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CENTRAL CARIBBEAN
MARINE INSTITUTE

CELEBRATING CCMI'S 20 YEAR ANNIVERSARY

CAYMAN ISLANDS REEF SURVEY REPORT

20 Year Report on the Status and Trends of the Coral Reefs in the Cayman Islands 1999 - 2018

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In 2018, the Central Caribbean Marine Institute (CCMI) celebrated the 20th anniversary of conducting research on the health status of the coral reefs in the Cayman Islands. While data has been collected almost every year in Little Cayman, Grand Cayman and Cayman Brac were also surveyed in 1999 and 2018.

Teams of scientists from CCMI completed field expeditions using the Atlantic & Gulf Rapid Reef Assessment (AGRRA) protocol to get a snapshot of the status of the reefs in the region. This significant record provides insight into the changes that have occurred between these points in time. Little Cayman benefits from less than 250 residents and limited development, making it a rare site in the Caribbean, offering an important understanding of the history and trends of the reefs for the region "(Manfrino et al., 2003; Coelho and Manfrino, 2007; Manfrino et al., 2013). The combined 20 year and annual surveys give a unique insight into how disturbances such as storms and bleaching, human impacts, and, conversely, marine protection have led to changes on these reefs. We also gain a glimpse at the coral reef biological diversity and capture differences over time and space, between the three islands.

CONTENTS

KEY RESULTS: SNAPSHOT

- Surveys of 25 sites around the Cayman Islands were conducted in 1999 and repeated in 2018.
- Coral cover has reduced across all three islands. Grand Cayman has seen a shift in coral cover from 21% to 15% in 1998 and 2018 respectively. Little Cayman has the highest coral cover but also saw a decline from 28% to 22% between 1999 and 2018 respectively.
- The Cayman Islands overall coral cover rates as 'Fair' in 2018 with 17% cover. This has declined from 21%, rated "Good', in 1999.
- Macroalgal cover, which is detrimental to coral recruitment, has not changed statistically on Little Cayman but has increased significantly on Grand Cayman and Cayman Brac.
- Total fish density (all fish families combined) has not changed on any island. Overall, the average length of fish across the three islands has increased except for parrotfish on Cayman Brac, which have decreased.
- Significantly, decreases in parrotfish and coral size, as well as the increase in percent macroalgal cover indicate a decline in reef health.

OVERVIEW

A team of six science divers from CCMI conducted reef surveys of 25 reefs across the three islands in 2018, revisiting sites which were first surveyed in 1999 (Manfrino et al. 2003). Data from this snapshot offers important insight into the resilience, resistance and vulnerabilities of reef ecosystems over the last 20 years.

We employed the same Atlantic & Gulf Rapid Reef Assessment (AGRRA) protocol as was used to survey the reefs in 1999. We measured and counted fishes, algae and corals to species level, as well as recorded coral health and mortality. For a broad context, we compared our results to the Healthy Reefs Framework developed for evaluating the Mesoamerican reefs www.healthyreefs.org/cms/report-cards. Statistical analyses were conducted separately for each island and for each fish family. This report aims to offer a general overview of trends which provides significant evidence for the increased need for conservation efforts to protect this vital resource across the islands.

THRESHOLD VALUES FOR INDICATORS

GRADE	VERY GOOD	GOOD	FAIR	POOR	CRITICAL
CORAL COVER	40%	20%	10%	5%	<5%

FIGURE 1: *Threshold values for coral cover established by the Healthy Reefs for Healthy People Initiative, used in the Mesoamerican Reef Report Card 2018.*

CORAL COVER

'Coral cover' is the percentage of reef that is occupied by living, reef-building, stony coral species and is an important metric used worldwide to infer reef health. Using coral cover data from the 1999 and 2018 survey sites, Grand Cayman decreased from 21% to 15%, Little Cayman decreased from 28% to 22% and Cayman Brac decreased from 15% to 13%. Based upon the Healthy Reefs Threshold Values (Figure 1), by 2018, a greater percentage of the reef sites are in 'fair' and 'poor' condition (Figure 2). Overall, average coral cover at the survey sites in the Cayman Islands decreased from 21% or 'good' condition in 1999 to 17% or 'fair' in 2018. Unfortunately, this trend is seen across the Caribbean where we have witnessed declines in coral cover for many decades (Gardner et al. 2003). The regional average of coral cover was 18% in 2015 (Perry et al. 2015) and coral cover in the Cayman Islands is somewhat better than several of our nearest neighbours (Table 1; Loh et al. 2015, Suchley & Alvarez-Filip 2018).

The prevalence of coral disease was lower in 2018 than in 1999. This is no surprise because in 1998, high prolonged ocean temperatures resulted in massive bleaching and coral mortality globally. In the Cayman Islands, we tracked an outbreak in white plague syndromes in corals, which resulted in a 40% relative mortality in corals from 1998 to 2009. We recorded notable decreases and increases in coral growth and recruitment at Little Cayman from the annual surveys: average live coral cover at survey sites across all three islands decreased from 25-14% from 1998 to 2009. Yet surveys conducted in 2010 indicated that live coral cover improved from 14-20%. In 2011, coral reefs recovered from 20% to 25% cover, indicating that corals were still capable of recovering from a global climate stress event (Manfrino et al 2013).

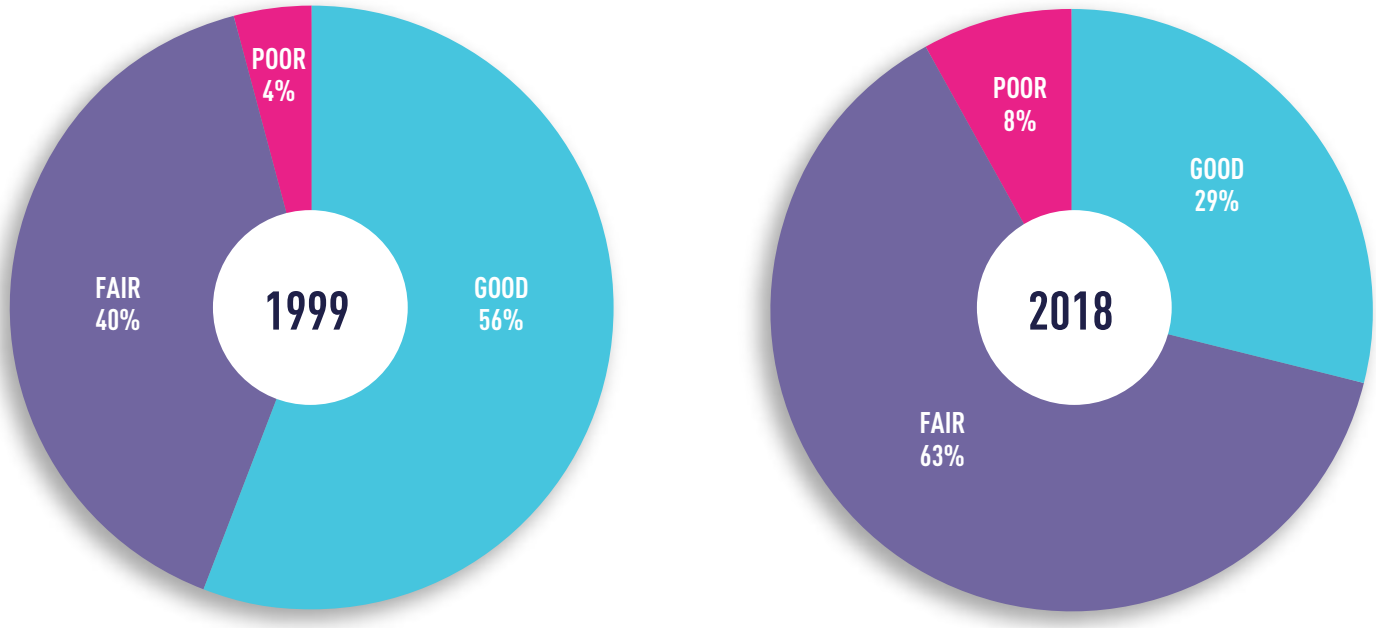

***FIGURE 2**: Comparison of reef health determined by coral cover for the reefs of Cayman in 1999 & 2018.*
The percentages indicate the proportion of reefs in each condition for that year. Across the country, the proportion of reefs in 'poor' and 'fair' conditions has increased and the proportion in 'good' condition has decreased. Coral cover in the Cayman Islands overall was 21% or 'good' in 1999 and was 17% or 'fair' in 2018.

CORAL COVER

	COUNTRY	% CORAL COVER	YEAR	REFERENCE
	Dominican Republic	31	2015	Loh et al. 2015
	Guatemala	27	2016	Healthy Reefs Report 2018
	Honduras	22	2016	Healthy Reefs Report 2018
	Cayman Islands	17	2018	This Report 2018
	Belize	16	2016	Healthy Reefs Report 2018
	Puerto Rico	15	2015	Loh et al. 2015
	Bahamas	14	2015	Loh et al. 2015
	Mexico	12	2018	Suchley & Alvarez-Philip 2018
	Antigua & Barbuda	9	2005-2013	Kramer et al. 2016
	Curacao & Bonaire	9	2013	Bakker et al. 2017
	Jamaica	8	2015	Loh et al. 2015
	Florida Keys	4	2015	Loh et al. 2015

***TABLE 1**: Percent Coral Cover in Countries Neighbouring the Cayman Islands*

CORAL SIZE

Coral diameter is used as an indicator for measuring reef structure and coral size varies with several factors in addition to age - such as species and wave action. Some species grow to massive sizes, over hundreds of years and can be several meters in height and diameter. Larger corals and branching corals provide reef habitat for myriad marine organisms. Smaller corals are less able to provide three-dimensional structure and hence are less able to support larger organisms. The ability of the reef to protect islands and coasts from storms and wave erosion is also greater with larger corals.

Unfortunately, by 2018, little growth was measured across the islands and the average coral colony size actually decreased on Grand Cayman and Little Cayman, as outlined in Figure 3. Species composition changed across all three Cayman Islands, with large massive species declining. The data indicate that corals are not growing to their maximum size. One good sign, however, is that coral recruitment is occurring. Smaller corals are an important indicator of the reef's capacity to continue to persist. Loss of coral size and coral cover however, means that the reefs have a significantly reduced ability both to support a complete ecosystem as well as to protect the island from storm and wave damage.

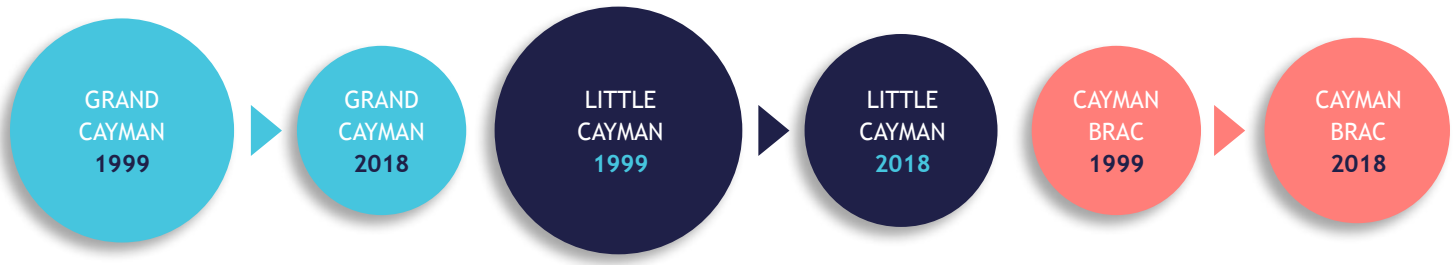

***FIGURE 3**: Change in Mean Coral Diameter for Each Island*
Each circle represents the average coral diameter for that year. Coral diameter decreased significantly on Grand Cayman from 44.5cm to 34cm. Little Cayman decreased from 48.7cm to 37.8cm and increased on Cayman Brac from 32.6cm to 35.8cm.

MACROALGAL COVER

The percentage of the reef occupied by fleshy seaweed (termed % macroalgal cover) is another metric widely used to indicate the health of coral reefs. Macroalgae are an important part of the ecosystem, as they provide nutrients, food for fish and protection for invertebrates. However, macroalgae become detrimental to the reef when they outcompete and crowd out corals for space. Their presence can reduce survival, growth and reproduction of adjacent corals. Similarly, when algae become established on the reef, they also reduce coral recruitment capacity because juvenile corals cannot find the hard substrate required for development. Scientists have even discovered that the smell of algae can deter coral larvae from returning to the reef. Algal abundance can, therefore, directly impede recruitment of the next generation of corals and thus reef recovery.

Unfortunately, macroalgal cover of survey sites on Grand Cayman and Cayman Brac has increased with statistical significance. Macroalgal cover has increase from 34% to 57% at the Grand Cayman sites and from 50% to 64% on Cayman Brac from 1999 – 2018. There was also an increase from 48% to 55% of macroalgae on Little Cayman, though it was not statistically significant. Across the Cayman Islands as a whole, percent cover of macroalgae has increased from 44% to 59%.

FISH DENSITY

Fish density is another metric commonly employed to indicate health of a reef because it reflects the ability of the reef to provide suitable habitat for its larger inhabitants and food for the people who rely on the reef. Additionally, the density of herbivorous fishes on the reef is key because of the role they play in limiting abundance of macroalgae and turf which have a very detrimental impact on coral health. Healthy herbivorous fish populations are therefore critical in helping prevent algal take over and so play a key role in promoting reef resilience and giving the reefs the best chance of continuing into the future. Fish density is usually measured by fish family per one hundred square metres to give an overall perspective in comparison to space available.

Combining all fish families, total density has not changed statistically speaking on any island using the 1999 and 2018 data (Figure 4). When we analyse fish families separately, grunts, snapper, filefish, parrotfish and surgeonfish show no significant differences in density. However, grouper density has declined on Little Cayman. This is attributed to a major over-fishing event that occurred at the western grouper spawning aggregation site (SPAG) between 2000 and 2002(Figure 5). The SPAG is now closed and the population is recovering.

Particularly noteworthy is that human population density in the Cayman Islands increased from 39,000 people to over 63,000 in the 20 years of this study (Cayman Islands Economics & Statistics Office Statistical Compendium). With changing local demographics, there is also potential for changes in fishing activities and pressure on the reef, which warrants further investigation.

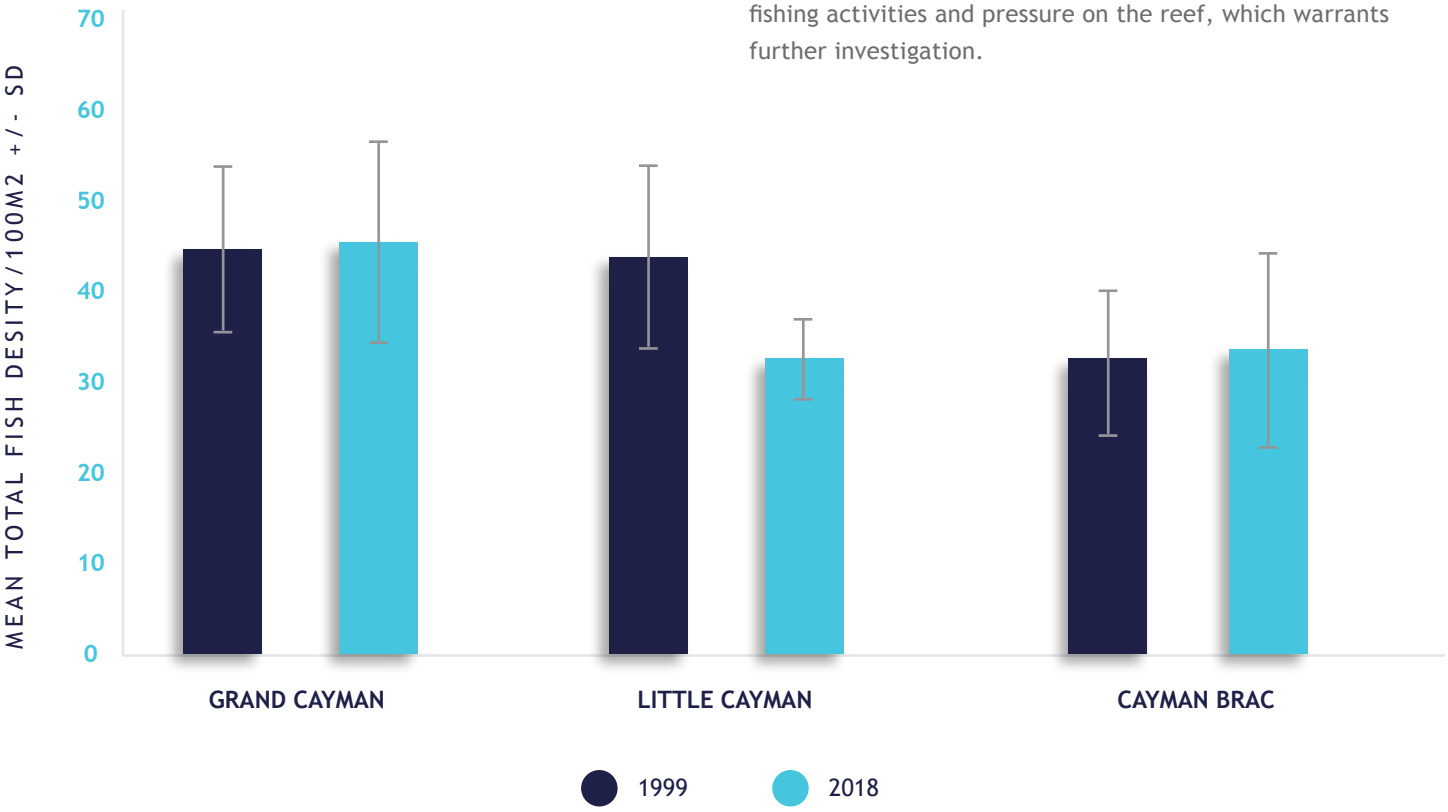

***FIGURE 4**: Density of All Fishes per 100m2 for Each Island in 1999 & 2018.*
Total fish density has remained constant on Grand Cayman and Cayman Brac over this time (46 fish/100m2 & 33-34 fish/100m2 respectively). Although fish density has declined on Little Cayman from 45 fish/100m2 in 1999 to 33 fish/100m2 in 2018 this is not statistically significant.

FISH DENSITY

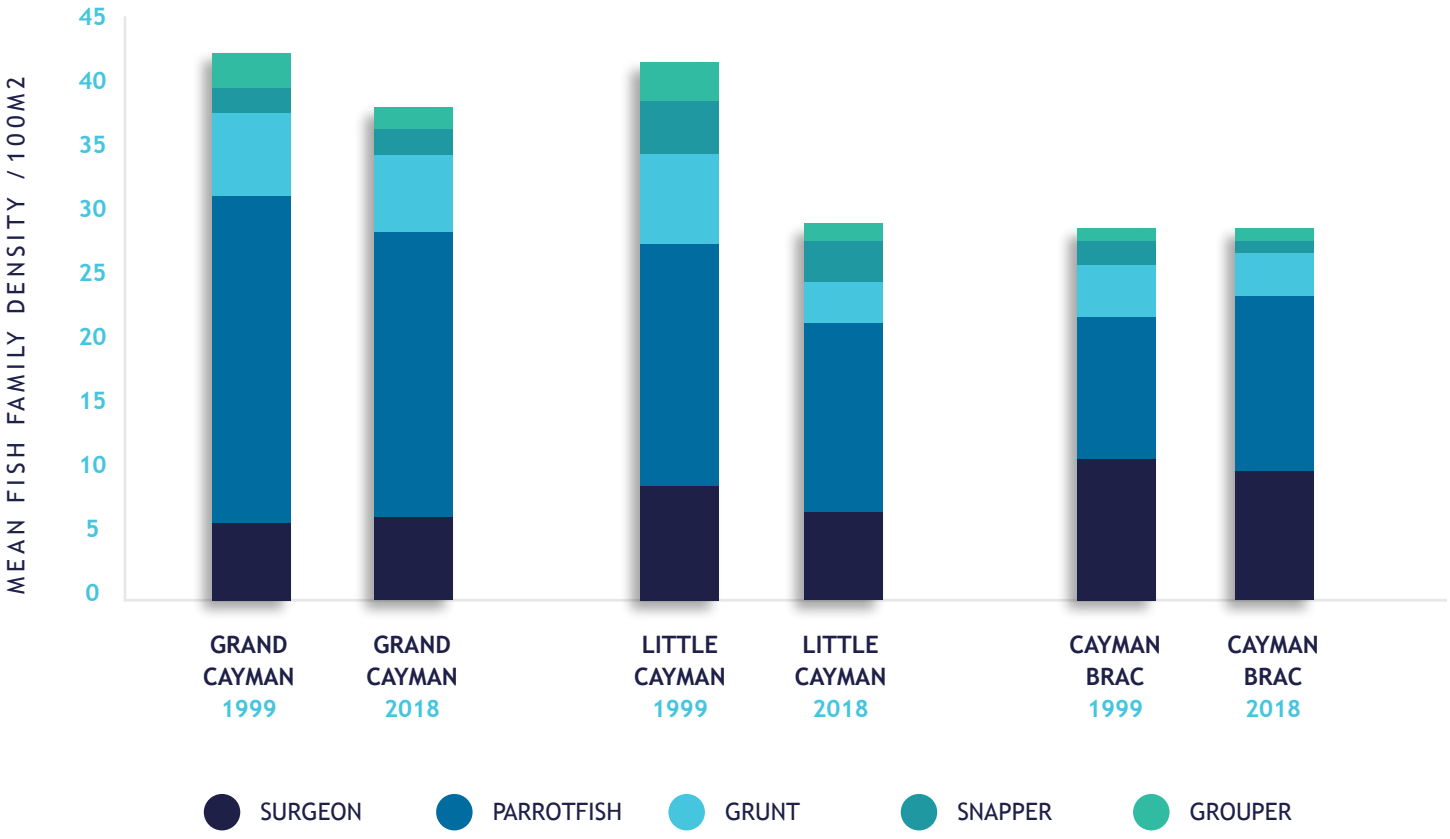

FIGURE 5: *Average Density per 100m2 of the Most Common Families for Each Island in 1999 and 2018.*
When analysing density of individual fish families separately, none have changed significantly except for grouper on Little Cayman only.

FISH SIZE

The final metric measured during the surveys is fish length. Much like coral size, this measurement informs us about the quality of the reef habitat as well as changes over time, for example as a result of management strategies, stochastic (random naturally occurring) events or changes in human pressure. This metric can also give an indication of a species' ability to recover from fishing pressure because the larger individuals produce disproportionately more offspring than smaller individuals.

While final analyses are still being conducted, the mean length of fish (grouped by family) have increased on all islands, except for parrotfish on Cayman Brac which have declined in mean length. The decline in average length of parrotfish on Cayman Brac is a cause for concern because the larger individuals play a disproportionately important role in the removal of algae and for reproduction of the species. Hence, the impact of parrotfish as grazers on Cayman Brac has diminished with the loss of the larger individuals. This may be linked to the significant increase in macroalgal cover on that island.

In August 2016, the Cayman Islands government instigated seasonal protection for fishing of the Nassau grouper in addition to the already legislated protection of the breeding areas (The National Conservation (General) Regulations, 2016). A low density of a species (like Nassau grouper or sharks, for example) in our transects make it difficult to conclude whether there are major changes from one point in time to another.

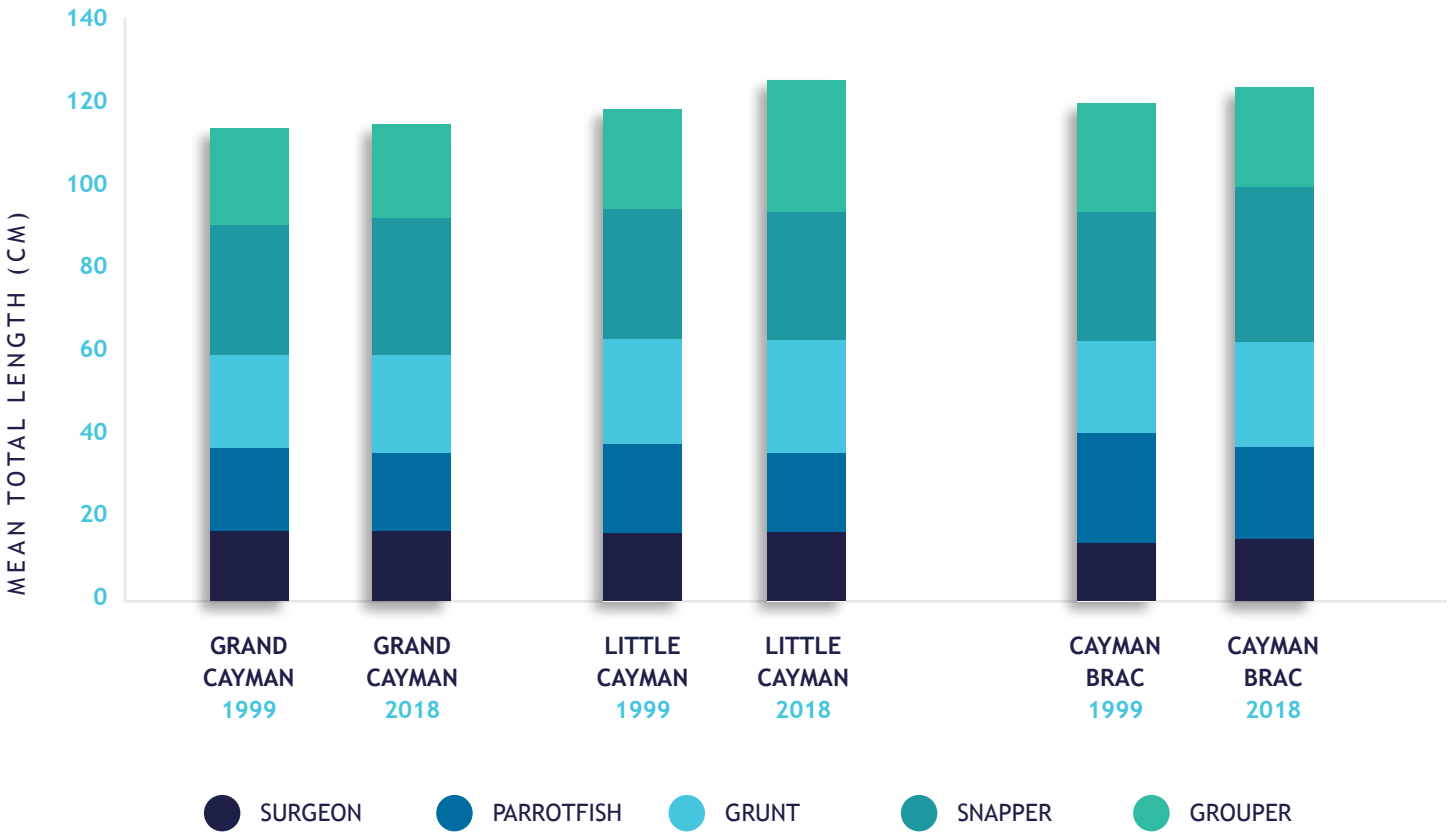

FIGURE 6: *Mean Length (cm) for Most Common Fish Families for Each Island in 1999 and 2018.*
There are no significant differences in average length for any fish family except for parrotfish on Cayman Brac (which declined from 26cm in 1999 to 22cm in 2018) and grouper on Little Cayman (see below).

FISH SIZE

On Little Cayman, the average grouper length has increased significantly since we collected the 1999 data. At the same time, grouper density has declined statistically significantly (Figure 7a). This could be the result of overfishing in previous decades, particularly the several thousand grouper that were caught in 2001 & 2002 from the Little Cayman west spawning aggregation. We need to investigate changes in the frequency of grouper species on these reefs to understand this more fully. Another possible explanation is that as fish have grown, they have come to require larger territories. Consequently, as territory size has increased the territories have become more spread out and thus the fish density has declined.

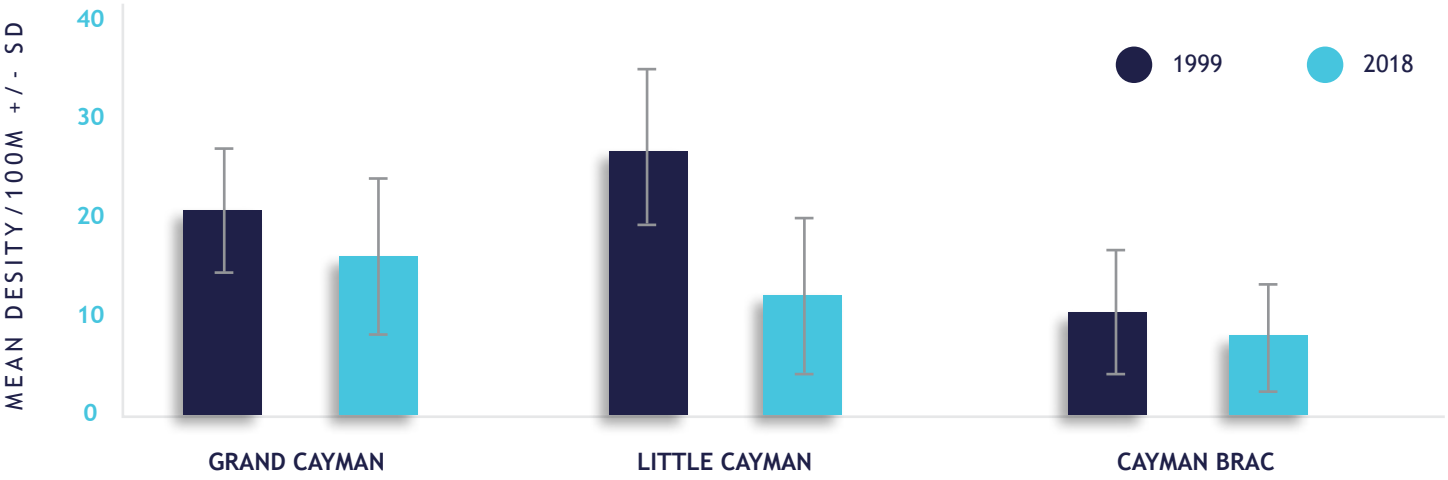

FIGURE 7A: *Average Grouper Density per 100m2 for Each Island in 1999 and 2018.*
Density of grouper has declined statistically significant on Little Cayman, from 2.8/100m2 in 1999 to 1.3/100m2. On Grand Cayman grouper density was 2.1/100m2 in 1999 and is now 1.6/100m2. On Cayman Brac grouper density was 1.1/100m2 1999 and in 2018 is 0.8/100m2

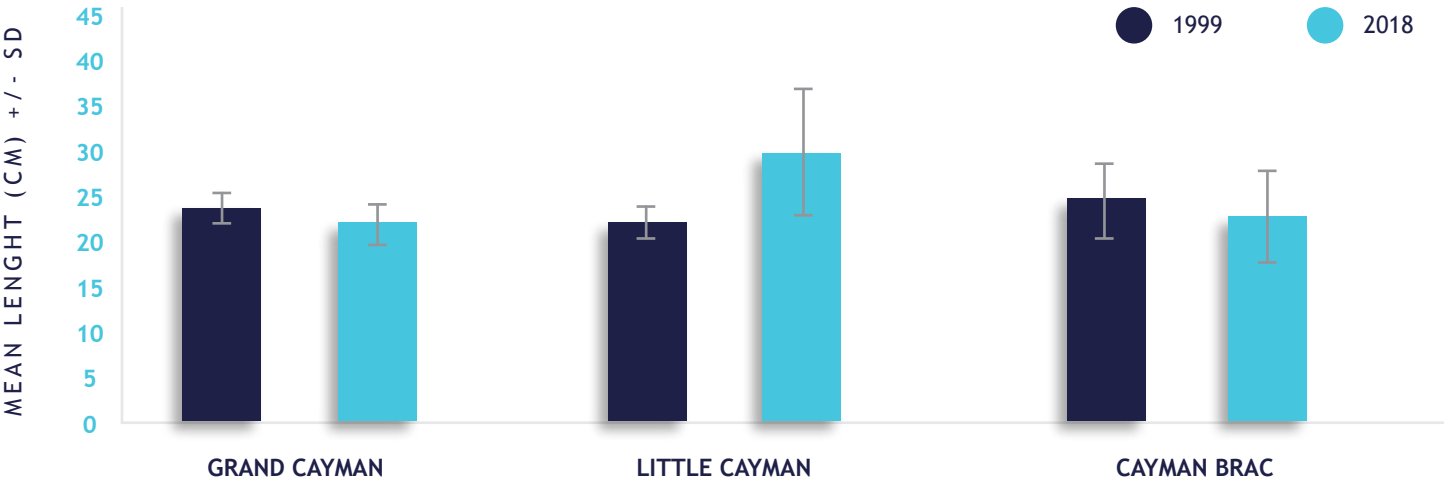

FIGURE 7B: *Average Length of Grouper (cm) for Each Island in 1999 and 2018.*
The average length of all grouper observed in our surveys increased significantly from 1999 on the reefs of Little Cayman (from 23cm to 31cm). On Grand Cayman and Cayman Brac average grouper length has not changed significantly (24cm to 23cm and 25cm to 23cm respectively).

CONSIDERATION FOR THE FUTURE OF CORAL REEFS

With so much bad news about coral reefs, it is critical that we reduce the threats to the reefs in the Cayman Islands. This is especially important because the reefs on Little Cayman have demonstrated the capacity for resiliency in the recent past (Manfrino et al, 2016). However, continued resilience and recovery will become unlikely if macroalgae continues to increase, human stress increases and natural disturbances (such as bleaching) become more frequent. Therefore, given the concerns regarding increasing sea temperatures, reducing human pressure is the most urgent action that our community can undertake to protect the reefs, as this report shows a general decline in reef health.

The two end points of CCMI's surveys, 1999 and 2018, help provide significant insight into major differences between the three islands. With further investigation, we can discern the factors that are responsible for the changes we have identified in this report. Annual surveys and analysis from Little Cayman helps make this an extraordinary dataset and story –that resilience and recovery is possible. However, the current rising seaweed cover will negatively affect coral regeneration and severely jeopardises the future of coral reefs in the Cayman Islands.

The very good news it that when we examined fish by their function, herbivores (plant eating) vs carnivores (animal eating), it is clear that herbivorous fish density and size on Grand Cayman has not decreased. However, it appears that algae are increasing to levels that the fish are unable to consume. It is imperative to address this further by active and targeted reef management of algae and herbivorous fish, and by increasing awareness of the great value coral reefs provide.

CONSIDERATION FOR THE FUTURE OF CORAL REEFS

New marine protections were proposed in 2019, which will increase in the Marine Protected Areas from 14% to 46%. This a huge positive step to protecting the coral reef ecosystem in the Cayman Islands.

The reef is also responsible for coastal protection from storms and wave erosion each year (Wolfs Company 2017). This protection becomes more critical, as the predictions that hurricanes will strengthen with warming waters (Elsner et al. 2008) are becoming a reality.

All stakeholders must come together, including the government and reef managers, researchers, corporations and the public who reside in the Cayman Islands, to prevent further decline in reef health and invest heavily in restoration efforts to improve the condition of the reefs of the Cayman Islands.

In summary, according to the coral cover thresholds outlined above and used in the Mesoamerican Reef Report Card 2018, the reefs the Cayman Islands are in 'fair' to 'good' condition. In publishing this report, CCMI hopes that everyone will be aware of the exceptional opportunity we have to take action to support healthy reefs. Our aim is that future surveys will reflect positive actions taken by all in the Cayman Islands now and into the future. As a direct result of these surveys, CCMI is undertaking a campaign to increase awareness of this report and the necessary positive actions that can be taken by all in the Cayman Islands. For more information please visit ***www.reefresearch.org.***

WHAT CAN WE ALL DO TO HELP?

GOVERNMENT & REEF MANAGERS

- Enforce and continue expanding marine parks
- Restrict development of infrastructure that would physically damage the reef
- Invest in improving & increasing coral restoration efforts
- Limit the fishing of ecologically important reef fish. Reduce pressure on larger individuals which produce more offspring, reef herbivores which consume the algae, and apex predators to maintain food web integrity
- Push forward climate mitigation actions for the country
- Increase awareness of the ways stakeholders can reduce impacts to coral reefs

RESEARCHERS

- Determine the key herbivore species on the reefs of the Cayman Islands and protect them as effectively as possible
- Work with reef managers to improve the success of restoration techniques and further develop mitigation strategies
- Research methods for improving (and further our understanding of) the mechanisms that support the survival and growth of coral recruits
- Educate the community about environmentally sustainable behaviours based on research outcomes

CORPORATIONS & BUSINESSES

- Avoid development of infrastructure that would damage the reef or marine ecosystems
- Establish an Environmental Sustainability plan for your business that requires sustainable actions at the work place, such as reducing power usage, providing transport for employees, reducing use of plastics, serving sustainably sourced foods in canteens, implementing recycling programmes, etc.
- Educate employees and clients on sustainable behaviours and the need for them
- Get involved in coral restoration efforts

PUBLIC

- Act to reduce your carbon footprint and vote for legislation that will reduce carbon emissions
- Consider your role in limiting developments or actions that would damage the reef and marine ecosystems
- Avoid eating reef fish, especially the larger individuals and the key species. Examples of such species are reef herbivores to consume the algae and apex predators to maintain food web integrity
- Reduce use of plastic, dispose of it properly and remove it from the oceans and coastlines
- Talk to friends, family and co-workers about the importance of these actions

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