Perry Institute for Marine Science
Today's science for tomorrow's oceans.

Mangrove Report Card for The Bahamas

2022 Edition

The country's first-of-its-kind assessment on the health and function of mangrove ecosystems.

Contents

Executive Summary

Dr. Craig Dalgren, Executive Director of the Perry Institute for Marine Science

Mangroves play critical roles in The Bahamas from both ecological and economic perspectives. Ecosystem services of Bahamian mangroves, including serving as a nursery for fishery species, protection against flooding and coastal erosion, and sequestering carbon have been valued at up to $3.2 million per mi^2 per year. Although there is no standardized and consistent mangrove monitoring program in The Bahamas, studies by the Perry Institute for Marine Science (PIMS) over the past 20 years provide important information on the value of Bahamian mangrove systems across several key indicators. In this report **we summarize what is known about the status of mangroves and their ecological integrity in The Bahamas.**

The Bahamas contains some of the largest mangrove areas in the insular Caribbean with approximately **612,000 acres of mangroves** – most of which are on Andros. Many of these mangroves, however, are naturally sparsely distributed dwarf mangroves (less than 3 ft in height) that provide less value for biodiversity, fisheries, carbon sequestration and shoreline protection than taller mangroves. There has been mangrove loss on highly developed islands like New Providence since the 1950s, but recent loss of mangroves has been limited, except for **major hurricane impacts,** particularly that of Dorian which killed huge mangrove areas on Grand Bahama and Abaco. Coastal development has also led to the fragmentation of mangrove creek systems throughout The Bahamas. Major impacts of this fragmentation have been documented in some places, but most areas require further study to determine how the value of mangroves has been affected. Finally, in-water surveys of mangroves around The Bahamas shows there is both natural variability and anthropogenic influence on the biodiversity of fish in mangroves and the value of mangroves for supporting key fishery species.

In summary, **mangroves throughout The Bahamas remain stable** and are generally productive, but they face **significant threats** in many places. Losses due to hurricanes and coastal development have had major impacts locally on some islands. Fortunately, mangrove **protection and restoration** can promote recovery of mangroves following impacts and increase the value of mangroves for supporting biodiversity and providing valuable ecosystem services.

All three mangrove species are protected within The Bahamas

What Are Mangroves?

Mangroves are highly productive and valuable ecosystems that grow throughout the tropics around the globe.

They are **uniquely adapted to tolerate saltwater,** and thus can occupy spaces – on shorelines and tidal flats, along creeks, and in salt ponds – that no other trees can. There are actually **three species of mangrove trees** in The Bahamas: red mangroves (*Rhizophora mangle*), black mangroves (*Avicennia germinans*), and white mangroves (*Laguncularia racemosa*). Shallow limestone banks and low-lying islands in the The Bahamas provide a massive amount of suitable habitat for mangroves. With very little freshwater runoff, however, Bahamian mangroves have been forced to adapt to life in saltier water. While this makes mangroves of The Bahamas shorter than those in other parts of the world, they still support an abundance of life and provide valuable ecosystem services.

Red mangroves are the most recognizable species due to their prop roots that sprout out from the trunk, arcing into the water to stabilize the trees. This enables the trees to grow in deeper water and further into the ocean than the other mangrove species and to grow taller, up to 30 feet in The Bahamas. **Black mangroves** generally live in slightly shallower water than red mangroves. They have special roots that act like snorkels, called pneumatophores, that absorb oxygen above the high tide line. **White mangroves** grow further away from the water than the other two species, usually above the high tide line. All three species have special salt-excreting glands on their leaves that allow them to tolerate saltwater. In this report, "mangroves" refer to all these species together, and the forests, scrublands, and sparsely-populated tidal flats they live in.

Red mangroves are easily identified by their prop roots that allow them to grow in deep water.

Black mangroves have pneumatophores that let them "breathe" through their roots.

White mangroves usually grow above the high tide line.

TAKE ACTION:

Visit a mangrove creek and educate yourself about these important Bahamian ecosystems

Tidal flats in The Bahamas are extensive and are often exclusively colonized by mangrove trees

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Why Mangroves Matter

Mangroves remove CO^2 from the air and bury it in sediments via their roots to reduce climate change

Mangrove trees occupy a unique position along relatively sheltered shorelines where the land meets the sea, allowing them to serve an important ecological role to animals both marine and terrestrial and to provide valuable ecosystem services to people living on the coast - valued at up to $3.2 million per mi² per year!

Along the water's edge, red mangrove roots provide **shelter for the young of many fish** and invertebrate species that live on coral reefs as adults. Similarly the branches of mangroves provide a **rookery for birds** away from land based predators. Because many of the fish and invertebrates living in mangroves as juveniles are the ones that we eat – like snappers, grunts, groupers and crawfish – mangroves are vital to support healthy fisheries. Mangroves are an important line of **defense against coastal erosion** from waves and storms, absorbing destructive energy and keeping shorelines from eroding and even building or fortifying shorelines as they grow. Mangroves are also among the most productive systems on the planet in terms of the amount of CO_2 they can absorb from the atmosphere and bury in sediments, providing a **critical buffer against greenhouse gas emissions and climate change.** But mangroves are also under threat. Coastal development and other human impacts have caused mangroves to decline in The Bahamas. Similarly, increasingly severe hurricanes have killed mangroves in parts of The Bahamas. **In this report card we examine the health of our Bahamian mangroves.**

The fish that we eat - like snappers, grunts and groupers - depend on mangrove nurseries

Indicators, grading & sites

There are many measures of mangrove health that can inform us about their conditions, the diversity of life they support, and the ecosystem services they provide.

A **comprehensive assessment and monitoring program** should examine each of these components to determine natural variability and how human impacts have affected mangroves. Unfortunately, such a program in The Bahamas has not yet been realized. Over the past 20 years, however, the **Perry Institute for Marine Science** and its partners have conducted numerous mangrove assessments - enough to establish a baseline for the condition of the country's mangrove ecosystems. For this initial report card, we selected **five health indicators,** and developed indices to give a broad overview of the status of mangroves in The Bahamas.

The first three indicators are satellite-based indices of condition:

1. Mangrove Area

We combined existing mangrove area maps and high-resolution multispectral satellite imagery to assess the area and productivity of mangroves in each island. We classified mangroves into three categories based on their size and density caused by natural variability in growth form. Each of these categories plays a unique role in supporting biodiversity and providing ecosystem services.

- Dwarf trees: height is <3 ft
- Scrub: height from 3 to 7 ft
- Tall: height is >7 ft

2. Mangrove Damage

This index examines the extent of damage and loss of foliage over the past 6 years of available data. It compares satellite-derived estimates of productivity in mangrove areas in 2016 and 2022 to show damage down to a resolution of 4 meters. This damage may be due to natural disasters like hurricanes, direct human impact, disease, or other threats.

- Low (<1%)
- Medium (1-10%)
- High (>10%)

3. Mangrove fragmentation

Mangrove systems may be compromised when they are divided by coastal development and human infrastructure. This index examines the extent that coastal infrastructure intersects mangrove creek systems and how natural hydrology may be affected. In many cases, data exists on the type of blockage and how it appears to affect flow, but we also highlight areas where more data is needed.

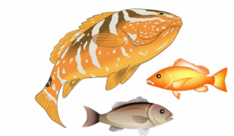
- Unknown
- No Flow
- Very Restricted
- Partial Flow
- Free Flow

The last two indicators are from in-water assessments of over 265 mangrove systems throughout The Bahamas:

4. Fish Diversity Index

Mangroves may naturally vary in the diversity of life that they support or they may be impacted by various human threats. Here we examine the number of species observed in mangroves (per 100 m² transect) from in water assessments of mangrove fish populations.

- Low (0-5 species)
- Medium (6-10 species)
- High (11-15 species)
- Very High (>15 species)



5. Fish Nursery Index

One of the key ecosystem services provided by mangroves is their role as a nursery for fish species that are important for fisheries or for the health of coral reef ecosystems. Here, we examine the density (no. per 100 m²) of fish belonging to key species including snappers, grunts, groupers, parrotfish and barracuda.

- Low (0 individuals)
- Medium (1-50 individuals)
- High (51-100 individuals)
- Very High (>100 individuals)

Each of these indices provides a stand-alone grade of mangroves throughout The Bahamas. We hope to continue to monitor these indices and add additional indices as mangrove restoration and monitoring becomes more deliberate and less ad hoc in The Bahamas.

Click here to find supplementary information related to this report or visit our website at PerryInstitute.org/mangroves

Mangrove area

The Bahamas is home to vast mangrove ecosystems, harboring the second largest mangrove area in the insular Caribbean region behind Cuba.

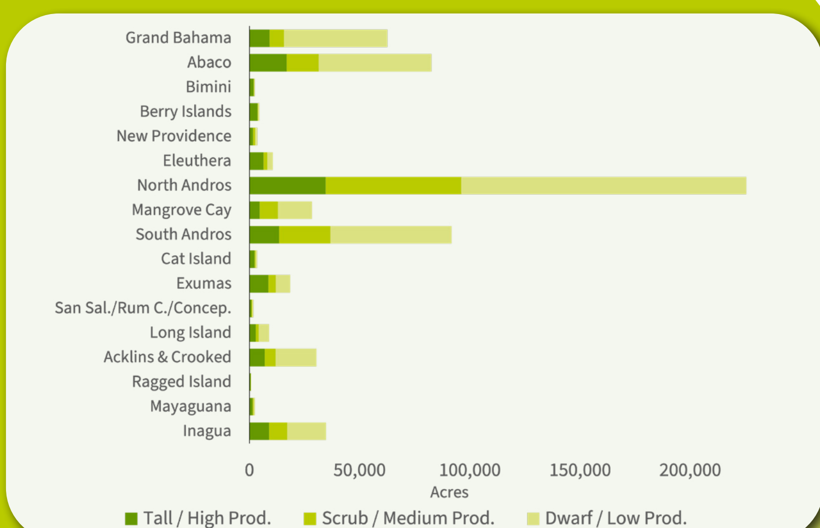


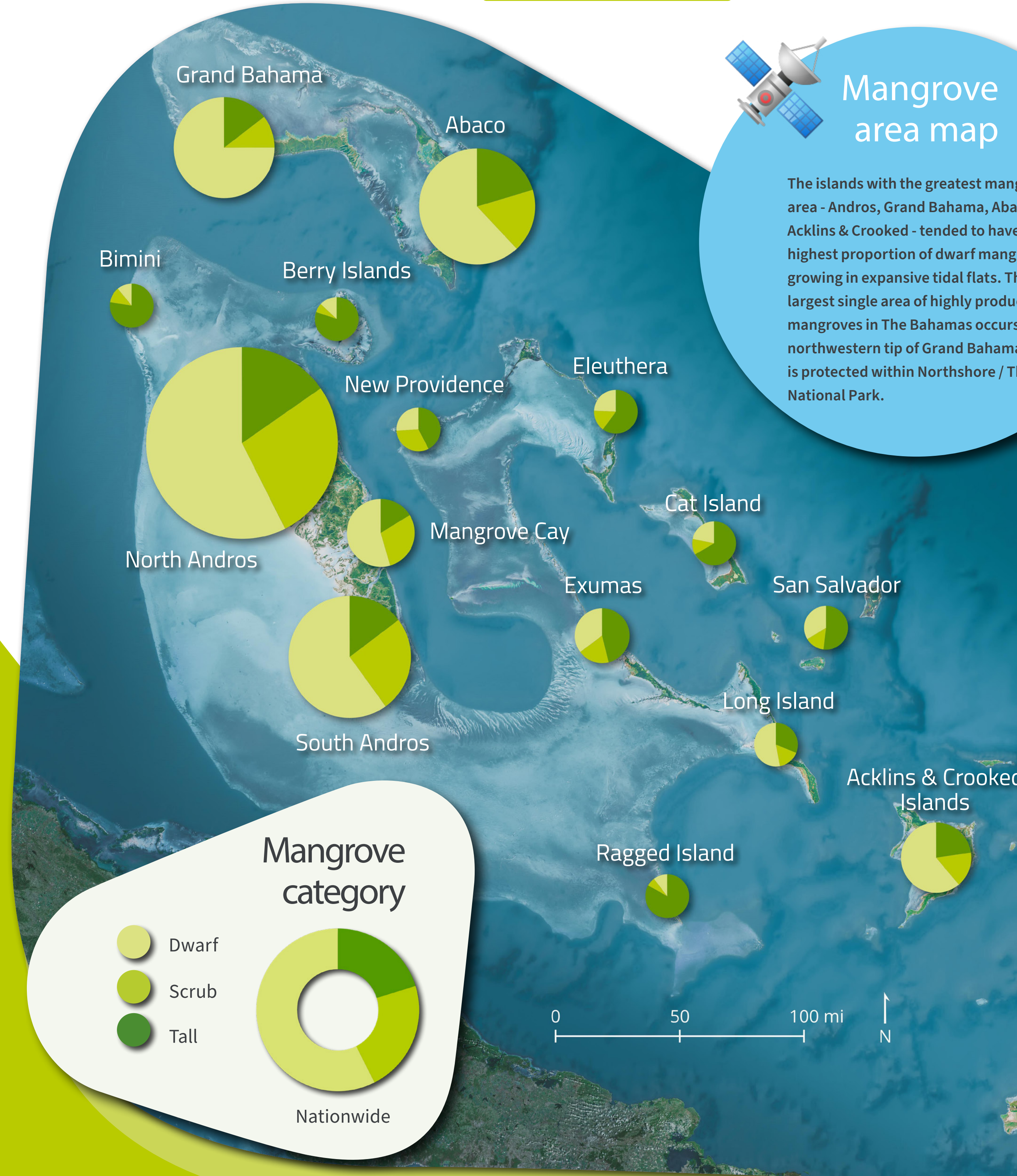
Fig 1: Total area of mangroves in each island, divided by mangrove category

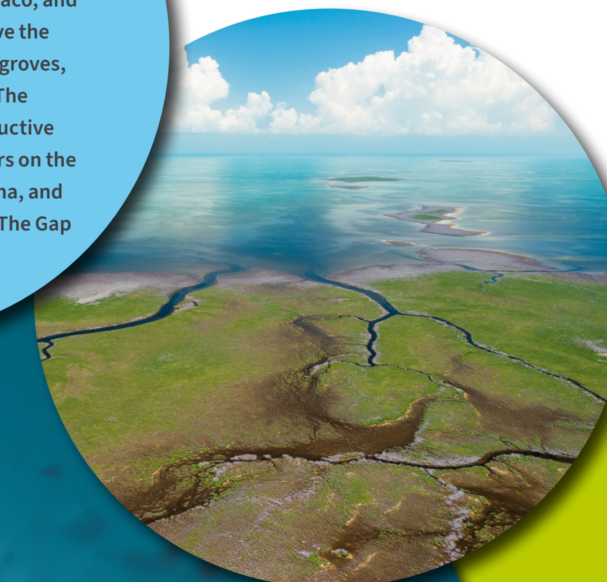
The amount of mangrove area varies among islands and the productivity and the ecosystem services they provide also varies considerably. Mangroves are **most common on the leeward side of islands** where they are sheltered from waves, but are limited to the fringes of creeks and protected sounds on the windward side of islands. Over **57% of mangroves in The Bahamas are considered dwarf** mangroves that only reach 3 feet in height. Their growth is stunted because of the conditions in which they live, including high salinity environments with little freshwater input and a rocky ground with little soil for roots to penetrate. These dwarf mangroves can serve as important areas for carbon sequestration and are great habitat for some fish species like mojarras (shad), and even juvenile bonefish, but they are **less productive nursery areas for many fish and do not sequester as much carbon as taller mangroves** that grow in more favorable conditions. With this index, we map out which islands have the most mangrove area and classify those mangroves based on their natural productivity.

Andros harbors the greatest area of mangroves in The Bahamas, with 56% of the country's total acreage.

Mangrove area map

The islands with the greatest mangrove area - Andros, Grand Bahama, Abaco, and Acklins & Crooked - tended to have the highest proportion of dwarf mangroves, growing in expansive tidal flats. The largest single area of highly productive mangroves in The Bahamas occurs on the northwestern tip of Grand Bahama, and is protected within Northshore / The Gap National Park.





DWARF TREES are less productive compared to scrub and tall mangroves, reaching heights no taller than 3 FEET

Mangrove damage

Over the past six years, nearly 90% of the productive mangroves lost in The Bahamas were a direct result of Hurricane Dorian

TAKE ACTION:
Report damaged areas to info@perryinstitute.org

Bahamian mangroves have been affected by a variety of threats that have damaged or killed plants or even destroyed the ecosystems entirely.

Over the past century, removal of mangroves by humans and conversion of mangroves into marinas, residential areas and other coastal development has been a large source of mangrove loss (see New Providence case study on page 22). Over the past decade, however, **mangroves have been relatively stable** and loss has been minimal, except in areas where major hurricanes have made landfall. In 2019 **Hurricane Dorian** had a major impact on mangroves across large areas of Abaco and Grand Bahama. In 2017, Hurricane Irma had an impact in the southern Bahamas, particularly for Acklins and Crooked Island, and Hurricane Matthew had an impact on mangroves on Andros in 2016. Here we identify areas where there has been substantial loss or damage to mangroves from 2016 through 2022. In some cases natural recovery has occurred and continues, but in others **restoration may be needed to "jump start" the recovery process.**

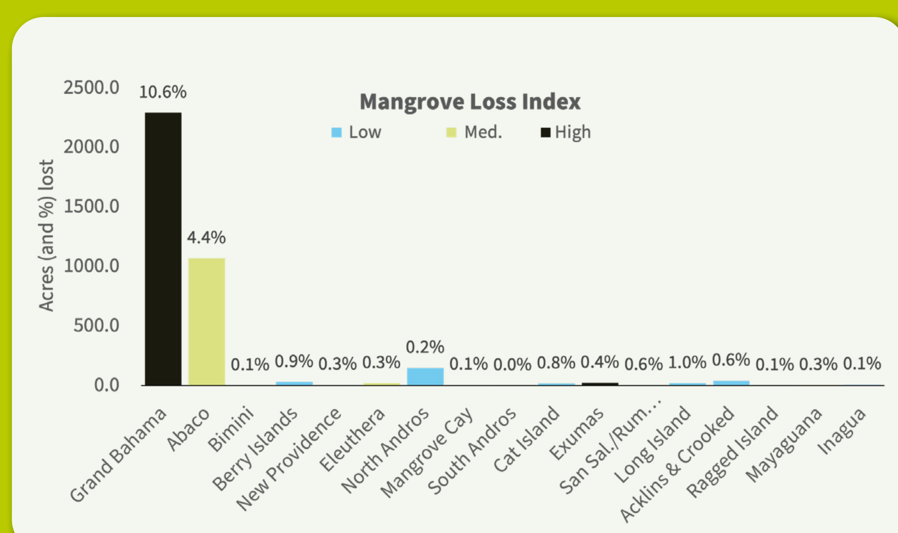
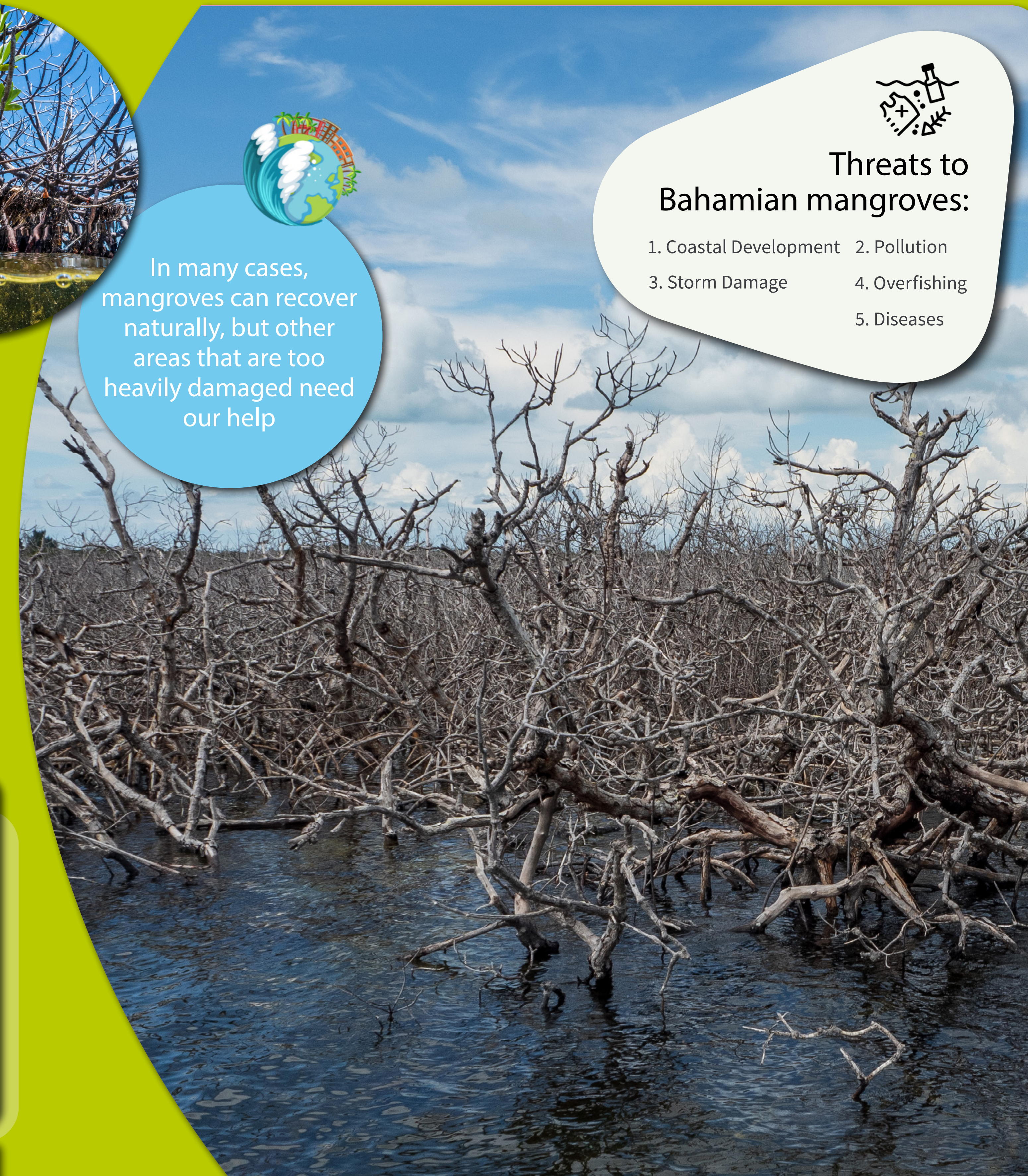


Fig 2: Total acreage of tall and scrub mangroves destroyed between 2016 and 2022 across The Bahamas

In many cases, mangroves can recover naturally, but other areas that are too heavily damaged need our help

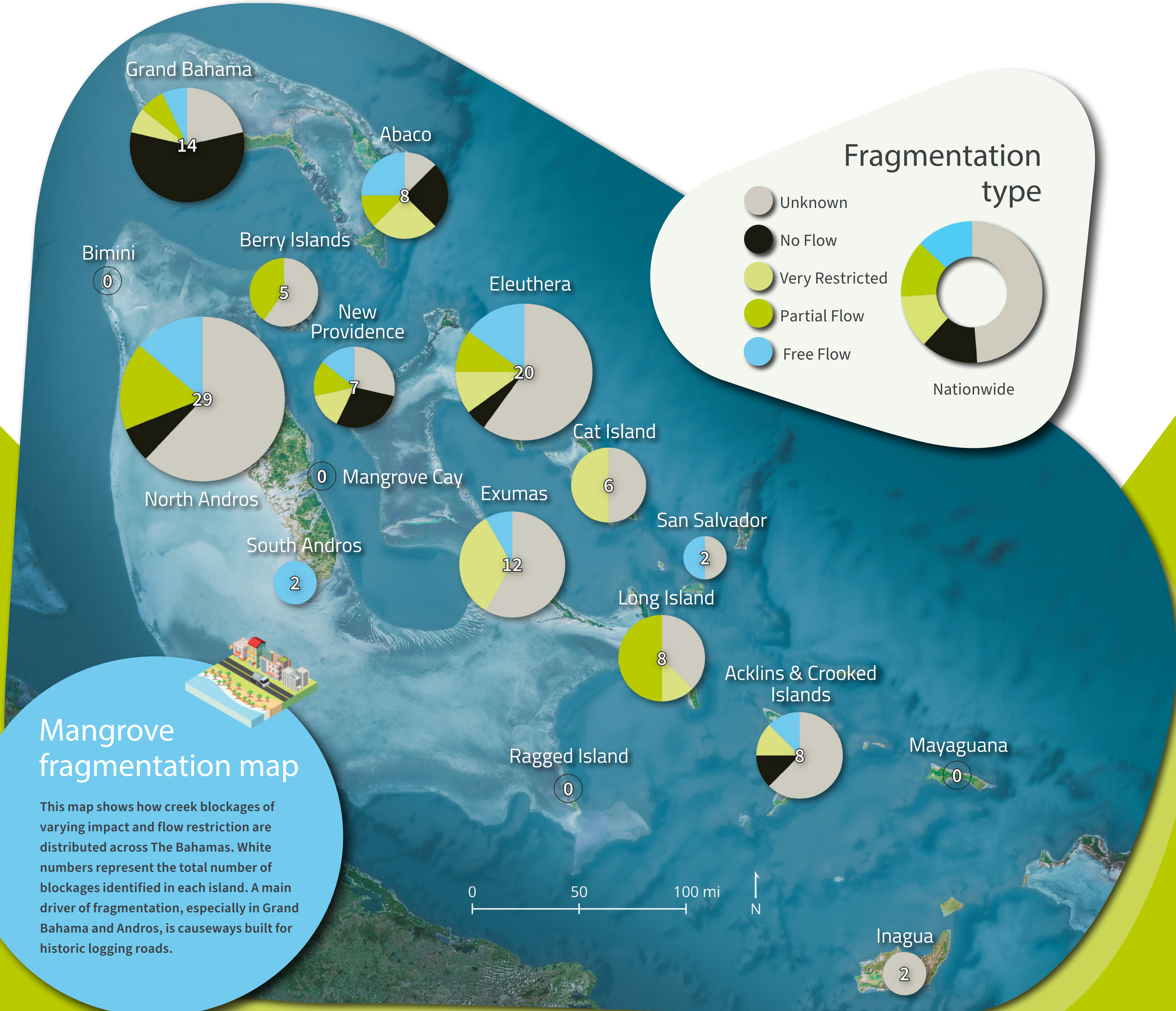


Threats to Bahamian mangroves:

1. Coastal Development
2. Pollution
3. Storm Damage
4. Overfishing
5. Diseases

Mangrove fragmentation

Mangrove fragmentation occurs when habitats are split, blocking natural water flow. This can have dire consequences for biodiversity and make flooding worse.



Mangrove fragmentation map

This map shows how creek blockages of varying impact and flow restriction are distributed across The Bahamas. White numbers represent the total number of blockages identified in each island. A main driver of fragmentation, especially in Grand Bahama and Andros, is causeways built for historic logging roads.

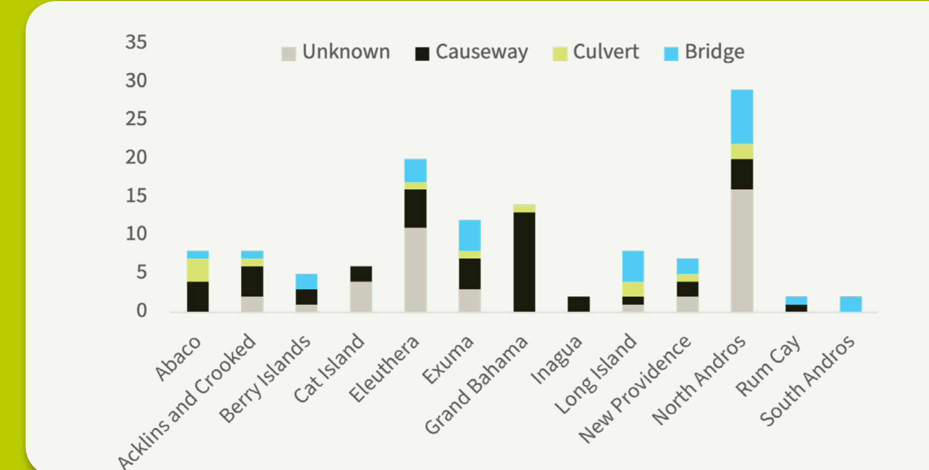


Fig 3: Number of each type of blockages by island

The reduction in mangrove area and productivity noted in the previous index is not the only way that mangrove ecosystems can be degraded and their ecological and economic value lost. **Habitat fragmentation** or the splitting of a habitat into several areas with minimal connection, can also change how an ecosystem works. Fragmentation to mangrove habitat usually occurs in **tidal creeks** and comes in the form of **flow blockage** due to a causeway that cuts off one part of a creek from another. Sometimes, culverts installed in the causeway are too small or are damaged, limiting water flow. In these cases, **fish and other species may no longer have access to significant amounts of nursery area,** reducing the ability of mangroves to support biodiversity and fisheries. Similarly, **restricted water flow may not be able to provide adequate drainage** during flood events, causing salt buildup or increased flooding that kills native plants and potentially puts lives and property at greater risk during storms.

CAUSEWAYS are the most common blockage and have the greatest impact on disrupting water flow & ecological function

Creeks with blocked water flow in The Bahamas have lower fish species richness & reduced populations of many key species throughout the creek, not just the blocked area

A bird's eye view

The color of the water on the two sides of the Gap Creek causeway illustrates the devastating impacts of creek fragmentation and flow blockage. This site is one of more than 50 across the Little Bahama Bank that we have surveyed in the aftermath of Hurricane Dorian using our advanced multispectral imaging drone to map patterns of mangrove health. To date, we've **mapped more than 20,000 acres** in The Bahamas with this system, providing a centimeter-level look at mangrove condition and how it is changing over time.

The seaward end of the creek is another story: water flows freely, providing great habitat for bonefish, turtles and other species. Removing the causeway would reconnect this creek and restore its function.

The inland part of Gap Creek in northern Grand Bahama is completely cut off from the ocean by a logging road causeway, seriously impairing its water quality and its ability to support fish populations.

Multispectral imaging allows us to see beyond the visual spectrum of light and detect invisible changes in plant health and water quality

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Fish diversity

Groupers were only observed in 5% of mangroves. Mangroves in Savannah Sound, Eleuthera & Exuma harboured the greatest densities of juvenile groupers

Fish species richness is used as a proxy for the diversity of life living in Bahamian mangrove systems.

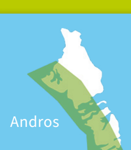
Diversity, or fish species richness, naturally **varies based on the quality of mangroves as fish habitat,** but can also vary due to human impacts or the effects of natural disasters. Overall, mangroves in The Bahamas had a fish diversity score of Medium (mean of 1.9 species per transect per site), but individual sites varied with **42% of sites having a score of High or Very High**.

Sixty-seven percent of mangrove sites within the Berry Islands received a score of Very High with an overall island score of Very High. Fish communities in Grand Bahama, Eleuthera and the Exumas were also diverse and ranked as High overall.

Conversely, **many mangroves (58%) around the Westside of Andros had Low fish diversity scores.** This is likely the natural state of mangroves there and not a result of human impacts as human presence there is low. Rather, the **mangroves in this area are not located in close proximity to coral reefs,** where they may receive larvae from a diverse range of species. Instead they are dominated by snappers (particularly gray snappers, which may live in mangroves their whole lives) and lack many of the fish that live on reefs as adults. In contrast, on the east side of Andros, two thirds of sites had scores of Medium or higher, and included parrotfish and other species.

Fish diversity

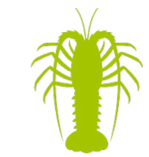
was higher in mangroves that were in close proximity to coral reefs



Mangroves in Westside National Park scored low in fish diversity but high in abundance

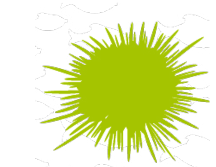
Queen conch were most abundant in the Exumas

Queen conch fisheries generate more than $7 million annually for the Bahamian economy.



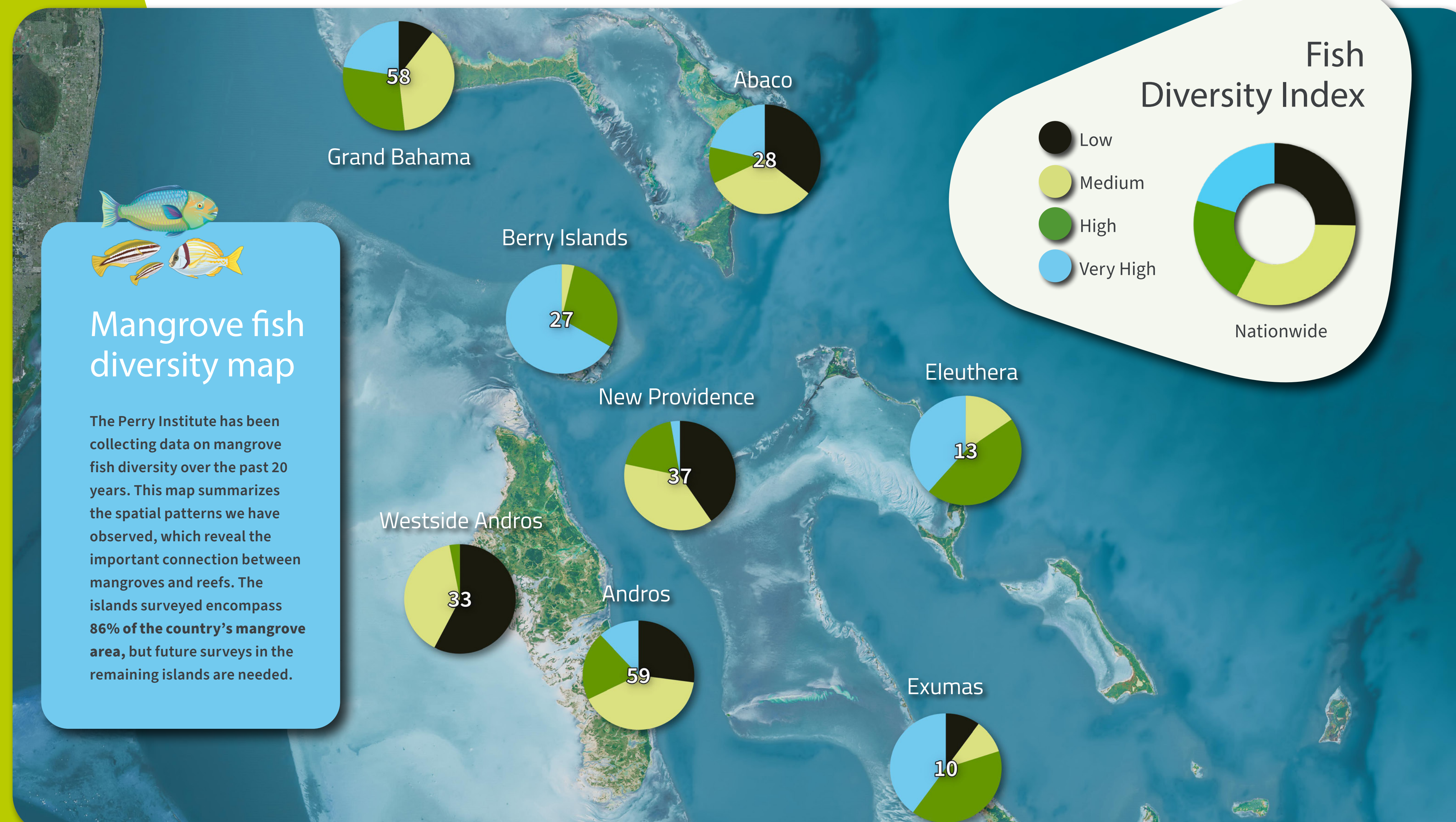
Spiny lobster were most abundant in Grand Bahama

The spiny lobster fishery is a cornerstone of the Bahamian economy, employing about 9,000 fishers in the country.



Diadema were only found in the Berry Islands & Abaco

Diadema antillarum, or long-spined black sea urchins, are key grazers that prevent algae overgrowth on coral reefs.



Mangrove fish diversity map

The Perry Institute has been collecting data on mangrove fish diversity over the past 20 years. This map summarizes the spatial patterns we have observed, which reveal the important connection between mangroves and reefs. The islands surveyed encompass **86% of the country's mangrove area,** but future surveys in the remaining islands are needed.

42 % OF SITES HAD A SPECIES RICHNESS SCORE OF HIGH OR VERY HIGH

Fish nursery value

Mangroves are nursery grounds for key reef species. They provide an essential habitat for many marine species including ecologically and commercially valuable fish like parrotfish, barracudas, groupers, snappers and grunts.

Fish spend the early stages of life within the safety of the mangrove roots before making their way out into the open ocean as adults. The **overall fish nursery index rating for Bahamian mangroves was High,** with 42% of sites rated as Medium and 46% as High or Very High. **Only 9% of mangrove sites were rated as Low.** Eleuthera (Savannah Sound), Grand Bahama and the Westside of Andros had mangrove sites with some of the highest nursery index scores.

These **patterns appear to be driven by grunts and snappers,** which were common throughout The Bahamas. The highest densities of snappers and grunts were from the Westside of Andros and Savannah Sound, Eleuthera, respectively. **Savannah Sound also had the highest density of groupers, barracudas and parrotfish.** Conversely, mangroves around **New Providence had the lowest densities** of grunts, snappers and parrotfish, which is likely **due to poor water quality,** habitat degraded by **coastal development** and **limited connectivity** between mangroves and reefs.

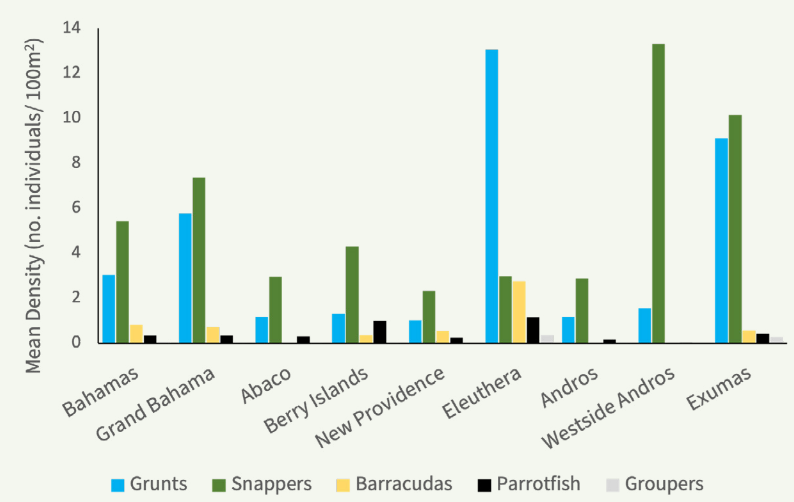
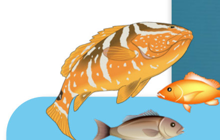


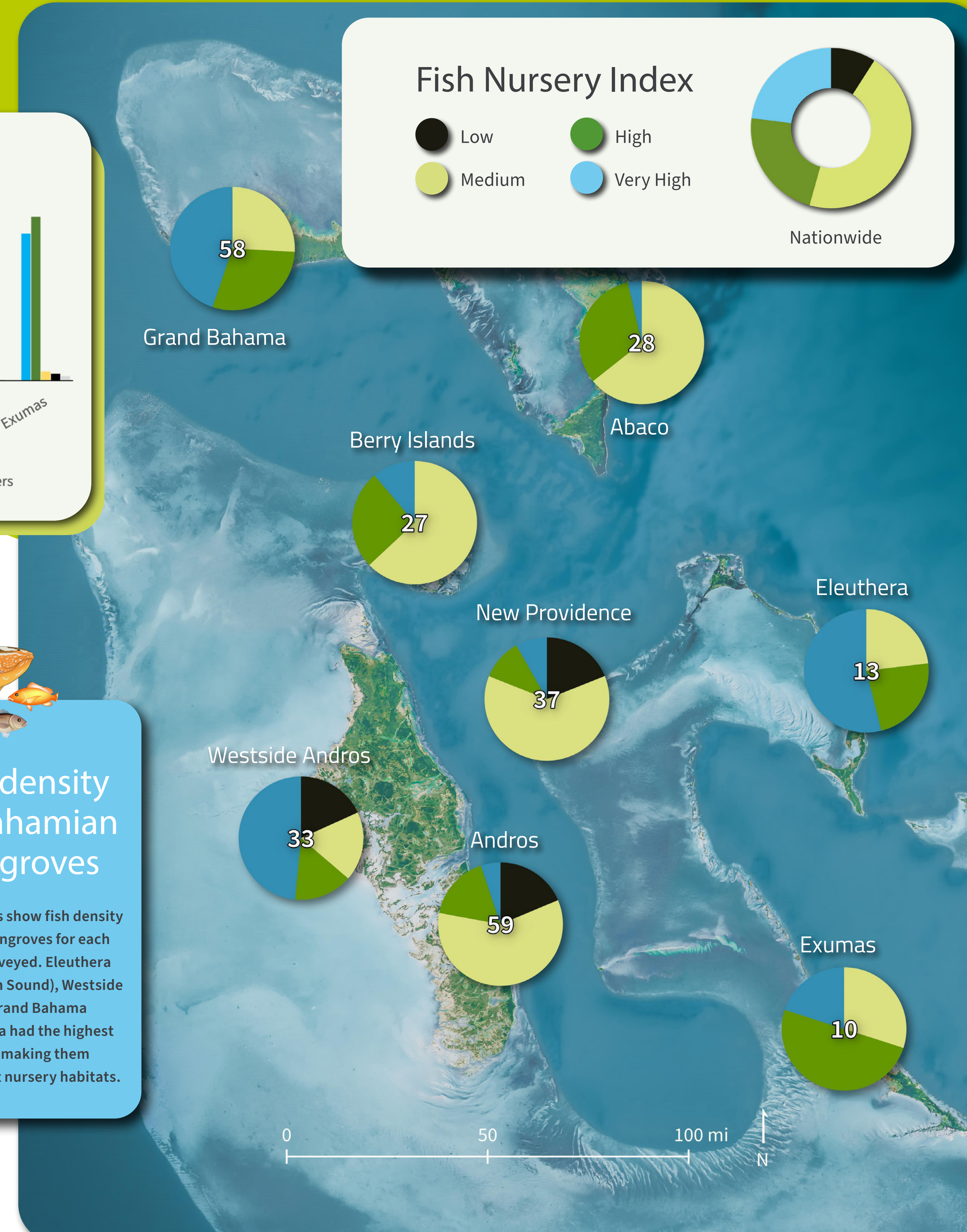
Fig 4: Mean density of key fish species by island

The mean density of parrotfish within mangroves was 14 fish per acre



Fish density in Bahamian mangroves

The charts show fish density within mangroves for each island surveyed. Eleuthera (Savannah Sound), Westside Andros, Grand Bahama and Exuma had the highest densities, making them important nursery habitats.



TAKE ACTION:
Dispose of waste properly and please DO NOT use mangrove areas as dump sites

A fish-eye view

In-water surveys at more than **250 sites** allow us to see exactly what is going on in the underwater world of mangrove creek systems. That's more than **15 miles** of transect surveys! Paired with our drone and satellite-based survey methods, we get a much more **holistic picture of ecosystem health and function** - from a single plant up to an entire island.

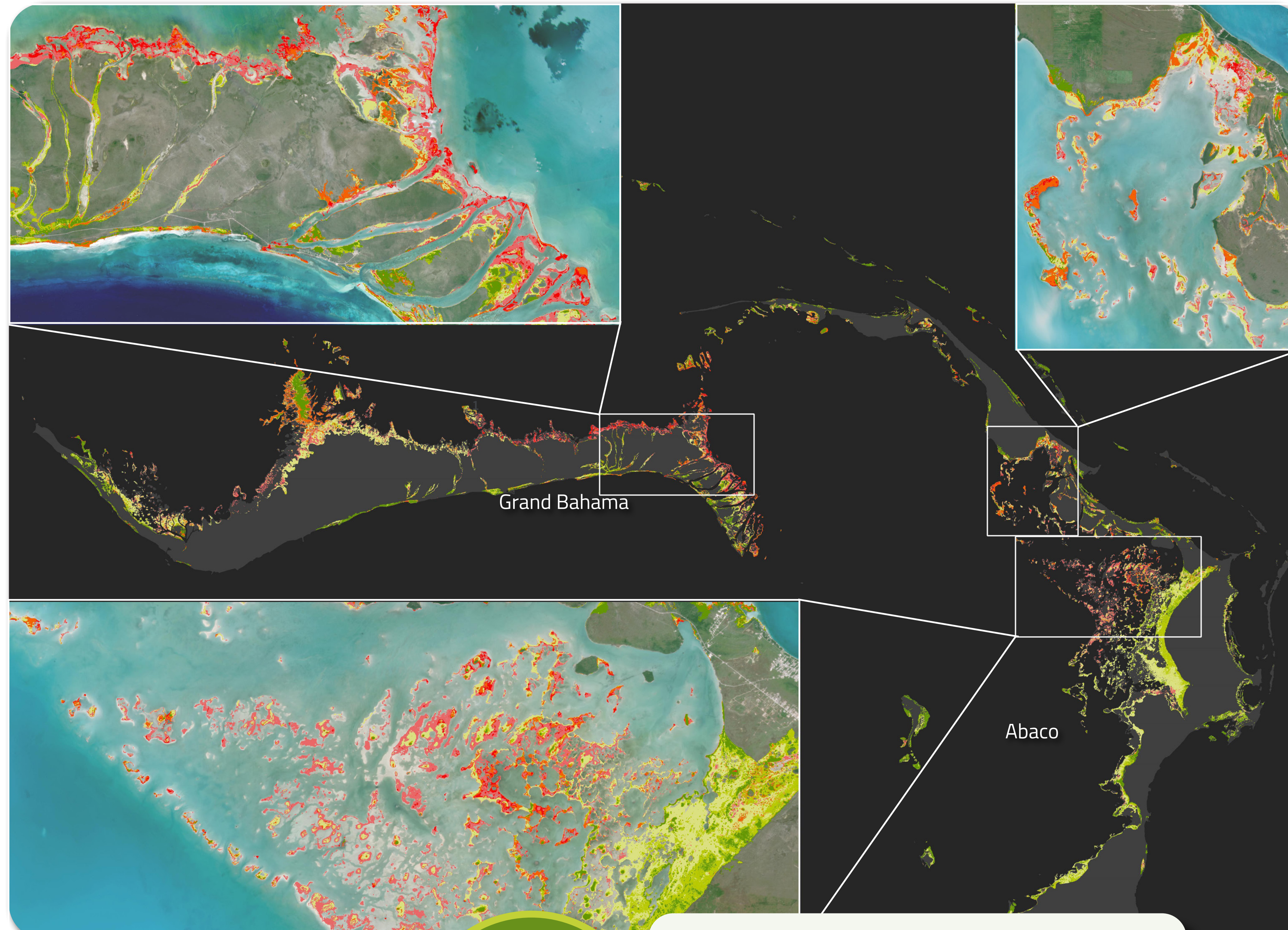
PIMS Senior Scientist, Dr. Krista Sherman, conducts an in-water survey to determine the fish diversity and nursery value of mangrove habitats in Stafford Creek, North Andros.

In Depth: Hurricane Dorian

Hurricane Dorian had a tremendous impact on mangroves of Abaco and Grand Bahama.

Using advanced high resolution satellite technology to map and characterize mangroves, we have improved estimates of mangrove loss and damage for both Abaco and Grand Bahama. On **Grand Bahama,** a total of nearly **14,000 acres** of mangroves (22% of the island's mangroves) **were wiped out** and nearly 9,000 acres (14%) saw significant damage. On **Abaco,** over **10,000 acres** of mangroves (14%) **died** and an additional 5,500 acres (7%) saw significant damage. Most of this damage was in East Grand Bahama, the north coast of Grand Bahama, and parts of the Marls of Abaco. There is **hope for recovery,** however. Three years after the storm, we are seeing **natural regrowth of plants that survived the storm and recruitment of new seedlings** in many areas. Nevertheless, there are significant areas with little to no recovery, where restoration is needed to jump-start the process. Focusing **restoration efforts** on these areas will be critical for helping mangrove systems recover before we start seeing significant ecological impacts from their loss, including loss of biodiversity, shoreline erosion, and degradation of fisheries.

TAKE ACTION: Volunteer to help restoration efforts in Grand Bahama & Abaco



14% of Abaco's mangroves died after Hurricane Dorian, or 10,000 acres

Mangrove loss from Dorian

- Stable mangrove
- Moderate damage
- Severe damage
- Mangroves destroyed

22% of Grand Bahama's mangroves were wiped out by Hurricane Dorian

In Depth: Dorian's fish impact

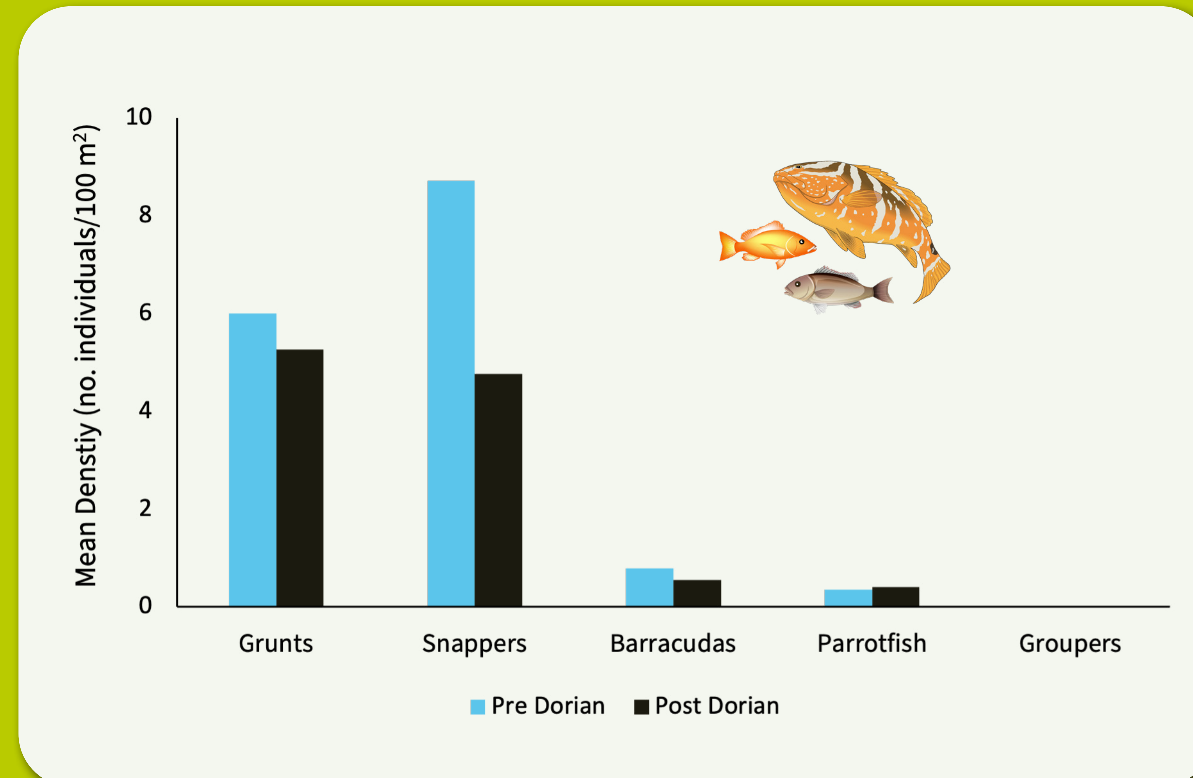
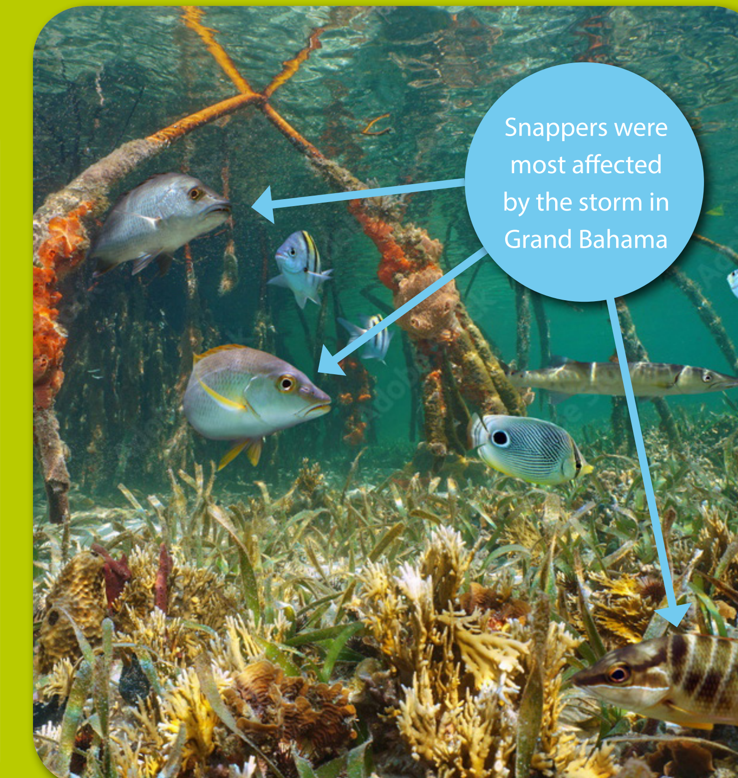


Fig 5: Mean fish densities throughout Grand Bahama before and after Hurricane Dorian



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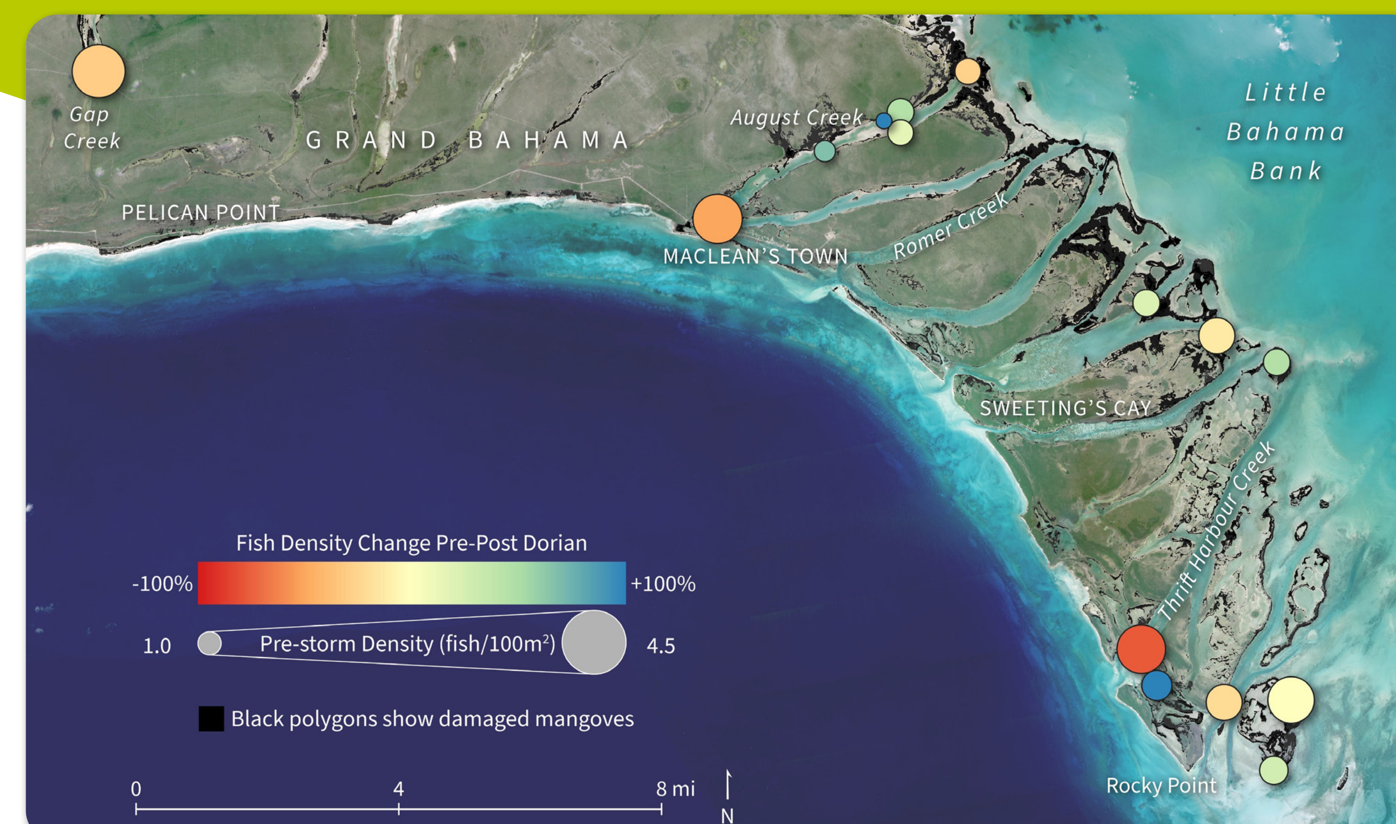
Recent mangrove loss hardly affected fish abundance, but populations are predicted to decline within 3-5 years in areas where mangroves are unable to recover.

Hurricane Dorian had a tremendous impact on the mangroves of Grand Bahama and Abaco, but the loss of living mangroves actually had minimal impact on fish populations two years after the storm. A comparison of fish populations in storm affected areas before Dorian (2013-2019) vs. after (2021) showed **few significant changes.** There were only a few sites where changes in fish populations occurred and these changes were inconsistent among sites. For example, one site near Thrift Harbour in East Grand Bahama showed a decrease in snappers and grunts after the storm, but a nearby site showed an increase in grunts and parrotfish and a decrease in snappers and barracudas. Overall, fish populations appeared to be stable – for now.

This is likely due to the fact that the **root systems** that fish use for shelter **remained intact after the storm** in most places even though the mangrove trees had died. These dead roots **have become brittle and are starting to break up.** As this happens, the value of these roots as fish habitat will decrease and **fish populations are likely to decline over the next 3-5 years** if living mangroves do not replace deteriorating dead mangroves. **Mangrove restoration is needed** in many places to prevent this decline.

TAKE ACTION:

Incorporate mangrove conservation needs into broader coastal zone management planning

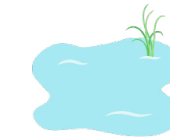


Most sites showed no significant short-term changes in fish populations before and after Hurricane Dorian

In Depth: New Providence

37% of New Providence's coastal mangrove creek areas have been lost since the 1950s

75 % of the former Malcolm Creek system was lost to development



Bonefish Pond is the largest remaining coastal creek in New Providence

Adelaide Creek remains mostly intact, but lacks protection & is threatened by encroachment

A story of development

While little mangrove area has been lost recently in New Providence, many mangroves have been lost to coastal development historically. An analysis of mangrove change for New Providence was conducted by comparing historic aerial imagery collected in 1958 and 1967 with 2014 satellite images. In the 50+ years since that aerial imagery was collected, **extensive development has occurred in New Providence's mangrove systems including clearing of trees, dredging and filling**. This has turned some formerly productive mangrove creeks into housing developments and marinas. Developments like **Seabreeze Canals, Coral Harbour and Old Fort Bay were all carved out of existing mangrove creeks.** In total, approximately 37% of New Providence's coastal mangrove creek area has been lost since the 1950s. The dredged canal systems that have replaced mangrove creeks provide a fraction of the original habitat value and ecosystem services. In addition to mangrove loss, **fragmentation by road building has reduced connectivity** in other creek systems, deteriorating their habitat quality for fish and other marine life, and **encroaching development has reduced water quality.**

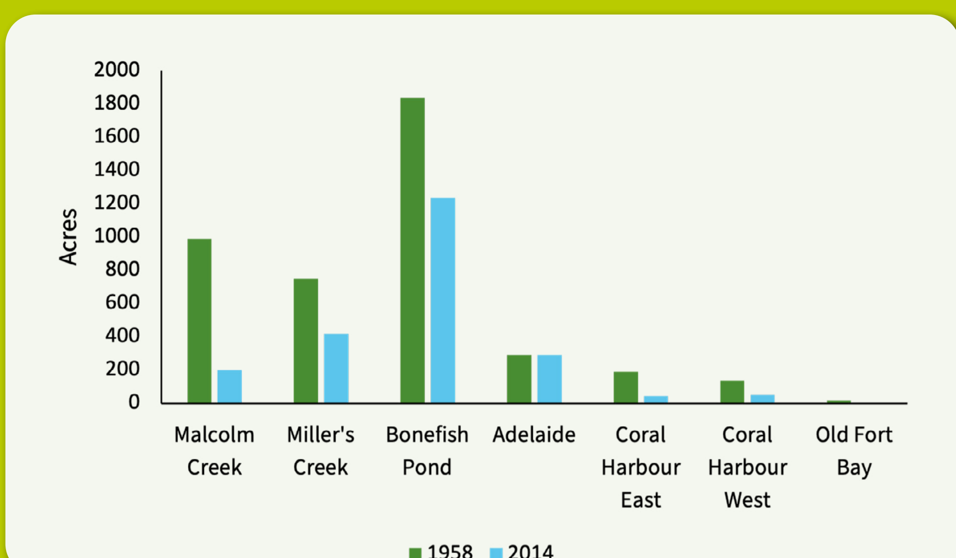


Fig 6: Mangrove creek change in New Providence from 1958-2014

In Depth: Restoration

Volunteers help to restore mangroves in Bonefish Pond

TAKE ACTION:
Contribute to restoration and monitoring efforts in your community

In places where mangroves were catastrophically damaged by Hurricane Dorian, restoration is needed to help "jump start" the recovery process.

In areas where mangroves have been lost or the function of mangrove systems has been compromised, their value in supporting biodiversity and providing ecosystem services is often lost. Here, mangrove restoration may be an option. **Mangrove restoration may take different forms** depending on the cause of mangrove loss, if the environment has been altered, and the goals of the restoration. There are several examples of mangrove restoration in The Bahamas. In places like Cross Harbour, Abaco and August Creek, Grand Bahama, where old logging roads had causeways that prevented water flow in mangrove creek systems, **installing a culvert to allow water flow or opening up sections of the causeway restored function of the mangrove system.** In places where mangroves were killed by **Hurricane Dorian,** however, **replanting mangroves is needed** to help the recovery process take hold. In places like Bonefish Pond National Park where a dredged channel altered water flow, a combination of restoring hydrology and replanting was necessary. In all cases, using the **best available science** to guide restoration will improve the likelihood of success for the restoration.

When replanting mangroves is needed, there are several options to choose from, including **planting seedlings** grown in nurseries, **planting propagules** directly or facilitating natural recruitment by **dispersing propagules** in an area. In each case, mangrove propagules (red mangroves) or seeds (white and black mangroves) are collected from healthy populations and then either grown in a nursery, planted directly at the restoration site or dispersed at the restoration site by water or dropped by air to replenish areas difficult to access. The **method used may depend on** characteristics of the **restoration site** as well as the goals of restoration, budget, available resources and scale of the restoration.

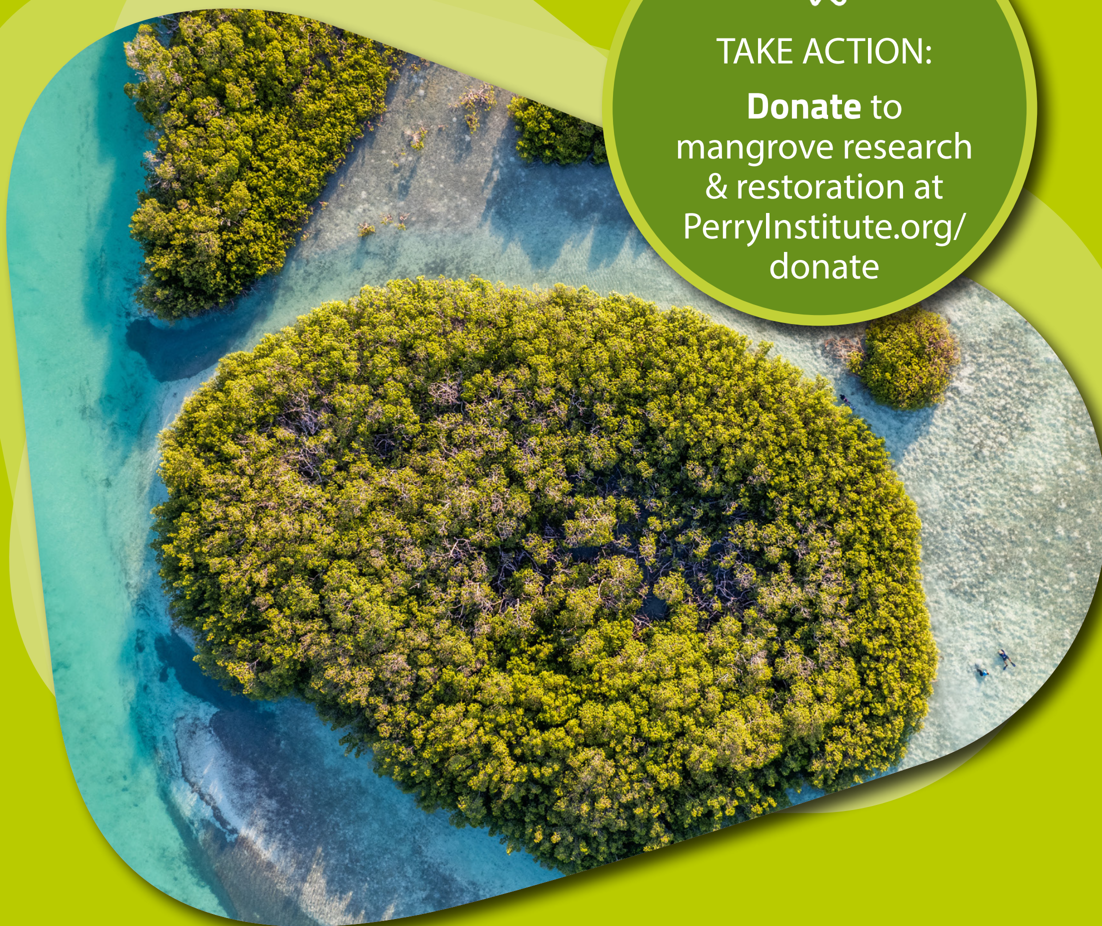
Stakeholders should also be included in each part of the mangrove restoration process, including assessment, planting and monitoring. Stakeholder input can be useful in targeting areas for ecological analyses, and social value can be used as a metric to help prioritize mangrove areas for restoration. **Understanding community perceptions** on and values of restoration efforts **will be key** to securing community support and driving behavior change.

Mangrove restoration has been undertaken on four islands in The Bahamas in the past decade: New Providence, Grand Bahama, Abaco and Andros

To date, PIMS has planted more than **20,0000 mangroves** for its restoration endeavors in Abaco and Grand Bahama

More than **50,000 mangroves** have been replanted collectively in areas affected by Hurricane Dorian. This site (pictured) is managed by Bonefish & Tarpon Trust.

PerryInstitute.org/donate



TAKE ACTION:

Donate to mangrove research & restoration at PerryInstitute.org/donate

Partners:

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