper Index	0–0.5	0.51–1.0	1.1–2.0	> 2
Bahamian Reef Health Index	1.0–1.75	1.76–2.5	2.6–3.25	3.26–4.0

Individual reef sites were scored on their condition for each indicator, with grades of Poor, Impaired, Fair, and Good. The condition of an indicator on any reef may reflect both environmental conditions and human impacts. For example, a reef may be poor due to natural limiting conditions, or it may have degraded from various human threats.



Map of surveyed areas and sites (2015-2019).

Benthic Index



Finger coral (Porites porites) was one of the most common brooding coral species in The Bahamas.

Coral Cover

Stressors – including the effects of coral bleaching due to climate change, disease, hurricanes, and chemical and nutrient pollution – have taken their toll on Bahamian coral reefs. Across nearly all of the sites, reef-building corals occupied less space on the reef than seaweeds that rapidly take over when corals die and ultimately prevent corals from re-establishing.

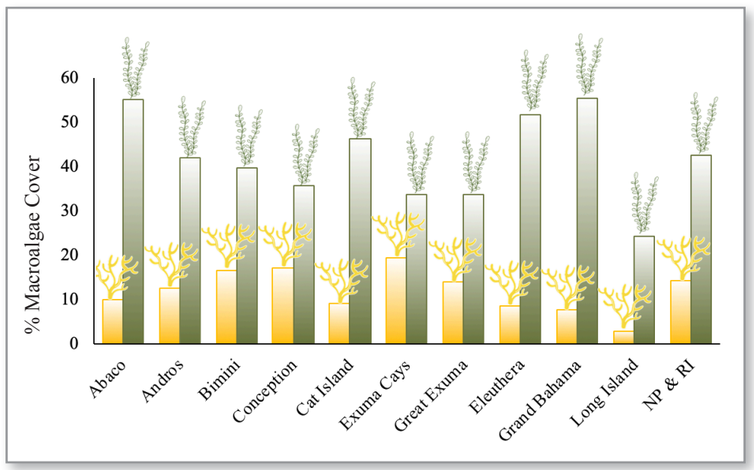
Benthic Index

In the map above, the benthic index compares the positive components of reefs that promote coral recruitment and growth (e.g., the relative amount of corals) to the abundance of seaweeds and other organisms that have a negative impact on corals. **Some of the sites with the highest coral cover, lowest amounts of seaweeds and highest benthic index scores are reefs in national parks**, like the Exuma Cays Land and Sea Park. Cumulatively, our benthic indices results from 1.67 million data points; that is, more than 11.5 km of surveyed seafloor.

AVERAGE CORAL COVER ON SURVEYED REEFS WAS JUST

11%

Reefs at John Miller's Blue Hole, off Eleuthera, had high coral cover.



*Macroalgae cover (green bars) has **increased** on coral reefs in The Bahamas compared to coral cover (yellow bars).*

>50% CORAL COVER ON MERMAID REEF & SANDY CAY REEF

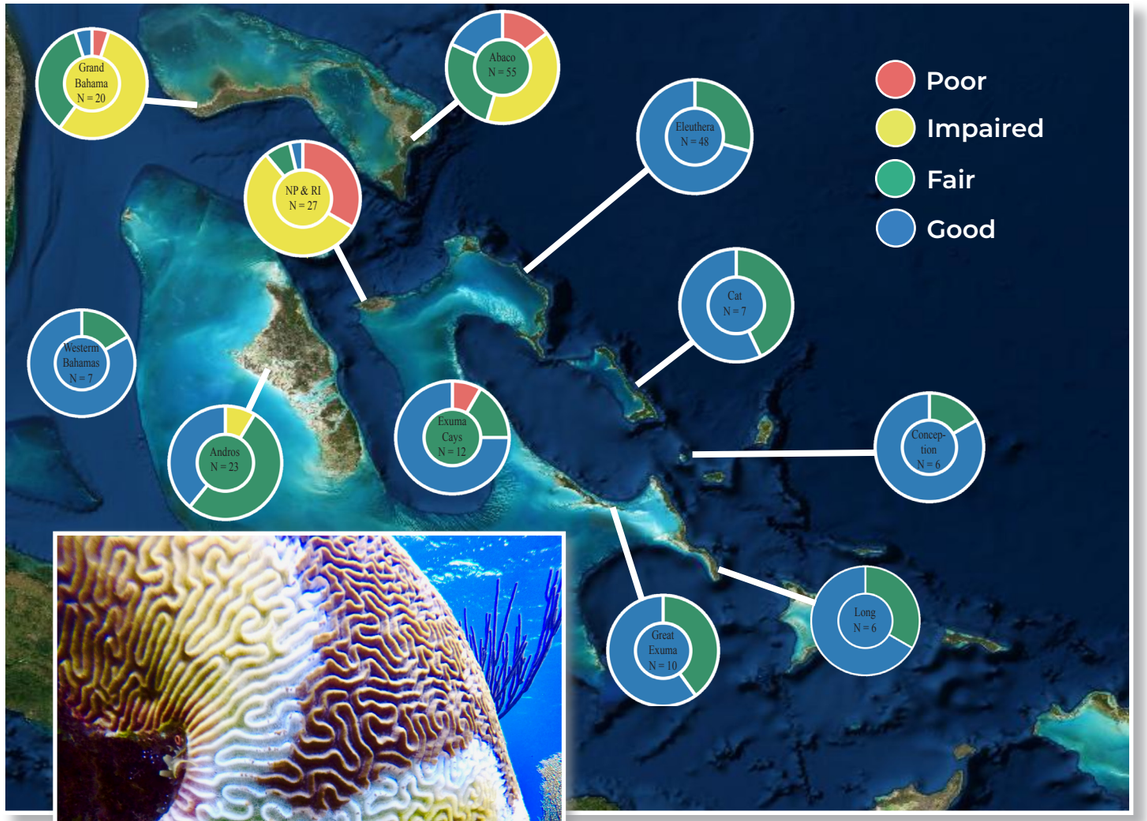
These two reefs, off-shore of Abaco, had the **highest** amount of live coral.

AVERAGE SEAWEED COVER WAS

46%

IN TOTAL, WE SURVEYED 11,670 m² OF SEAFLOOR

Coral Condition Index



A coral head with significant partial mortality.

Coral Condition

As coral colonies are affected by disease, temperature stress, predation, competition with other organisms, and other stressors, part of the colony may die. The coral condition index examines the amount of partial mortality averaged across all coral colonies surveyed on the reef. High rates of partial mortality may indicate higher stress levels or disease (past and present) for the corals.

Partial Mortality of Corals

Although overall **partial mortality was fairly low for most reefs**, with the majority of islands having corals that were over 60% alive on average, reefs off Grand Bahama, New Providence and Rose Island had higher rates of partial mortality among coral colonies. The amount of living coral left on a colony can vary between species. In The Bahamas, larger reef-building species like star corals (*Orbicella spp.*) and brain corals (*Pseudodiploria spp.*, *Diploria labrynthiformis*, and *Colpophyllia natans*) had the highest partial mortality rates.

>70 %

OF CORALS OFF GRAND BAHAMA HAD HIGH PARTIAL MORTALITY

BLEACHING & DISEASE CAN CAUSE TISSUE LOSS, BUT MAY NOT KILL THE COLONY ENTIRELY

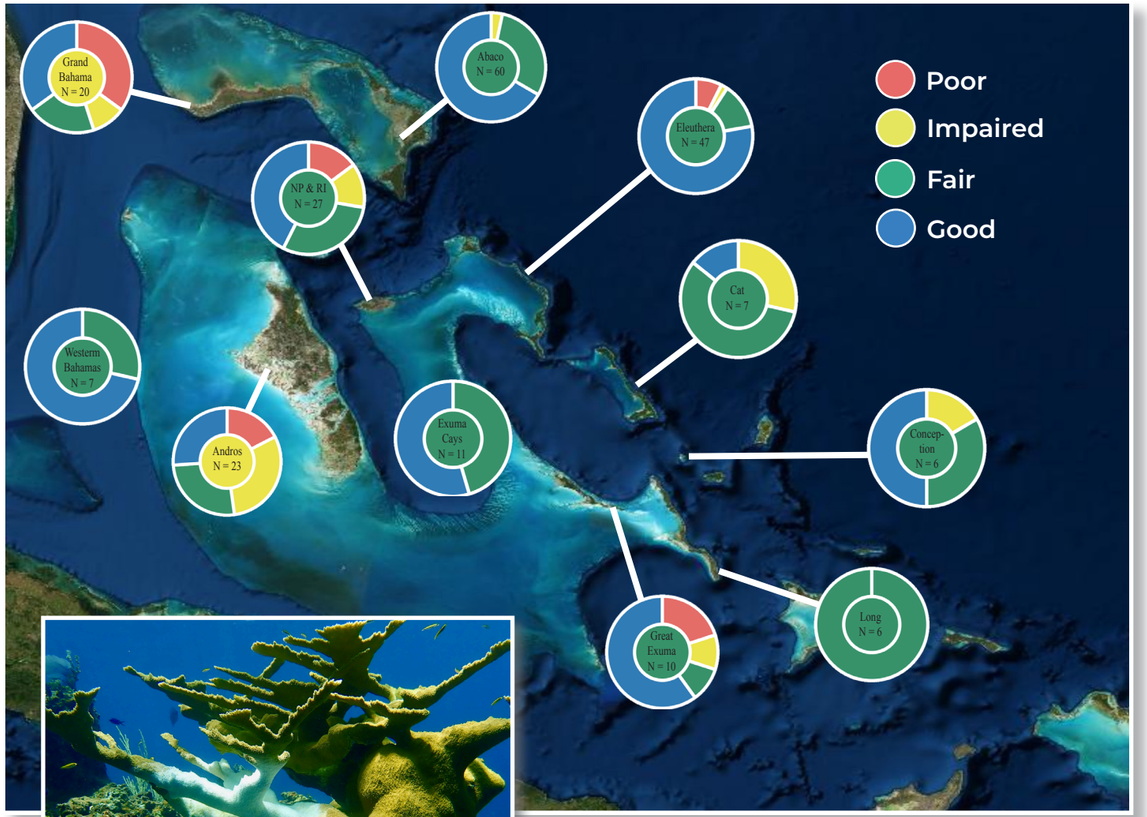
OFF NEW PROVIDENCE, CORAL AVERAGED

>44%

LIVE CORAL TISSUE

Brain corals *(inset) and* ***star corals*** *(pictured) had the highest rates of partial mortality.*

Coral Disease Index



White band disease caused significant partial mortality on this elkhorn coral.

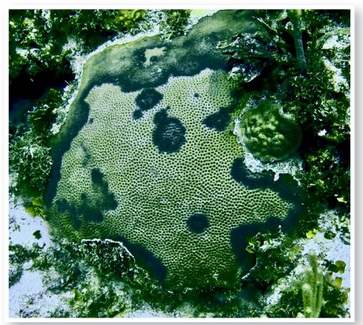
Coral Disease

Coral disease can be one of the greatest sources of partial mortality and whole colony mortality. During reef surveys in The Bahamas, eight different diseases were noted to varying degrees. The most prevalent diseases were Dark Spot Disease, which is not highly lethal and affects some of the more common coral species, and Black Band Disease, which affects massive corals and can cause significant mortality. Overall, disease rates were low in The Bahamas from 2015-2019 but a few sites showed concerning levels of disease. Andros had the greatest prevalence of disease, most of which was dark spot disease. Sites off New Providence and Grand Bahama had the highest rates of more lethal diseases like Black Band Disease. Some sites that were surveyed over multiple years showed outbreaks of disease in one year but lower disease rates in subsequent years.

Elkhorn coral (*Acropora palmata*) is critically endangered globally.

Their decline was mostly due to **White Band Disease; more than 3%** of elkhorn corals in The Bahamas were infected.

28,787
CORALS
SURVEYED



At 44% of sites, at least one disease was reported. Shown here, dark spot disease has ravaged a massive starlet coral.

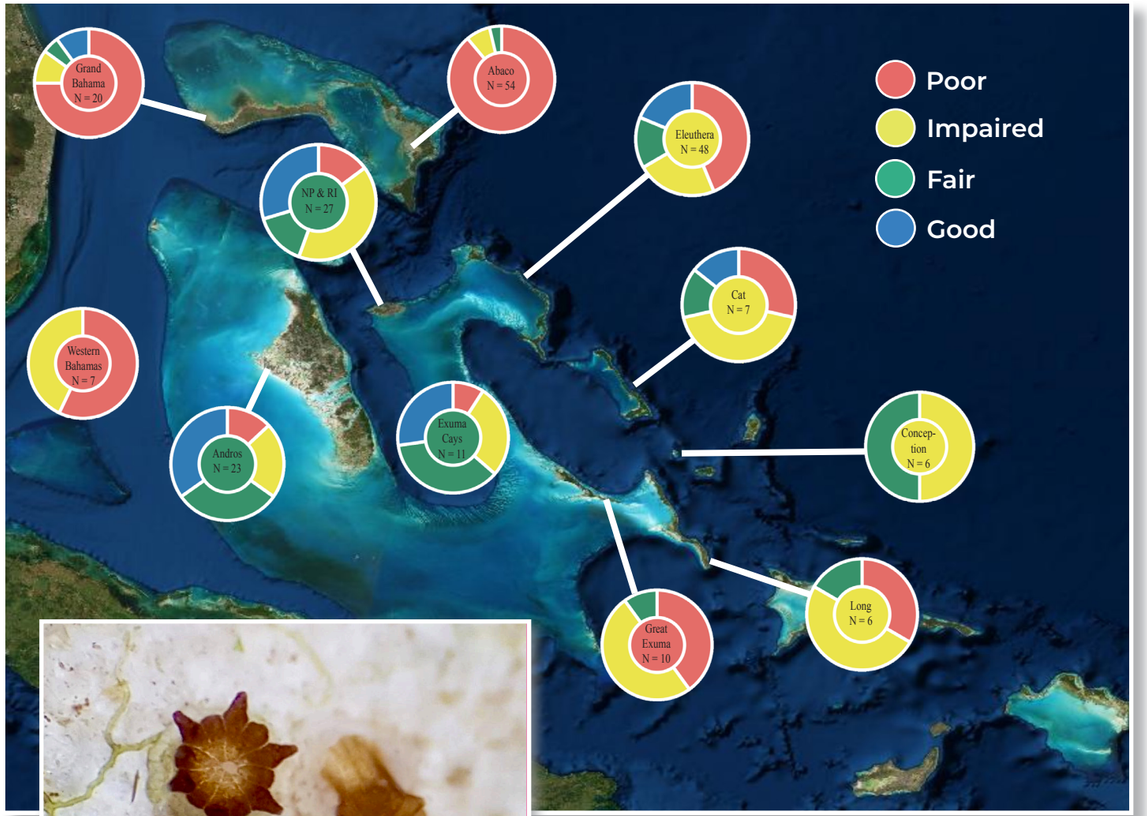
Black band disease present on symmetrical brain coral (Pseudodiploria strigosa) in The Bahamas.

Only **1.2%** of all corals surveyed showed signs of disease.

This was true across all surveys and sites.

DARK SPOT DISEASE INFECTED **~2%** OF LETTUCE CORALS

Coral Recruitment Index



A star coral recruit viewed under a microscope.

Coral Recruitment

Coral recruitment – that is, the addition of new juvenile corals to the population – is critical for maintaining healthy coral reefs. As corals die from bleaching, disease and other natural and anthropogenic causes, healthy reefs are replenished by larval settlement (i.e., recruits). Recruitment rates in The Bahamas are limited, however, due to low densities of adult corals.

In other words, fewer adult corals can ultimately reduce the fertilization success and larval production on a given reef.

Larvae that are produced face many challenges. Reefs overgrown by seaweeds, for example, offer less space for larval settlement. In turn, even the larvae that do settle onto overgrown reefs are at a higher risk of being smothered later by seaweeds. Adding to this problem is **the low number of reef-building species** recruiting to Bahamian coral reefs; **only 10%** of recruits were from star, brain, elkhorn, staghorn and massive starlet coral species.

40%
OF SURVEYS HAD NO RECRUITS

>2,400
CORAL RECRUITS WERE COUNTED

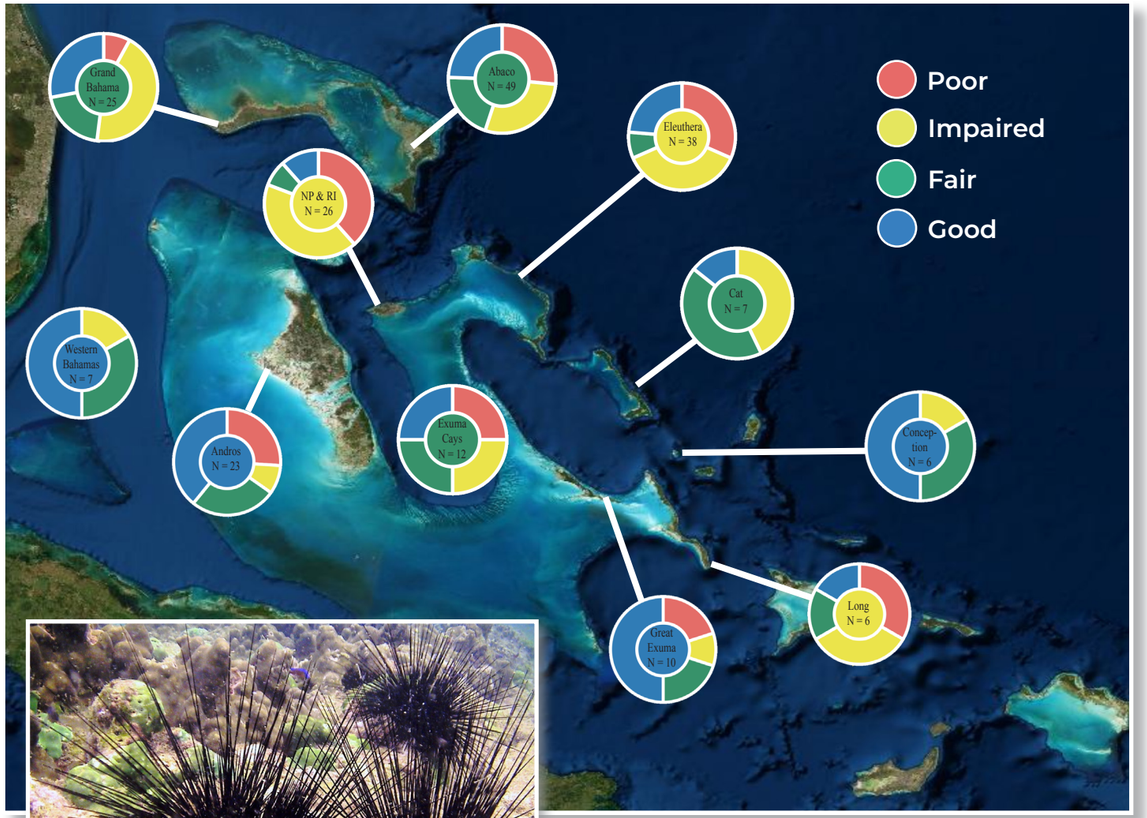
64% OF ALL RECRUITS BELONGED TO **1 GENUS** OF BROODING CORAL

An Abundance of Brooders

In The Bahamas, over 80% of coral recruits belonged to weedy brooding species. These corals, including finger coral and mustard hill coral, make smaller contributions to growing reefs than spawning corals, which tend to be major reef builders. Indeed, spawning corals like star and brain corals, provide the much-needed structure necessary for coral recruits to settle and flourish.

Over five years, we surveyed 400 m² of seafloor for coral recruits.

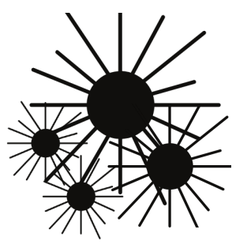
Large Parrotfish Index



Longspined sea urchins are important macroalgae grazers on coral reefs.

Why Reefs Need Grazers

Grazing of seaweeds is critical to coral reef resilience as it opens up space for coral larvae to settle onto clean substrate, as well as prevents new recruits from being smothered by seaweeds. The most important grazer on Caribbean reefs was once the Longspined sea urchin, *Diadema antillarum*. Unfortunately, over 35 years ago a pathogen decimated Longspined sea urchins throughout the region and the population has never fully recovered. Now, large parrotfishes are the dominant algae grazers, though not all parrotfish graze the same way.



DIADEMA DENSITIES ARE

10-100x

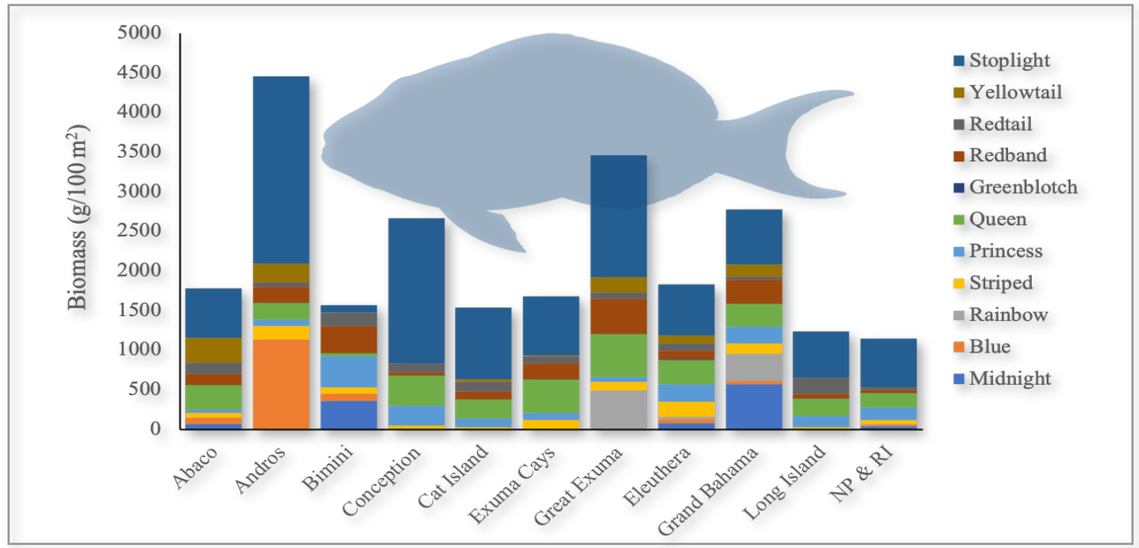
LOWER THAN BEFORE THE DIE-OFF

Stoplight parrotfish.

*The figure below shows **parrotfish biomass by species** surveyed in The Bahamas, between 2015-2019.*

Large Parrotfish Are The Most Important Grazers

Redtail (*Sparisoma chrysopterum*), Redband (*S. aurofrenatum*), Yellowtail *(Scarus hypselopterus)* and Stoplight parrotfish (*S. viride*) are among the most important grazers in The Bahamas. Parrotfish were found on all reefs in surveys, but their sizes and abundance (measured as biomass) varied among sites. This is partly due to the natural variability in reef structure and other factors, but fishing is increasingly impacting parrotfish populations - particularly for large species that contribute most to grazing.



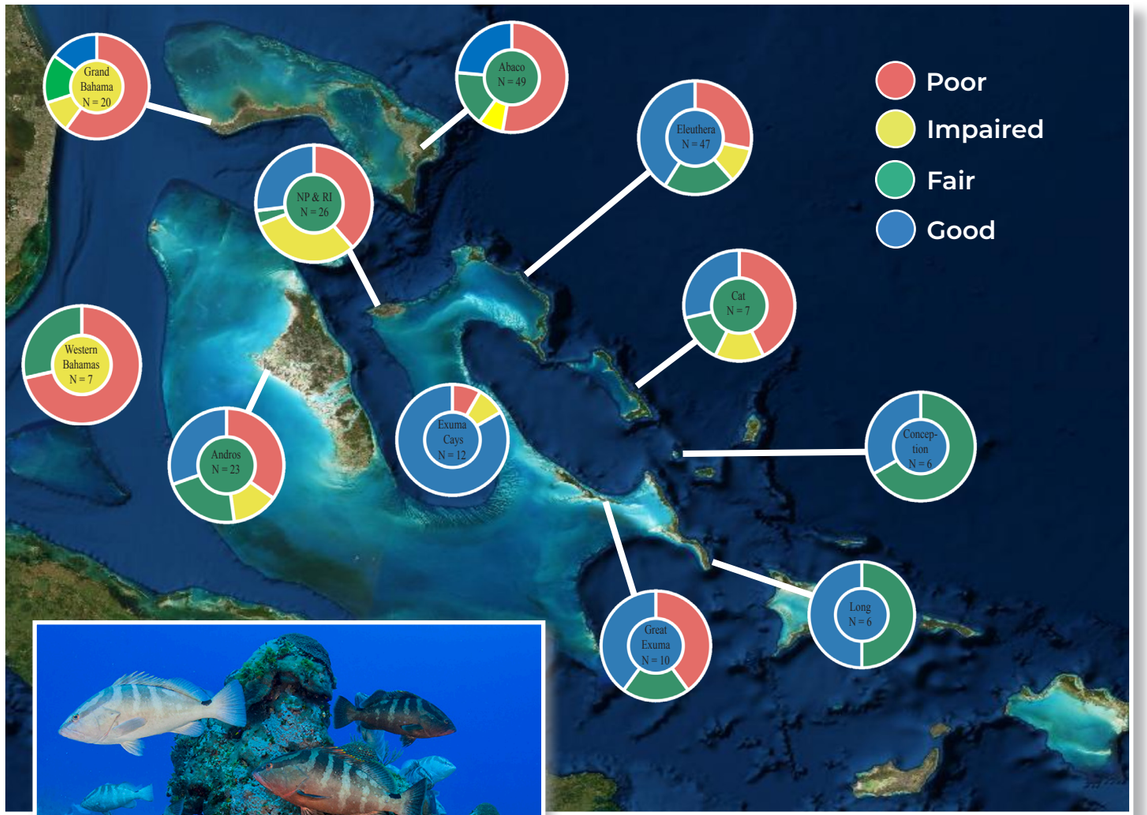
Parrotfish Decline

Around some islands, parrotfish populations have **decreased** over the past five years. The mean biomass values of key grazing parrotfish around New Providence & Rose Island, for example, has decreased from 1,715 g/100 m^2 in 2011 to only 685 grams/m^2 in 2019.

40%

DECREASE IN MEAN PARROTFISH BIOMASS AROUND NEW PROVIDENCE FROM 2011-2019

Grouper Index



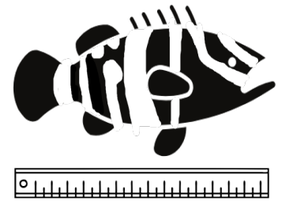
A spawning aggregation of Nassau grouper.

Reefs Depend on Groupers

Groupers are of economic and ecological importance to coral reefs. As predators, they play a key ecological role by controlling populations of other fish and invertebrates that they feed on, including those that are predators on corals. They are also among the most valuable fishery species in The Bahamas. Large grouper species have become rare throughout the Caribbean.

The Nassau Grouper is Critically Endangered

The Nassau grouper has been fished out from much of the Caribbean and is considered a *critically endangered species*; in fact, they are more endangered than Giant pandas and African elephants. The Bahamas remains one of the few places where populations of large groupers are still viable. Still, even here, we see reduced populations in some areas where fishing pressure is high. The healthiest populations are in marine protected areas (MPAs), where fishing is restricted.

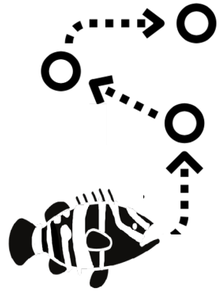


NASSAU GROUPERS TYPICALLY REPRODUCE WHEN THEY ARE **>54 CM**

Bahamian Nassau groupers spawn only **once per year.**

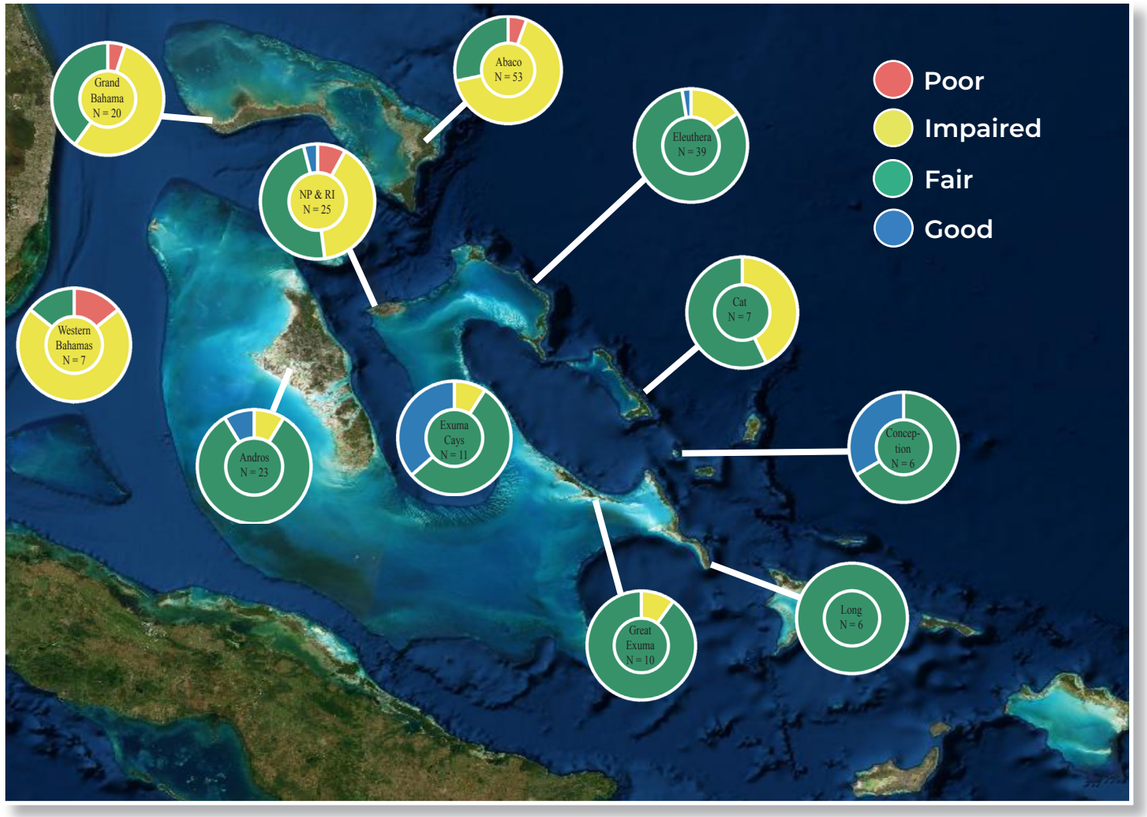
The Black grouper is a key predator on coral reefs.

NASSAU GROUPER FISHERIES ARE WORTH **>$32 MILLION**



NASSAU GROUPER WILL MIGRATE **>100** MILES TO SPAWN

Bahamian Reef Health Index



Bahamian Reef Health Index

To assess the overall health of reefs, the Bahamian Reef Health Index (BRHI) averages the scores of the other reef health indicators for each site. The only areas where BRHI scores averaged more than 3.0 were Conception Island (3.19) and the Exuma Cays Land and Sea Park (3.14), the former being a remote area and receiving national park protection (although enforcement is limited), and the latter, a well-protected no-take national park with relatively low levels of development. The location with the lowest scores was Western Bahamas (2.19), where sand dredging has occurred for decades. Despite having some reefs with the highest live coral cover in The Bahamas, Abaco's reefs suffered with the lowest coral recruitment index, low coral cover on average, and fewer large groupers than other sites. Reefs off New Providence and Grand Bahama were scored as IMPAIRED overall, primarily due to lower than average grouper and parrotfish index scores, as well as poor reef condition scores for New Providence/Rose Island, and poor recruitment scores for Grand Bahama.

Abaco

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

While the majority of reefs had below average BRHI scores, Abaco also had two reefs with **the highest amount of live coral cover** in the country – Sandy Cay Reef and Mermaid Reef. At restoration sites, critically endangered staghorn and elkhorn populations are increasing. Continued monitoring of Abaco's reefs will determine long-term impacts of Hurricane Dorian.

Andros

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Over 75% of reefs surveyed off Andros had above-average BRHI scores, but had a higher than average prevalence of disease. A mass bleaching event in 2015 posed threats to coral reef health. High coral recruitment may be the result of both higher than average coral cover and local retention of larvae.

Conception Island

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Conception Island stood out with some of the healthiest reefs surveyed in The Bahamas, likely due to both its remote location and its status as a national park. Nevertheless, there was evidence of reduced populations of elkhorn coral, staghorn coral and other critically endangered corals in several locations, likely as a result of past bleaching or disease events. Restoration of these populations may contribute to their recovery.

Cat Island

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Sites off Cat Island had above average scores for reef condition, but higher than average rates of disease, and low coral cover. It's possible these reefs exhibited lower levels of disease and bleaching in the past, and rates are increasing now, although more surveys are needed.

Only one site received a score of Good for all indices – Friday's Reef in the ECLSP.

Bahamian Reef Health Index

Western Bahamas

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Reefs around Western Bahamas – including Ocean Cay and Bimini - received the lowest overall BRHI score. This is likely because the area around Ocean Cay was commercially dredged for decades. Despite having better than average coral coverage, benthic scores were low due to high amounts of cyanobacteria and turf algae-sediment mats that inhibit coral growth. Plans for protection and restoration in this area can dramatically improve reef condition.

Eleuthera

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Eleuthera had some of the largest reef area surveyed, which varied from reefs exposed to the open ocean on the eastern side of the island, and those more sheltered on the Exuma Sound side of the island. As such, reefs varied considerably in ecological factors. While Eleuthera had one site that ranked among the top sites in coral cover and health, 90% of sites had below average benthic index rankings, primarily due to low coral and high macroalgae cover.

A brittle star settles on a spawning star coral.

Exuma Cays

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

All but one of the sites assessed in the Exuma Cays were in the Exuma Cays Land and Sea Park (ECLSP), the country's oldest and most effectively managed MPA. As a result it had some of the healthiest reefs, with the highest live coral coverage and grouper biomass, as well as the lowest macroaglae abundance of any area. One reef in the ECLSP was the only one in The Bahamas to receive GOOD scores for all indices.

Great Exuma

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Reefs surveyed off Great Exuma were all within the Moriah Harbour Cay National Park. All sites exhibited above-average coral condition and coral cover, as well as below average macroalgae. The reduction in macroalgae may be due to above average parrotfish populations at most of the sites.

60% OF SITES RATED IN "GOOD" HEALTH WERE IN MPAs

Grand Bahama

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Sixty percent of Grand Bahama's reefs received BRHI scores of POOR or IMPAIRED, with the vast majoritiy having below average benthic index scores and higher than average disease scores during surveys in 2018 and 2019. Further damage from Hurricane Dorian in late 2019, as well as the outbreak of SCTLD in late 2019 and early 2020, pose significant new threats to Grand Bahama's reefs.

Long Island

Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

Like Cat Island, Long Island has a minimal number of reefs surveyed, so additional assessments are needed to paint a clear picture of coral reef health. Reef condition off Long Island was above average, but exhibited below average scores of coral cover and high levels of disease; this suggests, despite low levels of bleaching and disease in the past, these rates might be increasing.

New Providence & Rose Island

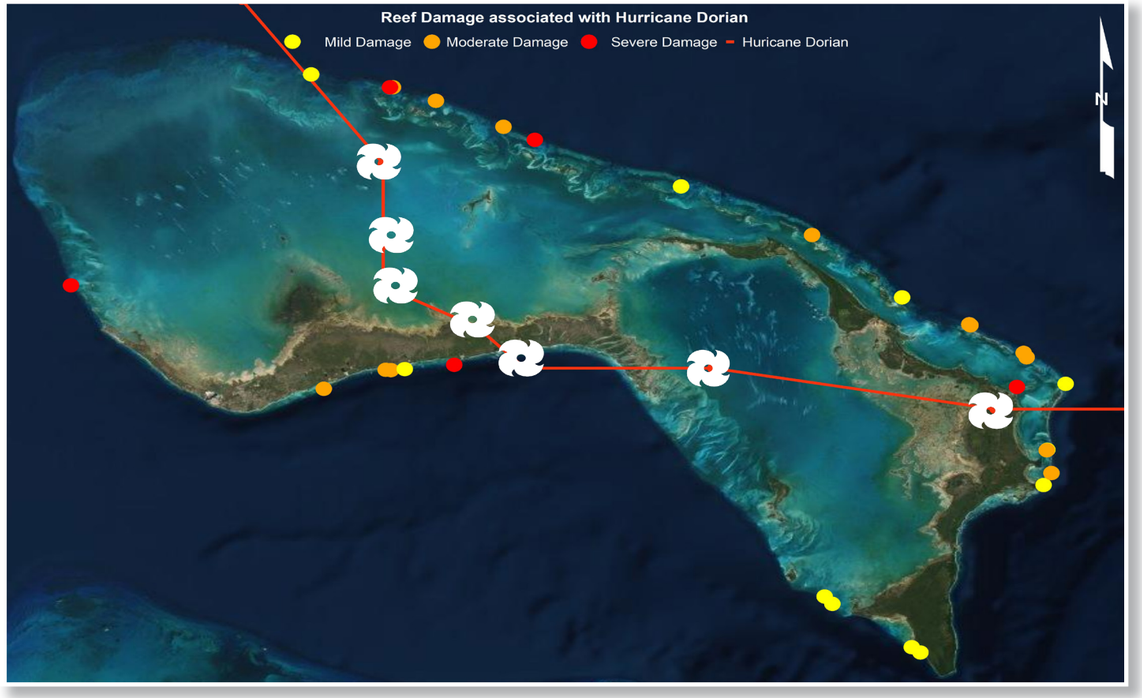
Benthic	Coral Conditon	Coral Disease	Recruitment	Large Parrotfish	Grouper

While reefs off New Providence and Rose Island were generally below average for several indices, including the Parrotfish Index (84% of sites) and Benthic Index (>75% of sites), there were some differences in aspects of reefs between those off Rose Island in the east and those off western New Providence. Nari Nari Reef off western New Providence also had the greatest loss of living coral reported over the past decade, likely due to petroleum leaking into the water from nearby Clifton Pier.

Only 3% OF ALL SITES SURVEYED WERE RATED "POOR" OVERALL

Around Conception Island, all sites rated "FAIR" or better.

© Shane Gross



This map traces the pattern of damaged reefs that we surveyed after Hurricane Dorian. The hurricane symbols depict Hurricane Dorian's path at 6-hour time intervals after it struck Abaco on Sepember 1.

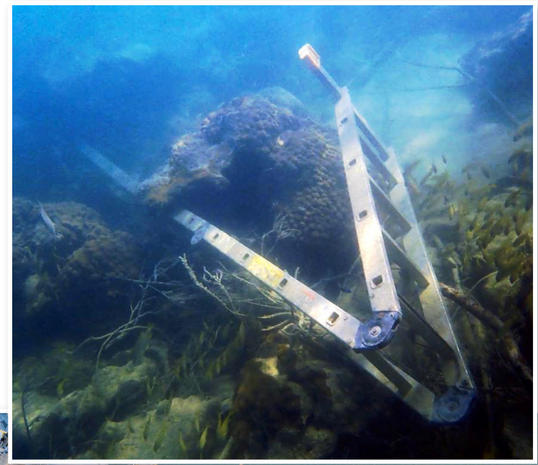
Hurricanes in The Bahamas

Around the world, coral reefs are often found in the areas most affected by tropical cyclones. No place is this more evident than in The Bahamas. Over the past century, The Bahamas has experienced at least one hurricane or tropical storm event every 2 years, with some islands experiencing hurricanes more frequently than others. While hurricanes can have devastating impacts to reefs, healthy reefs are resilient and can recover from most storms. Unfortunately, reefs that are in decline from other threats may not be resilient to hurricanes and the frequency and intensity of storms over the past couple of decades may limit the ability of reefs to recover from severe damage.

Hurricane Dorian

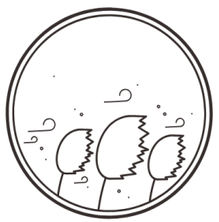
In September 2019, Hurricane Dorian became the strongest hurricane to make landfall in the Atlantic. It first hit Central Abaco and was one of the slowest moving major hurricanes, as it moved across Grand Bahama and eventually exited The Bahamas over the northern Abacos. The storm caused devastation to many reefs, including coral damage, bleaching, the influx of debris from land ranging from whole trees to pieces of houses and cars, and burial in sediment from inshore areas. While some reefs, like Sandy Cay Reef in the Pelican Cays Land and Sea Park, saw minimal impacts from the storm, Mermaid Reef, which had the highest percentage of live coral of any reef surveyed in The Bahamas, suffered severe damage; about 30% of Mermaid Reef's corals were dislodged and moved, leading to a reduction of coral cover by 40%.

Because many affected reefs were already considered IMPAIRED before the storm, their ability to recover may be compromised and may require restoration efforts.

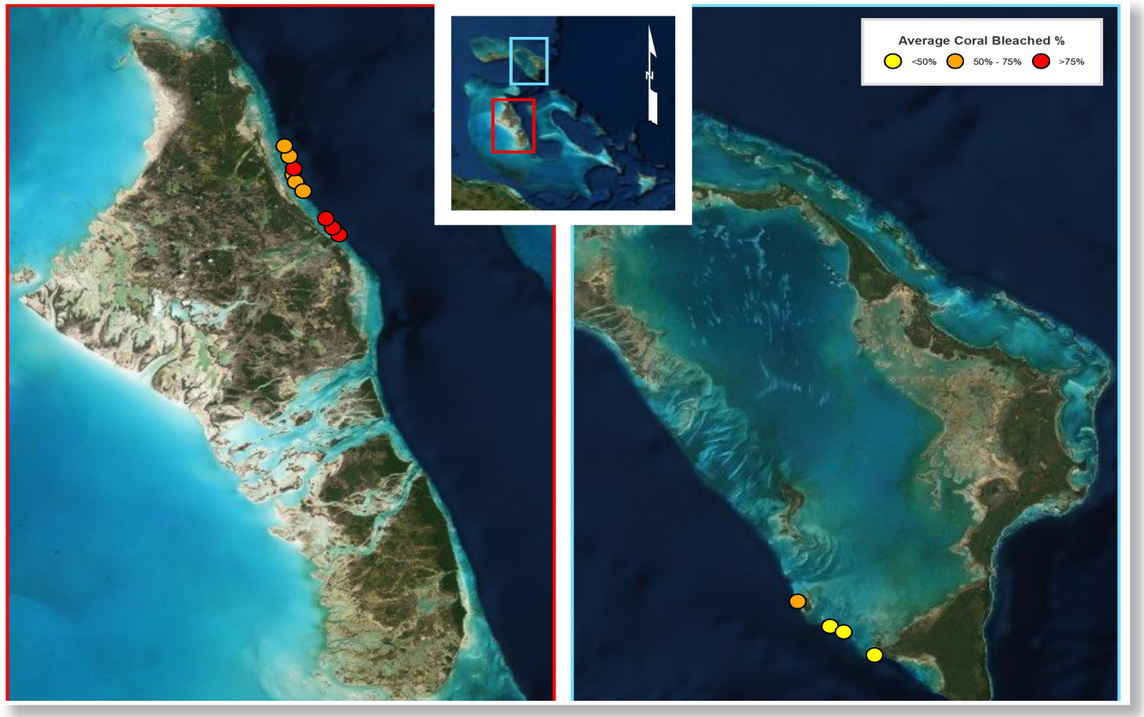


***Hurricane Dorian's** effects were severe, both on land and underwater.*

1/3
OF SITES OFF GRAND BAHAMA & ABACO HAD MORE BROKEN CORAL AFTER DORIAN



CASUARINA TREES THAT WERE SWEPT ONTO REEFS CAUSED THE MOST DAMAGE

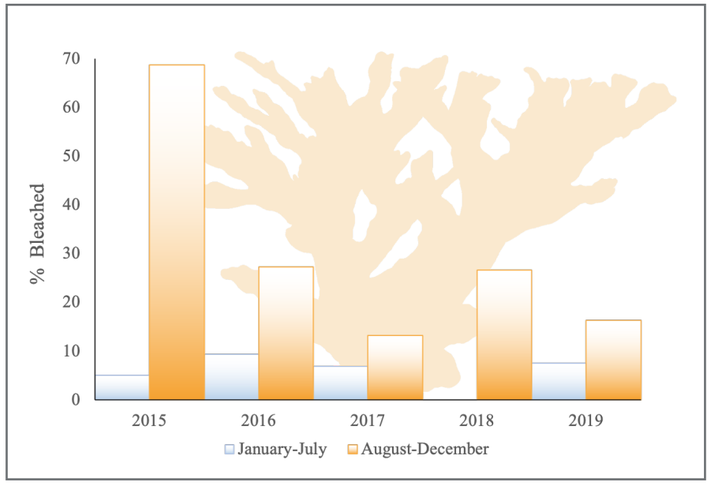


*This map compares the 2015 bleaching event near Andros (left) and South Abaco (right). Off **Andros**, **70-100%** of all corals surveyed had bleached; this range was **37-70%** of corals around **S. Abaco**.*

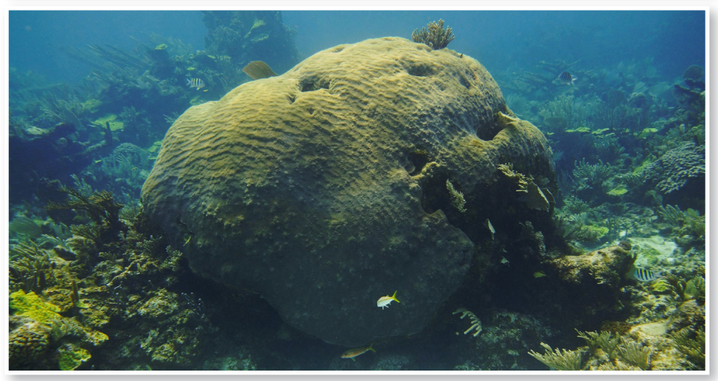
Coral Bleaching

Reef-building corals rely on nutrients from a symbiotic relationship with microscopic algae, called zooxanthellae, that live in their tissue. When environmental conditions become too stressful, this symbiosis breaks down and corals expel their zooxanthellae; as a result, the corals appear white, a phenomenon known as bleaching. This often happens in the summer, when water temperatures are warmer than usual. If conditions get too warm (e.g., if waters remain ≥0.5 °C above normal conditions for an extended period of time), the corals can die. Corals that recover are more susceptible to disease and other stressors that can kill them later. Mass bleaching events were first noticed in the 1980s and have increased in frequency and intensity recently. In The Bahamas, 2015 was a particularly bad bleaching year. Shortly after summertime temperature highs, nearly 70% of corals surveyed off Andros and Abaco were bleached, with 100% of corals bleached at some sites.

A bleached spiny flower coral.



Percent of surveyed corals that bleached from 2015-2019.



A bleached star coral colony (Orbicella faveolata) from Sandy Cay Reef in 2015 (top). Fortunately, four years later (i.e., 2019; bottom) 100% of that same coral head had recovered from bleaching.

SOME CORALS MAY HAVE **GENETIC ADAPTATIONS TO TEMPERATURE STRESS**

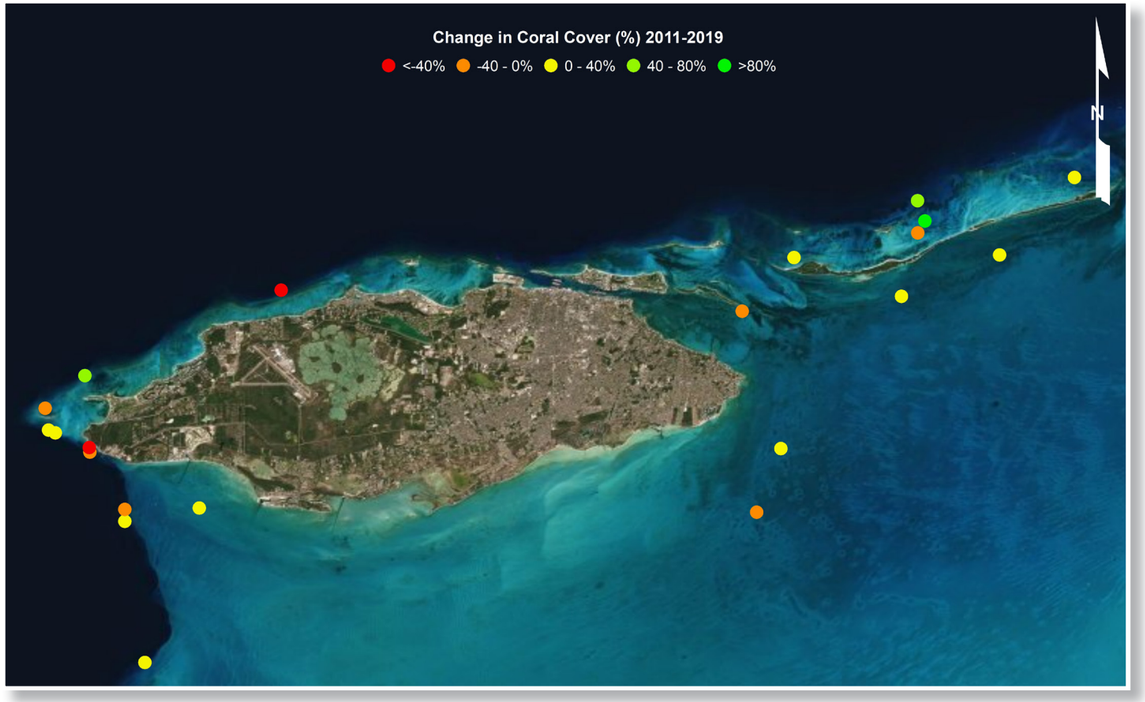
For example, corals on Mermaid Reef off Abaco.

CORALS CAN RECOVER FROM MILD BLEACHING

But they may be more vulnerable to disease, and less likely to reproduce.

AFTER HURRICANE DORIAN, >25 % OF CORALS HAD BLEACHED ON SOME REEFS.

This was likely caused by rapid temperature changes or prolonged water turbidity.



Change in coral cover from 2011-2019 around New Providence and Rose Island. This map shows a dramatic decline in coral cover around Clifton Pier Power Plant (-69%), where multiple oil spills were reported.

Coral Recruitment

Coastal development can affect coral reefs in myriad ways. Dredging, clearing land or changes in land use in the coastal zone can create sediment that smothers corals. Residential areas and resorts can increase runoff from land and wastewater; the increased nutrients and pollutants that result can increase macroalgae, change microbial communities and ultimately decrease coral populations. Industrial sites and even runoff from roads can further increase chemical pollution. Alteration of mangroves and other nearshore habitats can also reduce reef resilience. This is especially true for invasive Casuarina trees in the coastal zone, which may be swept onto reefs and increase coastal erosion.

Development In New Providence

Nowhere in The Bahamas has there been more development than around New Providence Island. While many changes that led to reef declines occurred before reef condition data was collected, over the past 10 years some reefs around New Providence have experienced significant changes. For example, in 2009, reefs around Clifton had 15-20% live coral cover (well above average for The Bahamas). By 2019, however, these reefs decreased in live coral cover up to 70%, with live coral cover only 6% at the site closest to shore. The decline in coral cover was likely caused by chronic petroleum leaks that contaminated coral reefs and led to a bloom of cyanobacteria that overgrew corals.

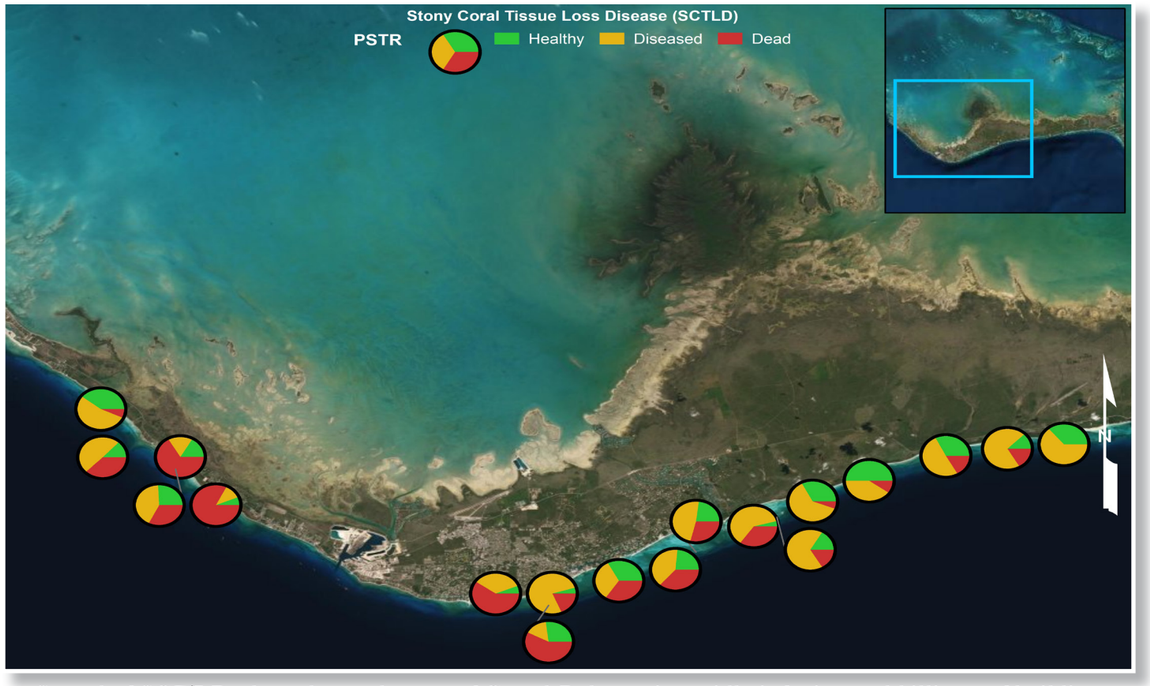
Mangroves provide nursery habitat for reef fish.

***Petroleum** and other chemicals are **toxic to corals** and other marine life.*

REEFS <3 MILES FROM OCEAN CAY, A FORMER SAND DREDGING SITE, HAD **1/2** THE CORAL COVER OF REEFS FARTHER AWAY

REEFS IN MPAs WITH LITTLE TO NO DEVELOPMENT HAD **50-75%** MORE CORAL THAN AVERAGE

Invasive Casuarina trees that outcompete native plants along the shoreline have shallow root systems that increase coastal erosion and can damage reefs - especially after hurricanes.



Spread of SCTLD along the south coast of Grand Bahama is rapidly infecting and killing reef building corals, like symmetrical brain coral (Pseudodiploria strigosa; pictured on Page 27).

Grand Bahama's port, where SCTLD may have been introduced in The Bahamas.

Stony Coral Tissue Loss Disease in The Bahamas

In 2020, the first outbreak of Stony Coral Tissue Loss Disease (SCTLD) was confirmed in The Bahamas near Grand Bahama. Although anecdotal reports suggest the disease may have spread to reefs off Freeport as early as July 2019, no cases of SCTLD were observed on any of Grand Bahama's reefs during AGRRA surveys that month off West Grand Bahama and later, in October 2019, in Peterson Cay National Park, Lucayan National Park and East Grand Bahama. By March 2020, all of this area had been impacted by SCTLD to some extent, with 18 species of corals observed to be infected and up to 95% of some species either recently killed or infected by the disease. SCTLD has also been confirmed off Nassau.

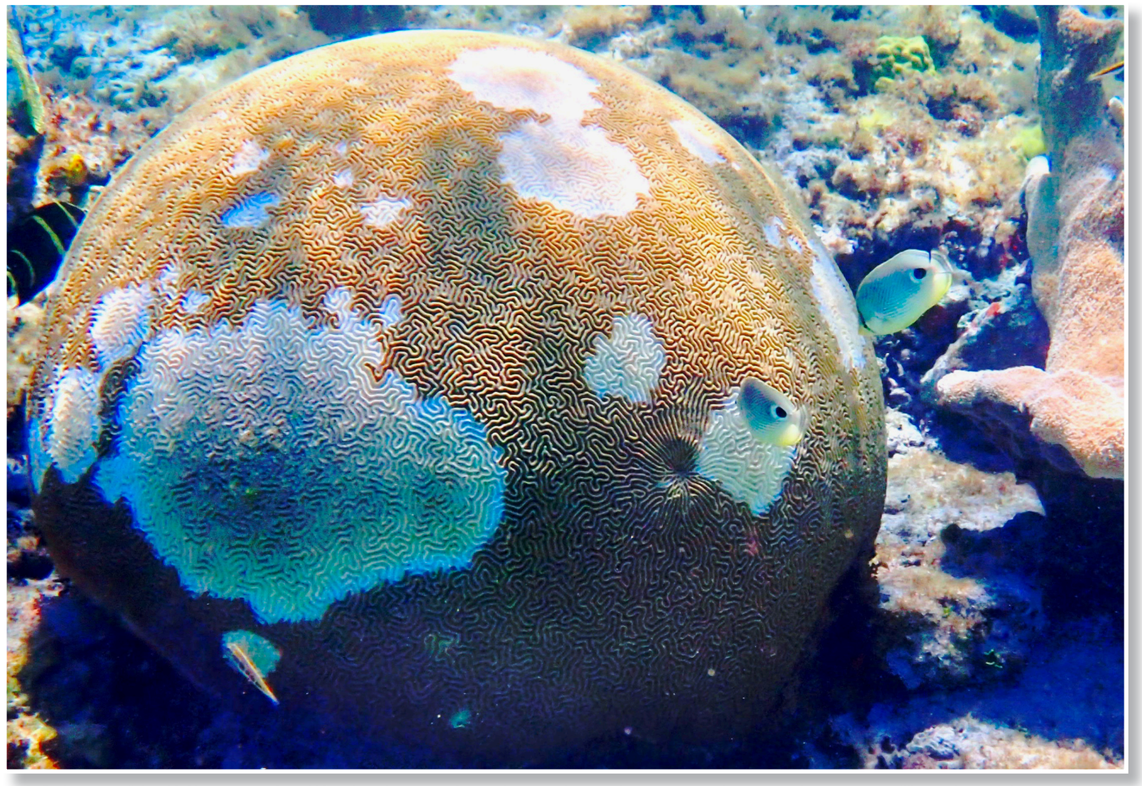
1/2
REEF-BUILDING CORAL SPECIES ARE AT RISK OF SCTLD

SCTLD Spread

Surveys of infection and mortality rates suggest that SCTLD may have first affected reefs around the port and spread from there. How and when the disease reached Grand Bahama is unknown. However, transport via shipping is suspected and the rapid spread of the disease may be the result of natural ocean currents, the effects of Hurricane Dorian, and potentially human activities such as boating, fishing, and diving. Preventing the spread of this devastating disease is critical to limit coral loss in The Bahamas, and prevent broader impacts to coral reef ecosystems as a whole.

FOR MORE INFO ON SCTLD, VISIT US AT HTTP://WWW.PERRYINSTITUTE.ORG/SCTLD

IN MARCH 2020, **80%** OF SYMMETRICAL BRAIN CORALS OFF GRAND BAHAMA WERE DEAD / INFECTED FROM SCTLD



Major reef-building corals, like brain corals (pictured) and star corals, are the most affected species.

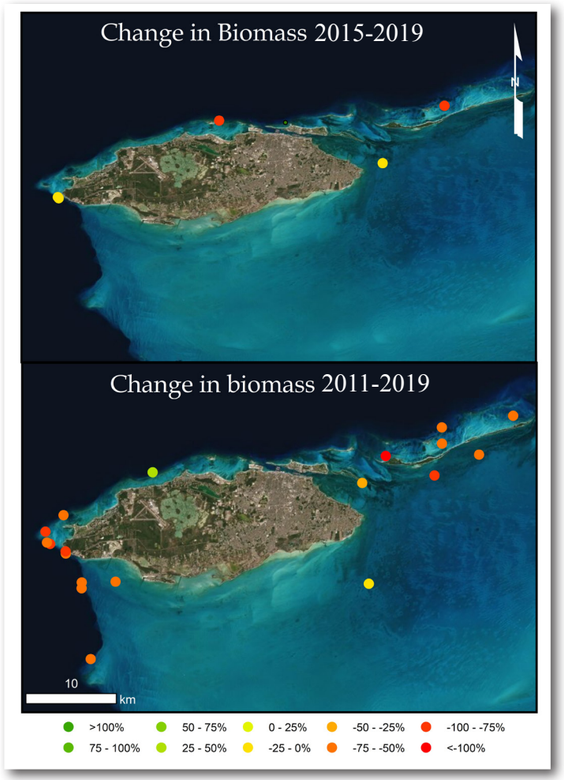
Fisheries Management in The Bahamas

While the major commercial fisheries of The Bahamas, including lobster, conch and grouper, have regulations such as size limits or closed seasons to promote sustainable fisheries, most reef fish species have no regulations based on their biology to protect them. An example of this is the emerging parrotfish fishery. Parrotfish are not considered a traditional fishery species in The Bahamas, but capture of parrotfish has become widespread and poses a significant threat to coral reefs. Indeed, parrotfish are one of the few groups of fish that can build reef resilience and help coral populations recover by controlling seaweed growth.

Parrotfish Decline

Over the past decade we have studied parrotfish populations and aspects of the fishery around The Bahamas. Surveys of the fishery have indicated that parrotfish are harvested throughout The Bahamas, but are mostly targeted by fishers from New Providence. In-water surveys of parrotfish comparing populations over the past decade **show a decrease in parrotfish populations at 84% of sites around New Providence and Rose Island** and that parrotfish biomass decreased by an average of 64% over the past decade. These numbers are alarming, as they indicate a reduction in the resilience of coral reefs at the same time that reefs face increasing threats from climate change, hurricanes, pollution and changes to the coastal environment.

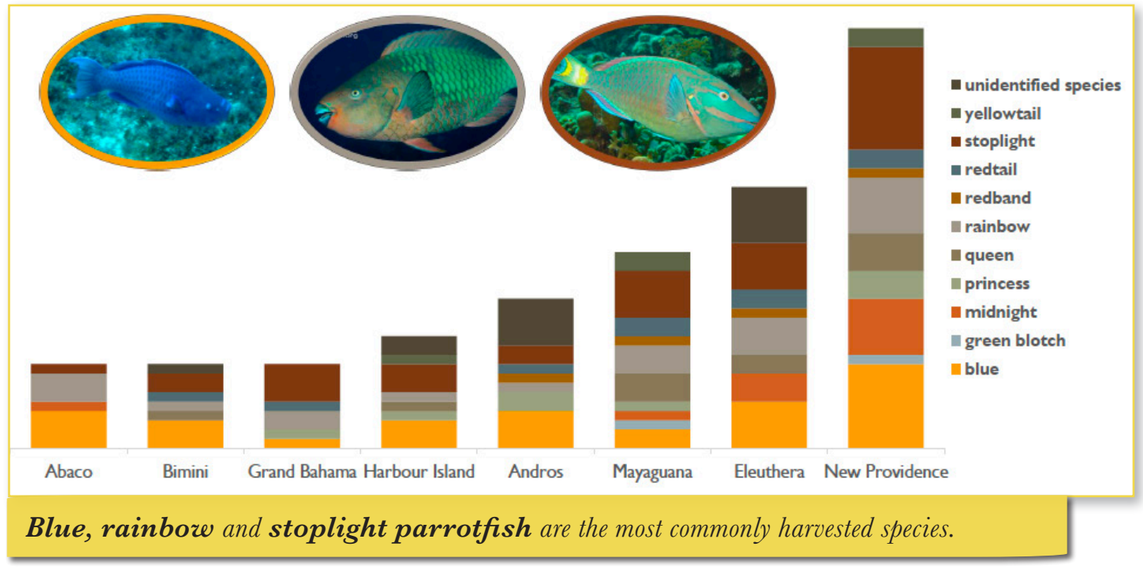
Increased grazing in the Exuma Cays Land and Sea Park (ECLSP) led to a 2x increase in recruitment.



The maps above show the percent change in parrotfish biomass on coral reefs around New Providence and Rose Island, from 2015-2019 and 2011-2019, respectively.

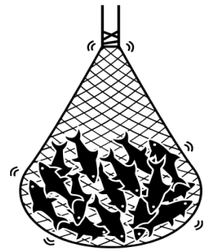
PARROTFISH CAN REMOVE UP TO **2 GRAMS/M²** OF CARBON ANNUALLY

In the **Exuma Cays Land and Sea Park,** parrotfish grazing intensity was **2x higher** than outside the park.

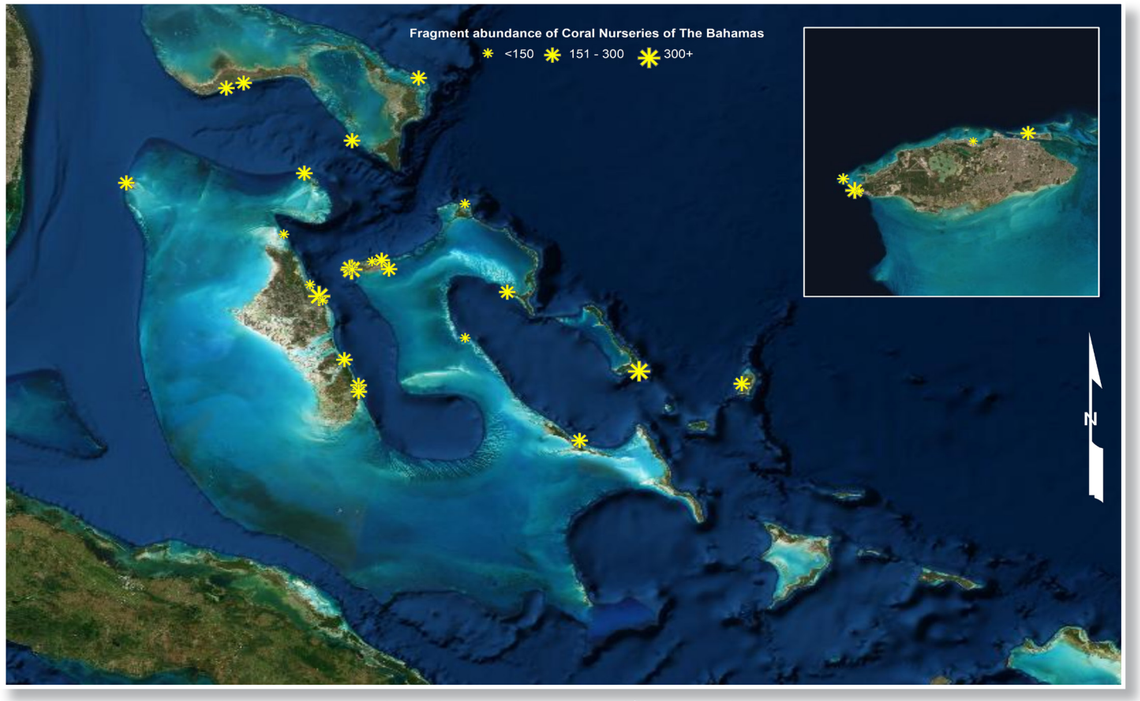


Blue, rainbow *and* ***stoplight parrotfish*** *are the most commonly harvested species.*

64% OF FISHERMEN REPORTED HARVESTING PARROTFISH



28% OF FISHERMEN CATCH PARROTFISH EVERY TIME THEY GO OUT



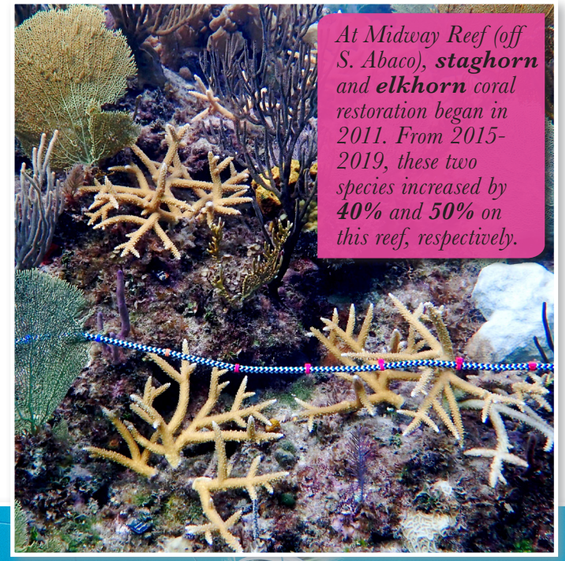
Coral nursery locations within the Reef Rescue Network. The size of the symbol represents the number of coral fragments growing at each nursery.

Reef Restoration in The Bahamas

Several coral species are considered endangered or critically endangered in The Bahamas. The declines we observed may have reduced coral populations below critical thresholds for successful reproduction; this is because successful fertilization of eggs during coral spawning depends on having genetically unique colonies in close proximity to each other. As such, many coral reefs may require active intervention to restore populations and increase genetic diversity. At present, three main techniques are used to restore coral populations. (1) For fast-growing branching species, like critically endangered elkhorn and staghorn coral, small fragments from naturally occurring colonies are grown in nurseries at increased rates and used to re-populate reefs. (2) For slower-growing mounding corals, a new technique called microfragmantation was developed to increase live coral cover, though this is a resource-intensive process. (3) Finally, we can increase the number and genetic diversity of corals by collecting gametes when the corals spawn, fertilizing coral eggs in the lab, and then rearing large numbers of larvae; in this case, coral larvae settle onto specially designed substrates that are later placed onto the reef.

Coral Nurseries

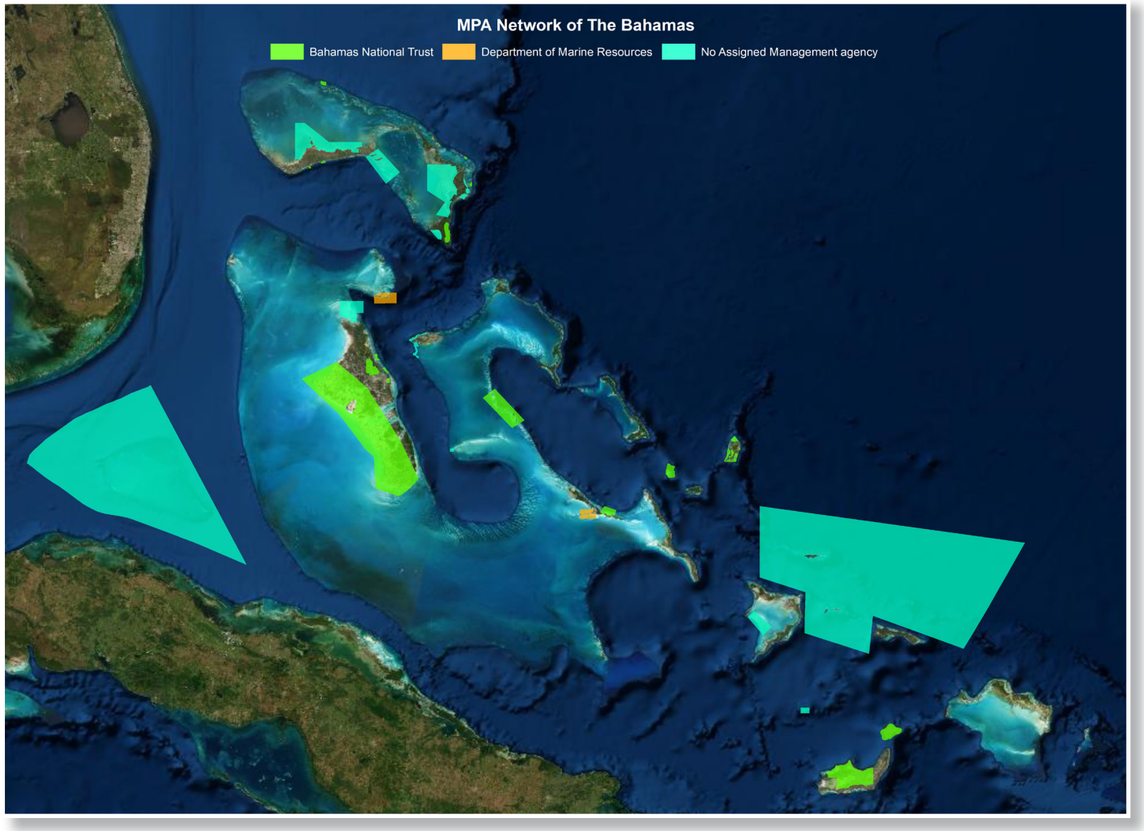
Though microfragmentation and larval propagation techniques are largely still in development, coral nurseries have been used in The Bahamas for over a decade. Currently, there are ~25 coral nursery sites, growing over 6,000 coral fragments. The success of these efforts is just beginning to be realized. For example, the only documented increases in the amount of staghorn and elkhorn coral in our surveys are from sites off southern Abaco, where restoration efforts have been going on for ten years.



*At Midway Reef (off S. Abaco), **staghorn** and **elkhorn** coral restoration began in 2011. From 2015-2019, these two species increased by **40%** and **50%** on this reef, respectively.*

<7%
OF SITES HAD STAGHORN CORAL

1/3
OF THEM WERE RESTORATION SITES



More than 11% of nearshore waters in The Bahamas are protected within MPAs, however the country has committed to nearly doubling its MPA network to 20% by the end of 2020.

Marine Protected Areas

Marine Protected Areas, MPAs, are parts of the sea that receive special protection from human threats. Typically, they restrict or limit certain activities to promote more natural conditions. For example, MPAs may restrict fishing activities to allow populations to recover, or prohibit anchoring to protect sensitive habitats. MPAs don't just protect resources within their boundaries. As healthy populations of fish and other species develop in MPAs, some individuals may travel into fished areas. Further, as more and more fish reach spawning size within MPAs, they export larvae to surrounding fished areas.

CORAL COVER WAS **76% GREATER ON AVERAGE** IN THE ECLSP THAN OTHER SITES IN THE BAHAMAS

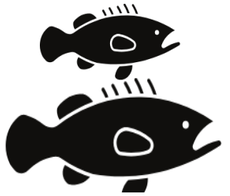
MPAs preserve ecosystem processes that promote healthy reefs.

The ECLSP

The Exuma Cays Land and Sea Park is the oldest and best-enforced MPA in The Bahamas. Protected since 1959, and being entirely no-take since 1986, many studies have shown that populations of fish, conch, crawfish and corals are healthier in the ECLSP than other parts of The Bahamas. For example, **coral recruitment was 50% greater** on average in the ECLSP than other sites in The Bahamas. Largely based on the success of the ECLSP, the government of The Bahamas is committed to protecting 20% of its nearshore waters by the end of 2020.

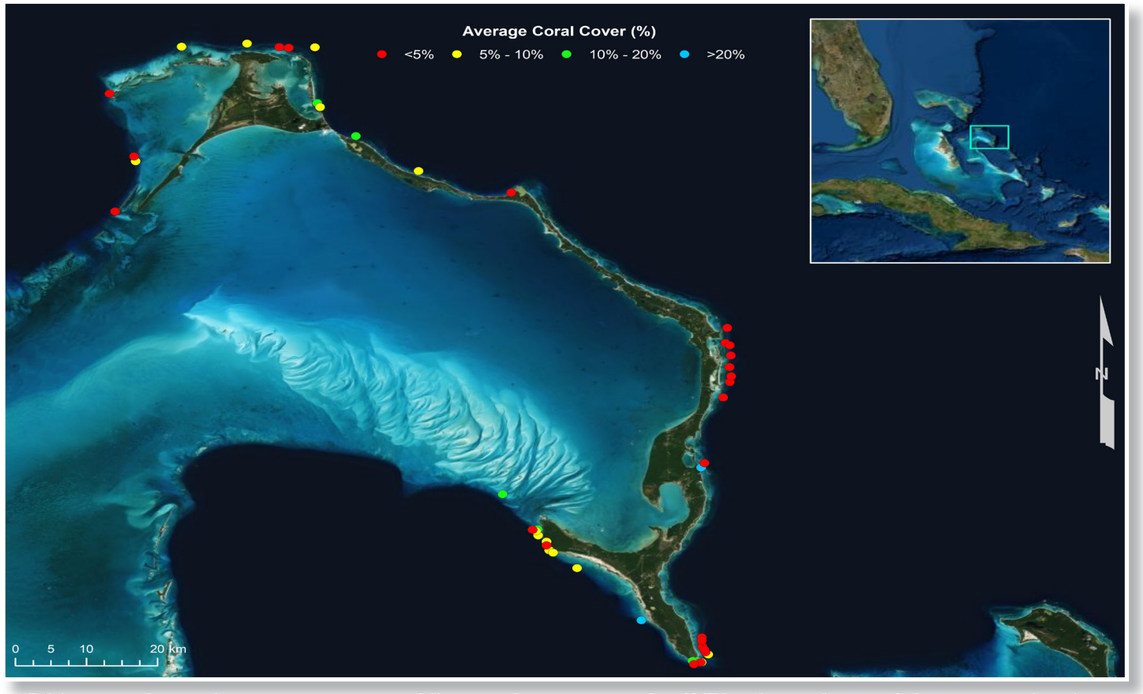
COMPARED TO THE REST OF THE BAHAMAS, IN THE ECLSP:

NASSAU GROUPER DENSITIES WERE **80% HIGHER,** & BIOMASS PER HECTARE WAS **150% GREATER**



BLACK GROUPER DENSITIES WERE **40% HIGHER**, & BIOMASS PER HECTARE WAS **450% GREATER**

Conch populationsa are healthier in the ECLSP than in nearby areas.



This map shows the average percent of live coral cover on reefs off Eleuthera. Some of the noteworthy sites are currently in proposed MPAs while others are likely to remain unprotected.

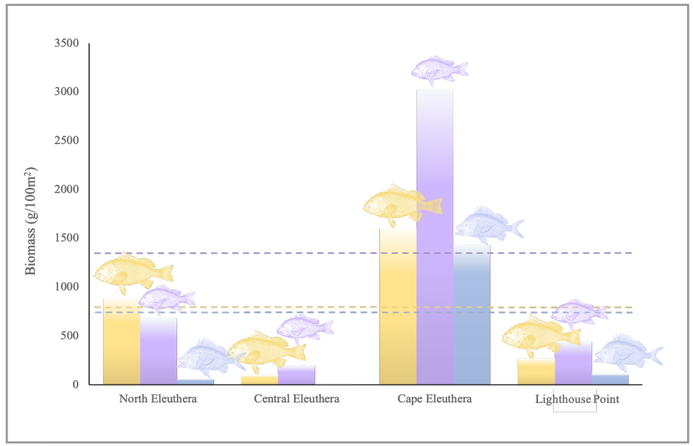
A Balancing Act

Many Islands in The Bahamas are currently faced with balancing the economic opportunities provided by coastal development and the expansion of tourism with the conservation of marine resources to preserve marine ecosystems and the valuable services they provide. Our data show that coral reefs within well-managed MPAs are among the healthiest in The Bahamas, and those closest to population concentrations and industrial centers often are impaired or in poorer health. Nevertheless, there are some examples where coral reefs remain healthy near population centers or have improved through sustained restoration and monitoring efforts.

Eleuthera

Nowhere is the difficulty of establishing a balance between coastal development and protection more evident at present than Eleuthera, where there is increasing coastal development in support for cruise ship-based tourism, resorts, marinas, and second homes. At the same time, there are nine new MPAs proposed around the island. While various social and economic factors must play a role in determining where coastal development is permitted or where reefs are protected, ecological evaluations must also be used to identify areas that are particularly sensitive to coastal development and to prioritize areas for protection based on ecological integrity. Protection from various threats and active restoration can improve the condition of most coral reefs, however identifying priority areas for protection is key.

Lighthouse Point off Eleuthera.



The graph above shows biomass (g/100 m2) of several key commercial fish species off Eleuthera. ***Groupers*** *(yellow),* ***snapper*** *(purple) and* ***grunts*** *(blue) are displayed.*

ELEUTHERA'S PROPOSED MPAs AVERAGED **6.36% LIVE CORAL**

© Shane Gross

Off Eleuthera, the site with the highest coral cover (34%) and the site with the most critically endangered Staghorn coral (9.5%) were ***not included in proposed MPAs****. However, the site with* ***the most critically endangered Elkhorn coral (21%, pictured) was inlcuded****.*

REEFS OFF LIGHTHOUSE POINT, WHERE BOTH PROTECTION AND DEVELOPMENT IS PROPOSED, HAD:

ONLY 5.4% LIVE CORAL COVER

LESS THAN 1/2 THE NATIONAL AVERAGE (11.7%) OF LIVE CORAL

30% BELOW ELEUTHERA'S AVERAGE (7.7%) OF LIVE CORAL

How Can I Help?

EAT SUSTAINABLE SEAFOOD & AVOID KEY SPECIES FOR REEF HEALTH, LIKE PARROTFISH

Try lionfish, an invasive fish species, instead!

DISPOSE OF YOUR WASTE PROPERLY

Chemicals that go down the drain end up in the ocean and damage coral reefs.

CONSERVE ENERGY! CLIMATE CHANGE IS A BIG THREAT TO CORAL REEFS

Turn off your lights, take quick showers, and unplug your unused electronics.

How can we protect coral reefs?

Coral reefs face a number of natural and human-caused threats, which are often increased by human impacts. Although reef health has undoubtedly declined, we can take many steps, as individuals and as a country, to: **1) prevent further damage to coral reefs, 2) improve their resilience to promote natural recovery,** and **3) actively restore key species.** The actions described here will not only support the natural beauty, ecological function, and biodiversity of reefs, but will help ensure they continue to provide Bahamian people with invaluable ecosystem services.

ON THE WATER, WE CAN:

ANCHOR ON SAND, AWAY FROM CORAL REEFS

KEEP CHEMICALS, LIKE BLEACH, AWAY FROM WATER

MAINTAIN OUR BOATS TO AVOID FUEL & OIL LEAKS

AS A COUNTRY, WE CAN:

1. Support MPAs. Create MPAs with active management and enforcement, such as Marine Parks and Fishery Reserves. The Bahamian government has committed to protecting 20% of its marine environment in MPAs this year! But these areas will only be successful if they have management plans that include protection from key threats, and if people comply with those regulations.

2. Regulate and manage fisheries. Less than 10 fishery species in The Bahamas are managed through minimum sizes, closed seasons and other harvest restrictions. Many species like snappers, grunts, hogfish and parrotfish are unregulated. These species should be assessed and managed to ensure their sustainability. There needs to be better compliance with existing regulations, including improved enforcement, eliminating illegal foreign fishing, and ensuring all fishers understand fishing regulations.

3. Implement sustainable coastal development. Because The Bahamas' economy is so dependent on tourism within the coastal zone, coastal development is inevitable. Identifying sensitive areas and using this information for planning is critical to preserve the natural resources upon which tourism depends. To prevent further damage to reefs, coastal development operations must: 1) include mitigation measures for impacts to sensitive habitats like coral reefs, 2) develop adequate waste disposal systems, and 3) remove invasives, like Australian pines (also known as Casuarina), and replace them with native species.

AS A COMMUNITY WE CAN:

RESTORE NATURE

REPLANT MANGROVES OR REPLACE INVASIVE CASUARINA TREES WITH NATIVE PLANTS

SUPPORT LOCAL BUSINESSES

ASK RESTAURANTS NOT TO SERVE PROTECTED, UNDERSIZED OR OUT OF SEASON REEF SPECIES

Contributors

Citation

Dahlgren C., K. Sherman, L. Haines, L. Knowles, K. Callwood. 2020. Bahamas Coral Reef Report Card Volume 2: 2015-2020.

AGRRA Data Collection

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