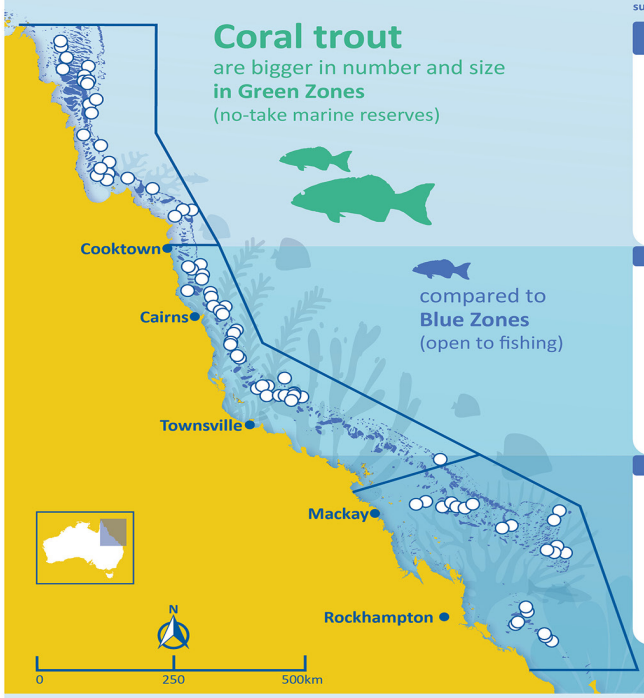
Annual Summary Report
on coral reef condition for 2019/20

Australian Government

Australian Institute of Marine Science

Initial recovery of the Great Barrier Reef threatened by the third mass bleaching event in five years

AIMS LONG-TERM MONITORING PROGRAM
2019 - 2020 Results



Total number of reefs surveyed in 2019 - 2020 **86**

	HARD CORAL COVER PER REEF	HARD CORAL COVER Status and Trend	CROWN-OF-THORNS STARFISH OUTBREAKS Status and Trend	BLEACHING SEVERITY Status and Trend
NORTHERN GREAT BARRIER REEF	Each square represents the current hard coral cover category on each survey reef. Number of reefs surveyed: 26	15% coral cover in both 2019 and 2020	Potential outbreak: 1 reef	0 High, 4 Low, 0 Medium, 22 None. Number of reefs with bleaching
Survey period | November - December 2019				
CENTRAL GREAT BARRIER REEF	Number of reefs surveyed: 33	From 12% to 14% coral cover between 2019 and 2020	Potential outbreak: 1 reef	4 High, 15 Low, 1 Medium, 13 None. Number of reefs with bleaching
Survey period | February and June 2020				
SOUTHERN GREAT BARRIER REEF	Number of reefs surveyed: 27	From 23% to 24% coral cover between 2019 and 2020	Active outbreak: 4 reefs. Incipient outbreak: 1 reef	0 High, 2 Low, 0 Medium, 25 None. Number of reefs with bleaching
Survey period | September - October 2019 and January 2020				

LEGEND

Survey Site Locations

HARD CORAL COVER: **Low** 0% to 10% **Moderate** 10% to 30% **High** 30% to 50% **Very High** 50% to 75%

CROWN-OF-THORNS (COTS): **No Outbreak** 0 to 0.1 COTS **Potential Outbreak** 0.1 to 0.22 COTS **Incipient Outbreak** 0.22 to 1 COTS **Active Outbreak** Over 1 COTS (Number of COTS divided by tow numbers)

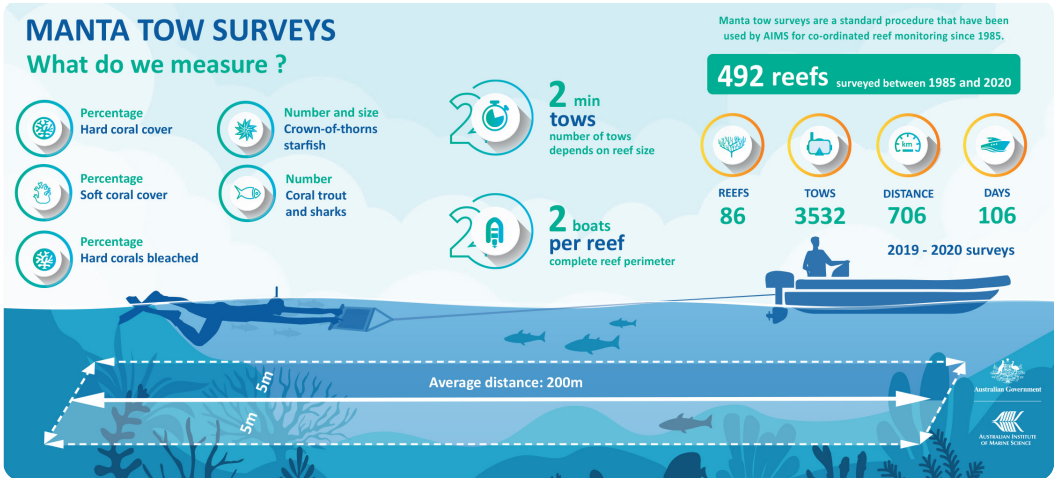
BLEACHING SEVERITY: **Low** Under 10% colonies bleached **Medium** Between 10% and 30% colonies bleached **High** Over 30% colonies bleached

SUMMARY

Two thirds of reefs surveyed between September 2019 and June 2020 have increased in hard coral cover since last surveyed, leading to small increases in region wide hard coral cover in the Central and Southern Great Barrier Reef (GBR), but no change in the Northern GBR. Most reefs surveyed had only low or moderate hard coral cover, particularly in the Northern and Central GBR and the few reefs with higher than moderate coral cover were largely found in the Southern GBR. The number of reefs with crown-of-thorns starfish outbreaks has declined in the Central GBR, but remained stable in the Southern GBR.

While the onset of coral recovery is encouraging, the effects of the third mass bleaching event in five years, which occurred late in the Austral summer, are not fully captured in this report. Reefs in the Northern and Southern regions were surveyed prior to the onset of a mass bleaching event and surveys during the peak of the bleaching were limited. However, LTMP in-water surveys did detect the onset of bleaching in the Northern and Southern GBR in late 2019 / early 2020, and widespread low to moderate bleaching in the Central GBR, where corals were still bleached in June 2020. The full impacts of the bleaching will be assessed once fieldwork recommences in late August 2020.

Surveys of reef fishes revealed that populations of coral trout inside no-take marine reserves are bigger in number and size than on reefs open to fishing, demonstrating that the benefits from the 2004 re-zoning of the GBRMP continue to accrue.



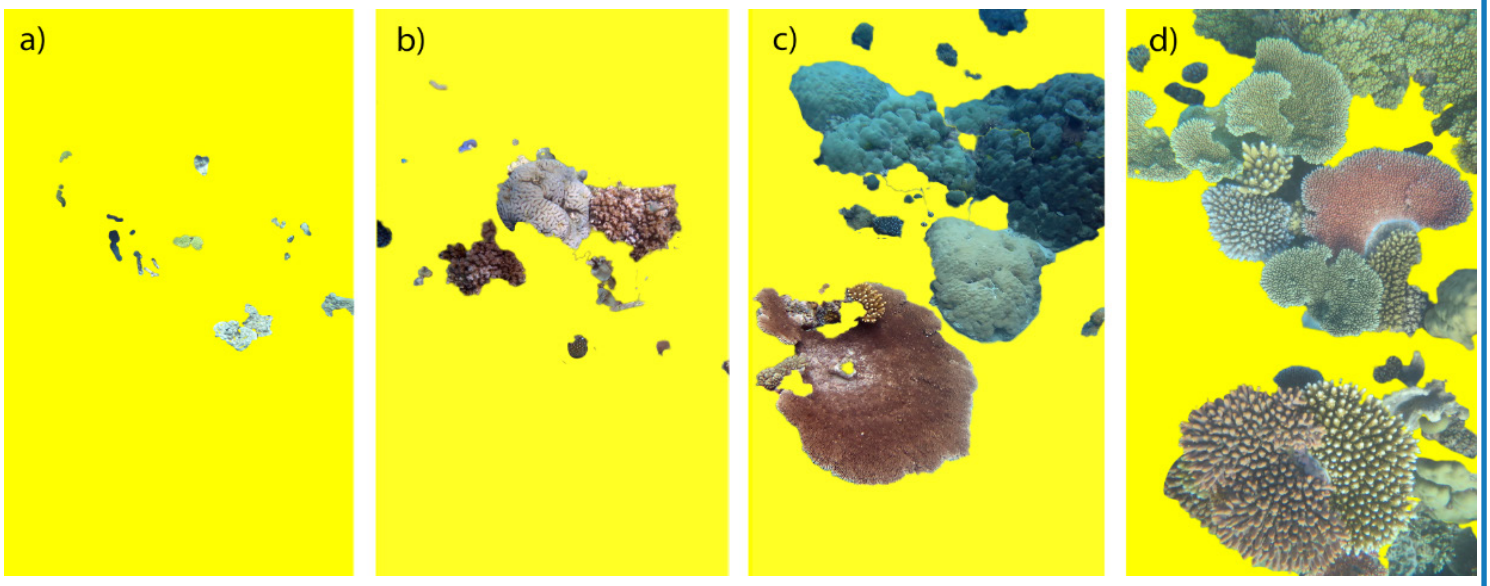
BOX 1 – WHAT DOES 'PERCENT HARD CORAL COVER' MEAN?

There are many ways to measure the status of coral reefs. One of the most common is to use percent hard coral cover as an 'indicator' of reef condition because it describes the abundance of a critical ecosystem engineer in coral reefs. This measure describes the proportion of the seafloor that is covered in live hard coral.

Percent hard coral cover is widely used by scientists worldwide and is a standard measure that applies to all locations. While it does not tell us anything about the diversity or composition of coral assemblages, it provides a simple and robust measure of reef health.

Percent coral cover can be estimated using various techniques. The technique used for this report is manta tow surveys, which are visual estimates of percent hard coral cover in broad categories (e.g. low = 0 to 10%, moderate = 10 to 30%, high = 30 to 50%, very high = 50 to 75% and extremely high = 75 to 100% - Box Figure 1) over the area covered by an observer during one 2-minute tow (~2000m^2). The percent hard coral cover for a reef is then estimated as the average of the estimates from all tows around a reef. A coral reef consists of more than just hard coral and contains a diverse array of other corals, sponges, algae, sand, rock and invertebrates. A reef does not necessarily need to have 75 to 100% hard coral cover to be healthy, with AIMS categorising reefs with 30 to 50% hard coral cover as a high value, based on historical surveys across the GBR.

Other techniques for determining percent hard coral cover involve counting the number of points within sampling units (quadrats, photos) as used by LTMP in fixed site surveys or the linear distance along a tape measure (line-intercept) that intersect live hard coral colonies. Adding up the total number of points of live hard coral cover and then expressing this as a percentage of the total number of points within a sample then yields the estimates of hard coral cover. Data from both the fixed site and manta tow surveys conducted by the LTMP are highly correlated and show the same trends in hard coral cover estimates; although, manta tow estimates are generally lower than those obtained from fixed site surveys as they encompass the entire reef including sandy back reef habitats that have low coral cover.



Box 1 Image – examples of categories of percent hard coral cover a) low (0 to 10%) b) moderate (10 to 30%) c) high (30 to 50%) d) very high (50 to 75%). The yellow areas show non-hard coral substrate and the categorisation is based on the proportion of the substrate covered in live hard coral colonies.

Introduction

With reef surveys extending over more than 30 years, the AIMS Long-Term Monitoring Program (LTMP) provides an invaluable record of change by repeatedly surveying coral reef communities over a large area of the Great Barrier Reef (GBR).
This annual update of the state and trends in hard coral cover across the entire GBR is based on manta tow surveys of coral reefs, mainly on the mid- and outer shelf (Figure 1). A total of 86 reefs were surveyed from September 2019 to June 2020 (reported as '2020'). Detailed reports on the state and trends of individual reefs are available shortly after the completion of each survey trip. Data summaries are available for download.

The dynamic nature of GBR coral reefs and the considerable variation among regions in the rates of decline and recovery of hard coral cover in response to disturbances are clear in the long-term record. Understanding the dynamics of the disturbance regime provides a critical context for the interpretation of the long-term monitoring data. For annual updates, the GBR Marine Park is divided into three regions (Figure 1), with each showing different trajectories of change in hard coral cover over time, mostly in response to the cumulative impacts of the main disturbances affecting the surveyed reefs, e.g. severe tropical cyclones, outbreaks of crown-of-thorns starfish and coral bleaching.

Over the 30+ years of monitoring by AIMS, the reefs of the GBR have shown their ability to recover after disturbances; however, such 'resilience' clearly has limits. This survey season revealed that the reefs of the GBR were beginning to recover from the recent disturbance history; however, the third mass coral bleaching event in five years will likely be a set-back to their recovery[1].

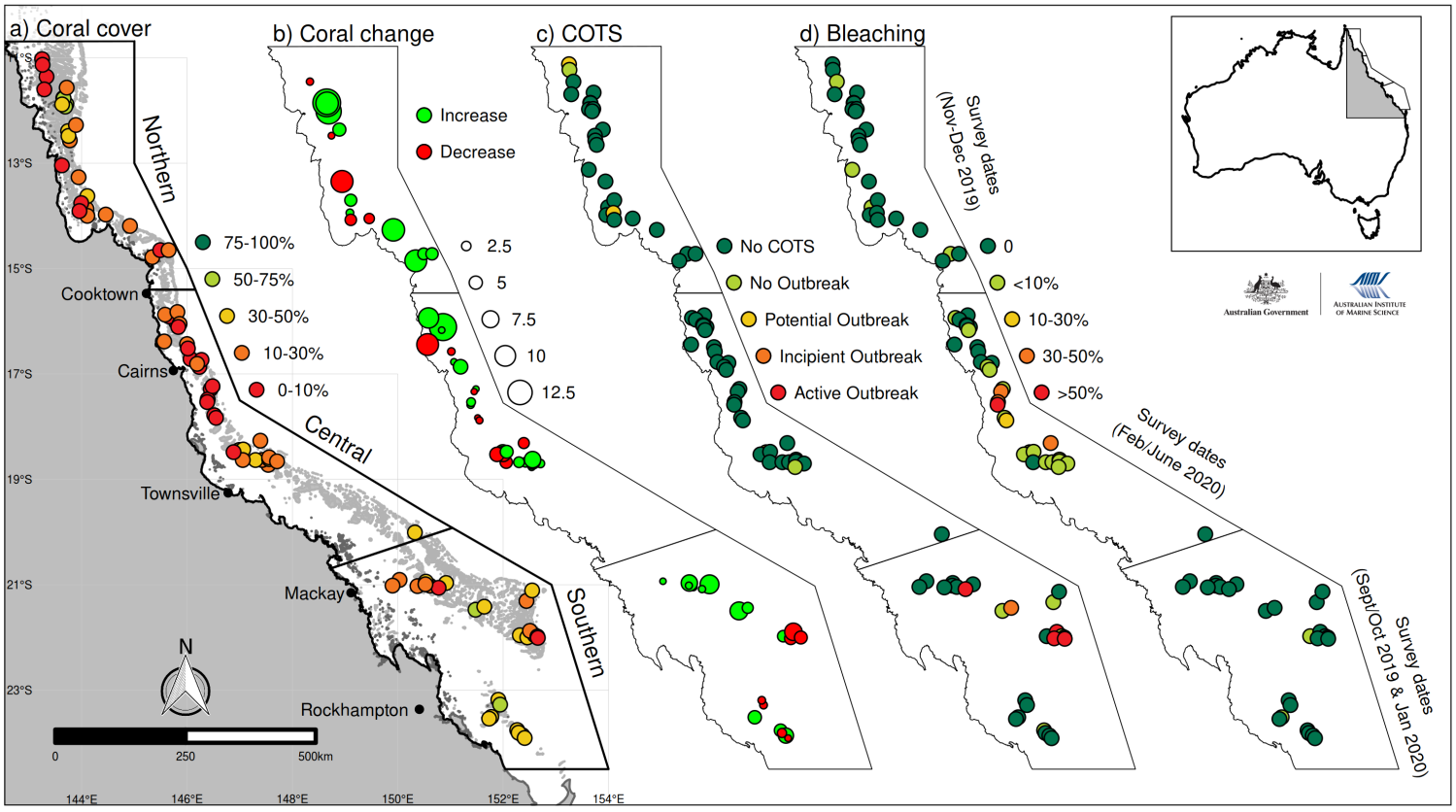


Figure 1. Summary of the results from the 86 reefs surveyed by manta tows between September 2019 and June 2020, along with the boundaries of the Northern, Central and Southern GBR reporting regions (see details of the long-term regional coral cover trends further below). a) The status of the surveyed coral reefs is defined by the category of hard coral cover. b) The coral change displays the magnitude and direction of the absolute annual change in reef-level percent hard coral cover between 2020 and the previous survey within the last two years. c) The COTS outbreak status of each reef is defined by the number of COTS per 2-minute manta tow: No COTS (0 COTS), No Outbreak (0 to 0.1 COTS), Potential Outbreak (0.1 to 0.22 COTS), Incipient Outbreak (0.22 to 1 COTS) and Active Outbreak (more than 1 COTS). d) The coral bleaching severity is reported as the percent of live coral colonies bleached at the time of survey per region: Northern GBR (November/December 2019), Central GBR (February and June 2020) and Southern GBR (September 2019 and January 2020). This figure does not represent the overall coral bleaching extent or severity because some surveys were done prior to the mass coral bleaching event and there were no surveys at the height of this event.

1 Results vary slightly from previously reported. Previous analyses excluded reefs with less than five visits over the time series, the current analysis includes all reefs. Differences are small and the trends remain unchanged.

Key Results

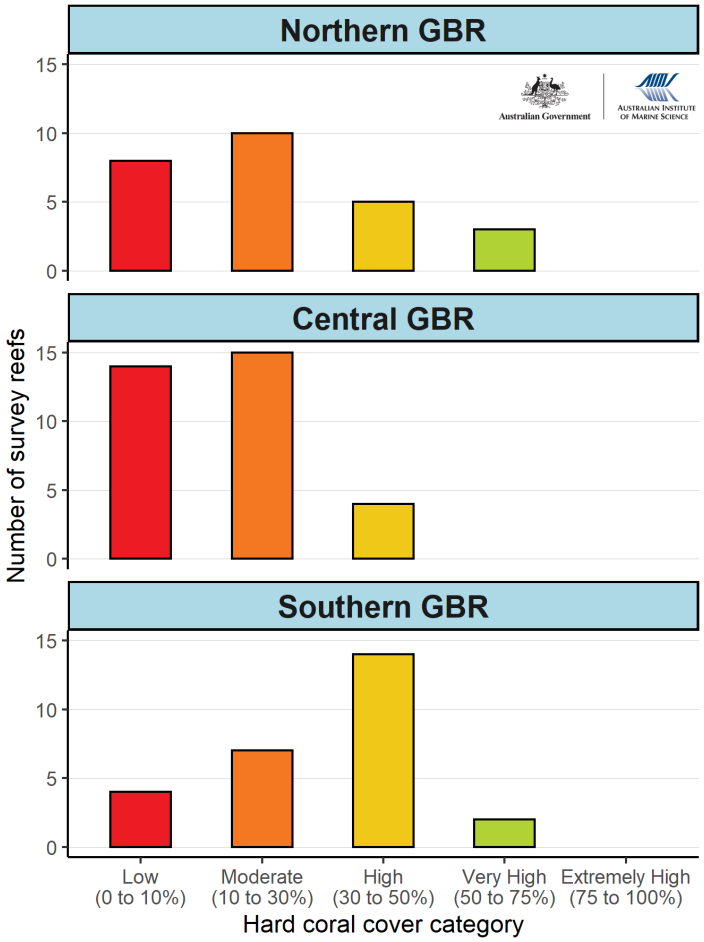


Figure 2. Status of the 86 reefs surveyed in the Northern, Central and Southern GBR in 2020. Data are the number of reefs with average hard coral cover falling within low, moderate, high and very high coral cover categories. Note there were no reefs with extremely high coral cover (75 to 100%) in 2020.

- In 2020, hard coral cover remains moderate in the Northern, Central and Southern GBR.
- While reef condition was variable both within and among regions, the majority of reefs (58 out of 86) had low (0 to 10%) or moderate (10 to 30%) coral cover and most of these were in the Northern and Central GBR. Few reefs had high coral cover (30 to 50%) and only five out of the 86 surveyed reefs had very high coral cover (50 to 75%).
- On the Northern GBR, hard coral cover was stable at 15% in 2020 but had increased from 12% in 2017, indicating that recovery from bleaching had begun.
- Following degradation from cyclones, crown-of-thorns starfish outbreaks and mass coral bleaching from 2016 to 2019, average hard coral cover on reefs in the Central GBR had increased slightly, from 12% in 2019 to 14% in 2020.
- Overall, mean coral cover on reefs in the Southern GBR had increased from 23% in 2019 to 24% in 2020.
- In addition to benthic communities, the AIMS LTMP also monitors fish communities. A noteworthy result this year was that coral trout numbers continued to increase on reefs inside no-take marine reserves compared to reefs open to fishing.
- A mass coral bleaching event unfolded late in the 2019/2020 Austral summer after a prolonged and widespread marine heatwave and affected reefs in the Northern, Central and, for the first time in recent years, Southern GBR.
- The COVID-19 pandemic disrupted fieldwork and as a result, surveys were not conducted at the height of the recent bleaching event.
- Coral mortality can occur for weeks to months after a coral bleaching event; therefore, the full impact of the 2019/2020 mass coral bleaching will be assessed during the next field season, which is set to begin in late August 2020.

Surveyed November/December 2019

There was substantial variation in the condition of individual reefs in the Northern GBR (Figures 1 and 2, Image 1). Eight of 26 reefs surveyed had low coral cover (0 to 10%) (Figures 1 and 2), whereas 10 reefs had moderate coral cover (10 to 30%). The remaining eight reefs had either high (30 to 50%) or very high coral cover (50 to 75%) (Figures 1 and 2). Of the 17 reefs previously surveyed since the end of the 2017 mass coral bleaching event, 12 had increased in hard coral cover by up to 15% per year (Figure 1), indicating the start of recovery from a period of cumulative disturbances from 2014 to 2017.

Region-wide hard coral cover continued to increase from the lowest levels recorded by the LTMP of 12% in 2017 to 15% in 2020 (Figure 3). Nonetheless, hard coral cover in 2020 was still well below the highest recorded coral cover in the LTMP dataset of 30% in 1988 (Figure 3). Surveys in 2020 found little evidence of crown-of-thorns starfish activity in the region, most reefs had no COTS, one reef was classified as No Outbreak and two reefs classified as Potential Outbreaks (Figure 1).

Despite being surveyed in December 2019, which was before the onset of the main mass bleaching event in late summer 2020, three of 26 Northern GBR reefs had low-level bleaching (<10% of corals bleached), indicating corals in this region were already responding to accumulating thermal stress. The full impacts of this event will be assessed during the next field season commencing in August/September 2020.

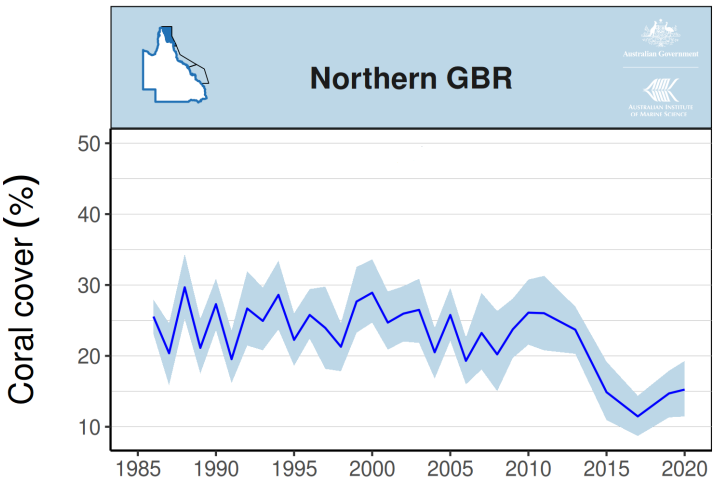


Figure 3. Trends in average hard coral cover for the Northern GBR based on manta tow surveys. Survey data from 129 reefs contributed to the 35-year time series; blue shading represents 95% credible intervals. Note that many reefs in this region do not have a regular survey history and in 2020 only 26 reefs were surveyed, which was less than planned due to adverse weather and the threat of crocodiles on many inshore reefs.

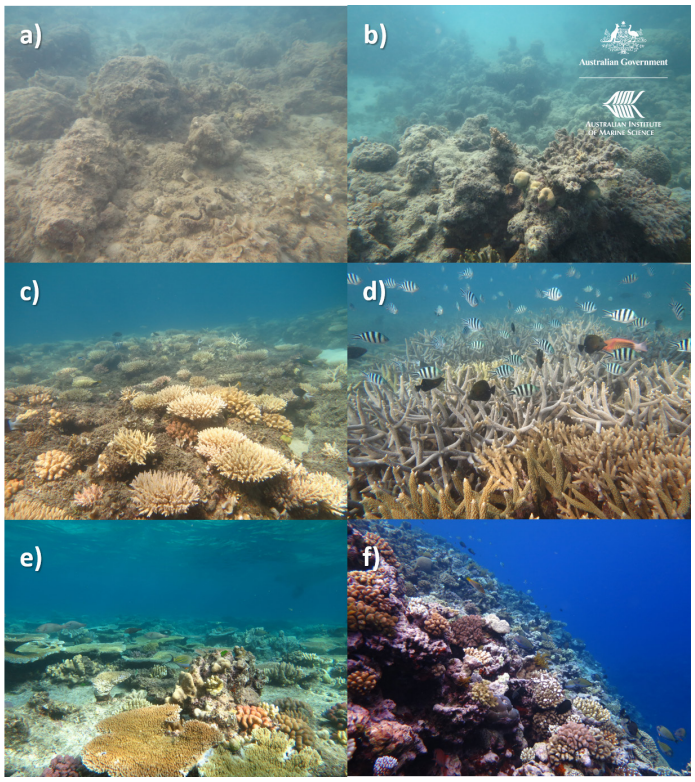


Image 1. Photos showing the variable state of reefs in the Northern GBR. Some reefs had yet to recover from a series of recent disturbances with low hard coral cover and dead standing skeletons covered in turf algae, mostly on inshore reefs such as a) Osborne Reef and b) Reef 11049. Some mid-shelf reefs had high numbers of juvenile corals, such as c) Linnet Reef near Lizard Island and other mid-shelf reefs housed abundant and diverse coral assemblages as seen at d) Ashmore Banks (A). Outer shelf coral assemblages had moderate to high levels of hard coral cover such as e) Reef 12-071 and f) Sandbank No 1.

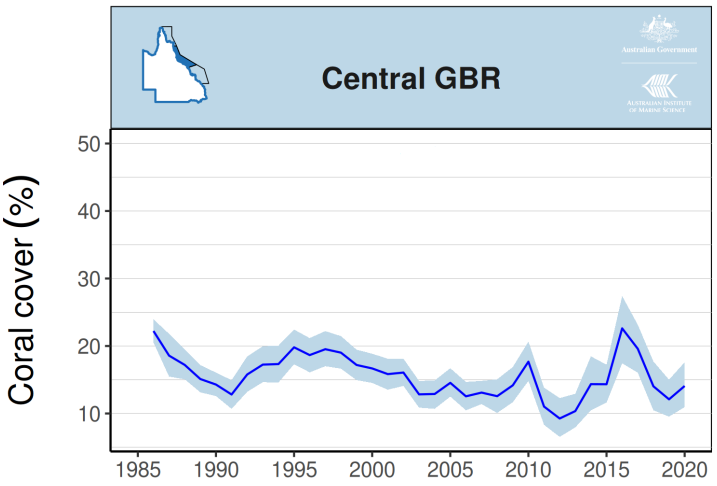


Figure 4. Trends in average hard coral cover for the Central GBR based on manta tow surveys up to June 2020. Survey data from 212 reefs contributed to the 35-year time series; blue shading represents 95% credible intervals.

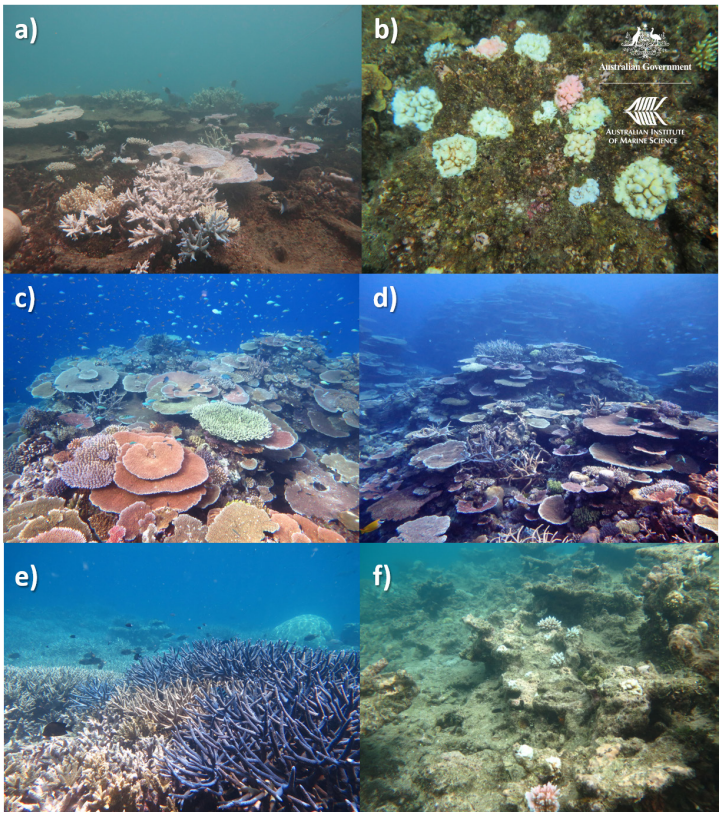


Image 2. Reefs offshore from Innisfail e.g. a) Farquharson Reef, were moderately to severely bleached in February 2020. While many reefs had good numbers of juvenile corals, some of them had also been affected by the bleaching event like b) Peart Reef. Some reefs appeared unaffected by the bleaching event and maintained healthy coral assemblages c) & d) Helix Reef and e) Agincourt Reef. Other reefs have had consecutive disturbances e.g. f) Peart Reef which had an active outbreak of COTS from 2016 to 2018 plus two coral bleaching events and currently has low coral cover.

Surveyed February and June 2020

Since regular surveys by AIMS began in 1985, hard coral cover on reefs in the Central GBR has generally been lower than in the Northern and Southern GBR.

Region-wide cover in the Central GBR decreased to the lowest level in LTMP records in 2012 (9%), following the impact of Severe Tropical Cyclone Yasi in 2011 (Figure 4). Hard coral cover then recovered rapidly to the highest average regional cover in the LTMP database record in 2016 (23%). From 2016 to 2019, hard coral cover decreased continuously to 12% (Figure 4), largely due to repeated mass coral bleaching in 2016 and 2017 and outbreaks of crown-of-thorns starfish. In 2020, hard coral cover increased to 14% from 12% in 2019 (Figure 4).

While the state of the reefs in the Central GBR in 2020 was variable, the vast majority of the 33 reefs surveyed had low or moderate hard coral cover (<30%) and four out of 33 reefs had coral cover higher than 30% (Figures 1 and 2, Image 2). None of the surveyed reefs had hard coral cover higher than 50% (Figure 2). On 10 of the 26 Central GBR reefs that were previously surveyed within the last two years, hard coral cover had decreased by up to 6% per year (Figure 1). Conversely, annual increases in hard coral cover by up to 14% were recorded on 16 Central GBR reefs (Figure 1).

Many reefs offshore from Cairns, Innisfail and Townsville have had outbreaks of crown-of-thorns starfish in recent years. However, there were no Active Outbreaks of crown-of-thorns starfish reported on Central GBR reefs in 2020 and only Kelso Reef was classified as a Potential Outbreak (Figure 1). The Great Barrier Reef Marine Park Authority's (GBRMPA's) Crown-of-thorns Starfish Control Program has been actively removing substantial numbers of starfish in this area, which would have contributed to the low numbers of crown-of-thorns starfish recorded during these surveys.

Coral bleaching was widespread in the Central GBR during the surveys in 2020, although the severity varied among reefs. Bleaching was recorded on seven of the 20 reefs from Cairns to north of Townsville that were surveyed in February 2020, the severity of which ranged from low (<10%) to moderate (10 to 30%). Reefs offshore from Townsville were surveyed in June 2020 and, despite being winter, many reefs were still bleached at low to moderate levels. However, no surveys occurred at the height of the mass bleaching event in late summer 2020 and the impacts of that disturbance have not yet been captured.

Surveyed October 2019 and January 2020

The Southern GBR has generally had higher coral cover than the Northern or Central GBR, but it has also been the most dynamic. Large declines in hard coral cover followed Severe Tropical Cyclone Hamish in 2009, which reduced coral cover to the lowest levels recorded by the LTMP of 9% by 2011 (Figure 5). Strong recovery occurred from 2011 to 2016 with hard coral cover reaching 32% in 2017. However, outbreaks of crown-of-thorns starfish began in 2018 on reefs in the Swain sector and regional coral cover again decreased to a low point of 23% in 2019 and increased to 24% in 2020 (Figure 5).

The state of individual Southern GBR reefs was variable (Image 3); however, there was a greater proportion of reefs with high coral cover than low or moderate coral cover, a contrast to the Northern and Central GBR where the majority of reefs had coral cover in the two lowest categories (Figures 1 and 2). Hard coral cover decreased by up to 8% per year on eight of 21 reefs since the last survey, whereas 13 reefs increased in hard coral cover by up to 9% per year since being surveyed in the last two years (Figure 1).

In 2016 and 2017, reefs in the Southern GBR were not exposed to the extreme sea surface temperatures that led to the mass coral bleaching events on the Central and Northern GBR. However, in the Austral summer of 2020, waters of the Southern GBR warmed substantially. The LTMP surveys were conducted in September 2019 and January 2020 and recorded low levels of bleaching on one reef. However, subsequent aerial surveys by the Centre of Excellence in Coral Reef Studies revealed widespread severe bleaching across much of the Southern GBR. A full evaluation of the impacts of the 2020 coral bleaching event will occur when reefs in this region are resurveyed in August/September 2020.

In 2020, the Southern GBR was a focus of crown-of-thorns starfish outbreaks with four of 27 reefs classified as having Active Outbreaks and one reef with an Incipient Outbreak (Figure 1). Two reefs (Small Lagoon and Reef 22-084) had Active Outbreaks for the first time while Chinaman and Reef 21-064 have had ongoing outbreaks for some years (Figure 1). Low numbers of crown-of-thorns starfish were recorded on five reefs classified as No Outbreak. Outbreaks appear to have run their course on two of these reefs (Wade Reef and Jenkins Reef) and have reduced coral cover below the threshold necessary to sustain high crown-of-thorns starfish numbers.

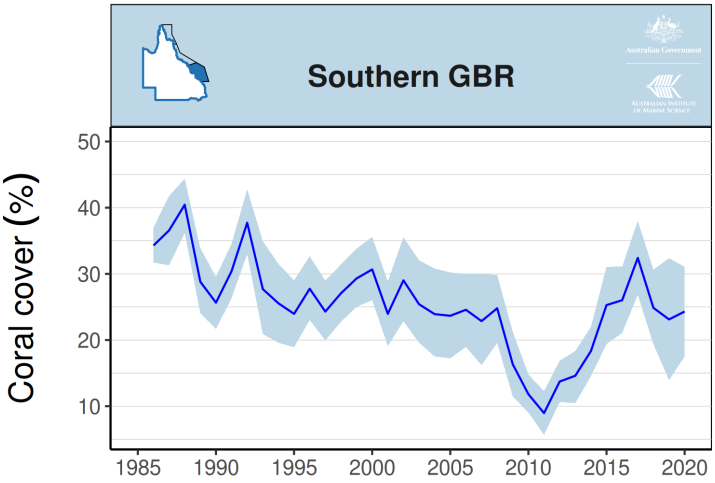


Figure 5. Trends in average hard coral cover for the Southern GBR based on manta tow surveys up to June 2020. Survey data from 151 reefs contributed to the 35-year time series; blue shading represents 95% credible intervals.

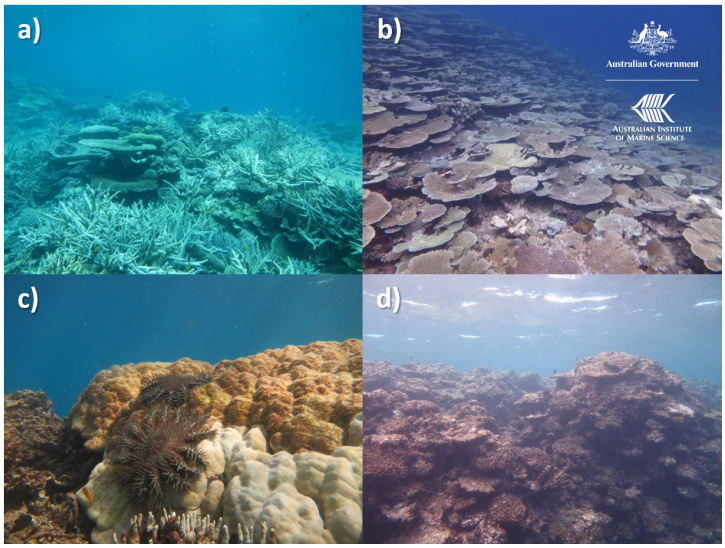


Image 3. Many reefs in the Southern GBR still have high coral cover, such as a) Reef 22-084 in the Swain sector and b) Lady Musgrave Island Reef in the Capricorn-Bunkers. However, outbreaks of crown-of-thorns starfish continue to decimate coral populations on many reefs in the Swain sector c) & d) Chinaman Reef.

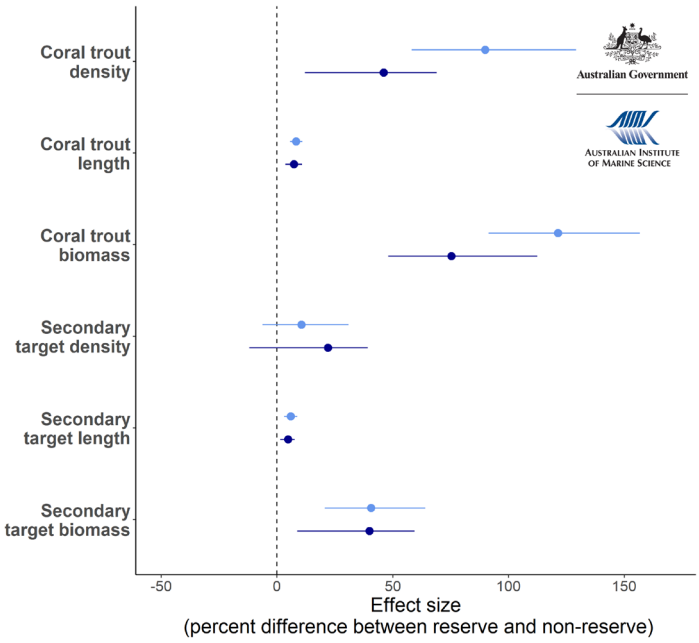


Figure 6. GBR-wide difference in the abundance, size and biomass of coral trout and secondary target fishes between no-take marine reserves and non-reserves. Data are the modelled median differences between no-take marine reserves and fished reefs with associated 95% uncertainty intervals and are expressed as a percent difference between no-take marine reserves and non-reserves (Effect size). Effect sizes were averaged over all surveys since the re-zoning in 2004. A positive effect indicates higher values in no-take marine reserves and statistical significance is inferred where uncertainty intervals do not intersect the zero line. Data have been previously reported in 2012 (dark symbols) but have since been updated to include the period 2006 to 2020 (light symbols) to provide an update of the effectiveness of re-zoning.

Effectiveness of the 2004 re-zoning of the Great Barrier Reef for fish populations

The re-zoning of the GBR Marine Park under the Representative Areas Program came into effect in 2004, after an extensive public consultation period and increased the area of Marine National Park Green Zones ('no-take' areas) to 33% of the Marine Park.

The LTMP was modified to facilitate a dedicated monitoring program to collect evidence to examine the effectiveness of this re-zoning. By 2012, the abundance and biomass of coral trout were substantially higher on reefs inside the no-take marine reserves than on the adjacent reefs that remained open to fishing.

In 2020, the abundance and biomass of coral trout have continued to increase on reefs inside the no-take marine reserves compared to reefs open to fishing. Coral trout abundance was 91% higher and biomass was 122% higher on reefs inside no-take marine reserves compared to reefs open to fishing (Figure 6).

Other highly prized fishes such as snapper, emperors, cods and wrasses (termed 'secondary target' species) remained at similar levels of abundance and biomass inside no-take marine reserves compared to those recorded in 2012, and secondary target biomass was 41% higher inside no-take marine reserves compared to reefs open to fishing (Figure 6).

These latest results show that not only was the re-zoning of the GBRMP successful, it has continued to accrue benefits to coral trout, the fish species that are the main targets of both commercial and recreational fisheries.

Assessing the long-term health of the Great Barrier Reef

The GBR has been subjected to intense disturbances in recent years. A fourth wave of crown-of-thorns starfish outbreaks began in 2012 between Lizard Island and Cairns, and by 2019 had progressed south to reefs offshore from Townsville. The Crown-of-thorns Control Program has been active in the Central GBR and the number of Active Outbreaks has decreased from previous years; however, reefs just south of the epicentre of the outbreak off Townsville could not be surveyed due to COVID-19 restrictions on fieldwork, and thus it is unknown whether the outbreak has progressed to these reefs. While there were few severe cyclones this year, a widespread marine heatwave led to the third mass coral bleaching event in five years during the late Austral summer, with corals still bleached during surveys in June 2020. As LTMP surveys occur annually from September to June, information on the spatial extent and severity of bleaching were limited to reefs surveyed from January to June 2020. The full impacts of this event will not be assessed until reefs are revisited next field season, which is due to start in late August 2020.

The predicted consequences of climate change, which include more frequent and intense mass coral bleaching events, are now a contemporary reality. At the same time, chronic stressors such as high turbidity, increasing ocean temperatures and changing ocean chemistry can all negatively affect rates of recovery, while more frequent acute disturbances mean that the intervals for recovery are becoming shorter.

The geographical scale of recent mass coral bleaching and crown-of-thorns starfish outbreaks means that breeding populations of corals have been decimated over large areas, reducing the potential sources of larvae to recolonise reefs in the near future.

Hard coral cover in the Northern and Central GBR continues to be close to the lowest levels recorded in the 30+ years of the LTMP. Reefs in the Southern GBR have moderate hard coral cover but have a limited genetic connection to reefs further north. This limits their capacity to serve as a major source of coral larvae to support reef recovery elsewhere.

The prognosis of more frequent disturbances, each causing greater damage to reefs, combined with slower rates of recovery will inevitably lead to less living coral on the reefs of the GBR. Measuring and understanding the process of, and limitations to, coral reef recovery will be a continued focus of AIMS' research and monitoring over the next years.

Annual Summary Report on coral reef condition for 2019/20

Australian Government

Australian Institute of Marine Science

About the Australian Institute of Marine Science

The Australian Institute of Marine Science (AIMS) is Australia's tropical marine research agency. In existence for almost half a century, it plays a pivotal role in providing large-scale, long-term and world-class research that helps governments, industry and the wider community to make informed decisions about the management of Australia's marine estate.

AIMS science leads to healthier marine ecosystems; economic, social and environmental benefits for all Australians; and protection of coral reefs from climate change.

More here: https://www.aims.gov.au/

This report is available online at https://www.aims.gov.au/reef-monitoring/gbr-condition-summary-2019-2020
Data downloads
Enquiries and further information contact the Long-Term Monitoring Program
Email: monitoring@aims.gov.au