

Aerial surveys of the 2024 mass coral bleaching event on the Great Barrier Reef

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The Great Barrier Reef's (GBR) waters warmed early in December 2023, exceeding historical summer maxima that typically occur in the hottest summer months (late January – February), causing the highest levels of thermal stress on record. Increased reports of coral bleaching in the Southern region of the GBR prompted the first set of aerial surveys on the 23rd & 24th of February 2024. Spatial patterns of heat stress across the entire GBR and the prevalence of bleaching observed in the Keppel Islands and Capricorn Bunker group required Reef-wide aerial surveys across the entire GBR ecosystem (including both the Great Barrier Reef Marine Park and reefs throughout the Torres Straits) in March 2024.

Thermal stress started building in late December through January and again in late February until the middle of March, throughout all three regions of the GBR. Reef waters accumulated heat stress throughout the summer, as maximum Degree Heating Weeks (DHWs) were reached on the 8th and 15th of March 2024 in the Southern and Central GBR and the 21st of March 2024 in the Northern GBR. The most intense and prolonged heat stress occurred at inshore reefs in the Southern GBR, with heat stress exposure peaking at 2.3-2.5°C above historical summer maxima and leading to an accumulation of heat stress up to 12.0 - 15.5°C-weeks (DHWs; estimated by the US National Oceanographic and Atmospheric Administration (NOAA) [NOAA Coral Reef Watch Daily 5km Satellite Coral Bleaching Heat Stress Degree Heating Week Product \(Version 3.1\)](#)) at surveyed reefs, reaching the highest levels to date in the satellite record on the GBR.

This prolonged heat exposure has caused mass bleaching of coral reef communities observed within all three regions of the Great Barrier Reef. The combination of aerial (Images 1-4) and in-water surveys in 2024 confirm a mass bleaching event, with prevalent and extreme bleaching observed at multiple reefs in all 3 regions of the Great Barrier Reef Marine Park.

This is the fifth mass bleaching event to occur since 2016 and the seventh mass bleaching event on the GBR since 1998.

Aerial surveys are a crucial tool to assess the prevalence and spatial extent of coral bleaching across the large GBR ecosystem and were conducted in 2024 by trained observers from the Great Barrier Reef Marine Park Authority and the Australian Institute of Marine Science from both helicopter and fixed-wing airplanes.

In 2024, 75% of the reefs surveyed during the aerial surveys across the entire Reef experienced heat stress capable of causing coral bleaching (>4°C-weeks to <8 °C-weeks) and 29% of reefs surveyed were exposed to intense levels of heat stress capable of causing severe coral bleaching and mortality (DHW's > 8°C-weeks) in 2024. The spatial footprint and intensity of thermal stress is increasing across the GBR, with 46% of reefs exposed to the highest maximum DHW level ever experienced during the 2024 summer, predominantly in the Southern and Central GBR. In 2016 and 2017, these records occurred on less than 20% of reefs in the Central and Northern GBR.

Aerial surveys were conducted during the final heat wave in March 2024, however coral colony responses to heat stress will continue to progress. A proportion of bleached corals may recover over the next several months, with survivorship numbers depending on the intensity of heat stress exposure and coral type. The onset of coral mortality has been reported from ongoing in-water surveys at reefs in the southern, central and northern regions from early to late March. It is important to note that although bleached corals are stressed, they are still alive. As water temperatures cool, bleached corals may regain their colour and survive this stress event.

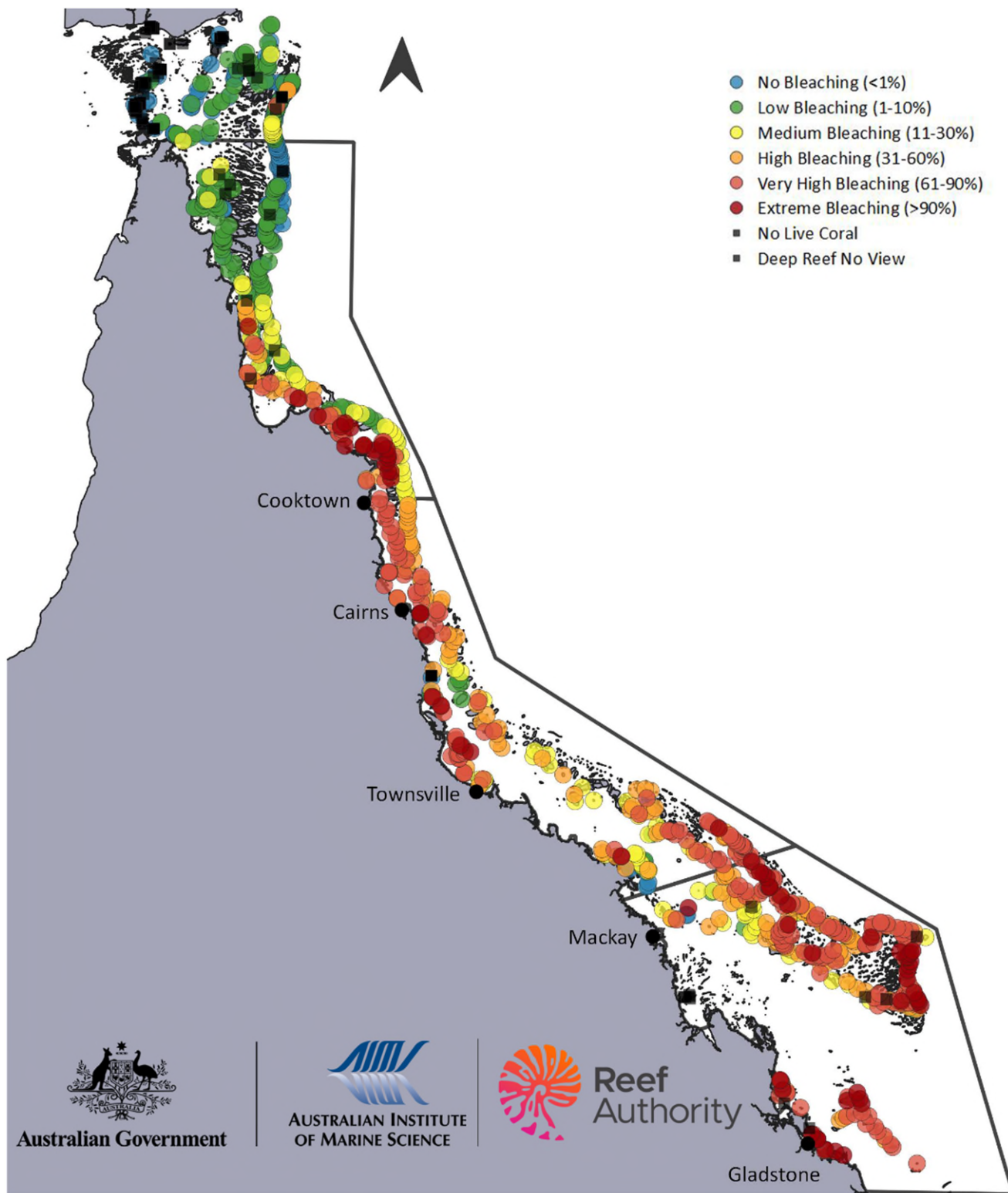
As outlined in the Great Barrier Reef Authority's [Position Statement on Climate Change](#), climate change is the greatest threat to the Great Barrier Reef. Only the strongest and fastest possible actions to decrease global greenhouse gas emissions will reduce the risks of thermal stress on the Reef and limit the impacts from climate change on the GBR. Future impacts can only be minimised by reducing global greenhouse gas emissions as quickly as possible, combined with fast-tracking actions to build Reef resilience.

2024 GBR aerial bleaching survey – summary of findings

A total of 1,080 reefs were surveyed from the air between the Torres Strait in the north and the Capricorn Bunker Group at the southern end of the Great Barrier Reef Marine Park, with 1001 reefs having sufficient coral cover and visibility to record a bleaching response observation (Table 1).

The shallow reef habitats of 792 reefs exhibited some level of coral bleaching (79% of all surveyed reefs), with 49% of surveyed reefs showing high to extreme levels of bleaching (>30% coral cover bleached) and 32% of all surveyed reefs (GBR Marine Park + Torres Strait), 39% of surveyed reefs within the GBR Marine Park, showing very high or extreme prevalence of bleaching (>60% coral cover bleached; Map 1 & Table 1).

Coral bleaching observed from the air was largely consistent with the spatial distribution of heat stress accumulation (estimated by the NOAA DHW product), with a higher prevalence of coral cover with signs of bleaching on reefs that were exposed to the higher levels of accumulated heat stress (>4°C-weeks) this summer. The 2024 Aerial Survey Map illustrates the variation in bleaching prevalence observed across the Reef (Map 1).



Map 1 - 2024 Aerial survey observations of bleaching prevalence in shallow-water coral communities throughout the Great Barrier Reef.

Aerial surveys began in the Southern GBR through the inshore and mid-shelf Capricorn Bunker region on the 23-24 of February 2024, as heat stress had increased above Alert Level 2 thresholds ($> 8^{\circ}\text{C-weeks}$; NOAA DHW product) at the time of survey. Surveys across the length of the GBR continued from 2nd – 27th March 2024, within 5 to 10 days of peak heat stress in the remaining regions. A total of 1080 reefs were surveyed by a combination of helicopter and fixed-wing aircraft. Aerial survey scores and methods are described in the [AIMS Standard Operating Procedure](#)

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Results by region

Torres Strait, which includes coral reefs from the northern sea border to Papua New Guinea to the tip of Cape York:

Torres Strait reefs surveyed were exposed to heat stress levels that ranged from 0.97 to 8.94°C-weeks, however the majority of surveyed shallow-water coral reefs in this region had no to low levels of bleaching (94% of surveyed reefs; Table 1).

Northern region, which includes coral reefs from the tip of Cape York to Cooktown:

Heat stress patterns ranged from 2.29 to 9.70°C-weeks at surveyed reefs in the northern region of the GBRMP. The pattern of shallow-water coral community bleaching as seen from the air varied from low (1-10% coral cover bleached) to extreme (>90% coral cover bleached). The northern limit of aerial observations of very high prevalence of bleached corals extended from the inshore reefs near Lockhart River into Princess Charlotte Bay, and the inshore and mid-shelf reefs around Lizard Island. Bleaching prevalence ranged from no bleaching to medium levels of bleached corals (11-30 % coral cover bleached) on the offshore reefs from Lockhart River to Cape Flattery. No bleaching to low levels (1-10 % coral cover bleached) were common on both inshore and offshore reefs from Lockhart River to Cape York.

Central region, which includes reefs from Cooktown to the Whitsunday Islands:

Degree heating weeks ranged from 2.39 to 11.41°C-weeks at surveyed reefs in the central region of the GBRMP. Between Cooktown and the Whitsundays, bleaching prevalence was typically highest on inshore reefs, and lower on the outer-shelf reefs. On the outer-shelf reefs, bleaching prevalence ranged from low (1-10% cover bleached) to high (31-60% cover bleached). In the Whitsundays region, the inshore islands had variable bleaching extent with lower prevalence of bleached reefs, while the offshore reefs showed medium (11-30% cover bleached) to very high (>60% cover bleached) bleaching prevalence.

Southern region, which includes reefs south of the Whitsunday Islands, offshore from Mackay to the Swain reefs, the Capricorn-Bunker, Keppel Islands and Gladstone region:

Thermal stress was the highest ever recorded from the NOAA satellite record (1985-2024) in the southern region of the GBR, ranging from 6.22 to 15.55°C-weeks at surveyed reefs. Within the Southern region, bleaching prevalence ranged from high (31-60% cover bleached) to extreme (>90% cover bleached) at 80% of the reefs surveyed across inshore, mid-shelf and offshore reefs, reflecting the intense heat stress exposure in this region. Only 3% of surveyed reefs were not bleached, and 16% had low or medium levels of bleaching.

Table 1: 2024 Aerial Survey observations of bleaching prevalence within the Great Barrier Reef Marine Park (GBRMP), Torres Strait (TS) and across the whole of GBR ecosystem (Whole GBR = GBRMP + TS). Total reef count and percentage of surveyed reefs by bleaching prevalence and region.

Aerial Survey Score	Aerial Survey Score description	GBRMP (count)	GBRMP (%)	TS (count)	TS (%)	Whole GBR (%)
0	No Bleaching	97	12%	112	60%	21%
1	Low Bleaching (1-10%)	119	15%	63	34%	18%
2	Medium Bleaching (11-30%)	107	13%	8	4%	12%
3	High Bleaching (31-60%)	172	21%	2	1%	17%
4	Very High Bleaching (61-90%)	252	31%	1	1%	25%
5	Extreme Bleaching (>90%)	68	8%	0	0%	7%
Total reefs with aerial survey score		815		186		

*21 reefs within the Great Barrier Reef Marine Park and 58 reefs within the Torres Strait region were not scored due to having no live coral visible or surveyors could not view the coral reefs due to sediment or water depth on top of reef

About the aerial surveys

Aerial surveys¹ are an important and reliable method to provide a broad assessment of coral bleaching across the scale of the entire Reef. These surveys are conducted from low-flying aircraft, at slow speed, during calm, clear weather conditions and low tide. Trained observers can document the percentage of bleached coral visible (white or fluorescent colours) among the shallow-water coral community on the reef flat and upper-reef slope (in waters less than 6 metres deep) and assigning each area of a reef surveyed to one of six community bleaching prevalence categories (see map legend).

The National Oceanographic and Atmospheric Administration (NOAA) Coral Reef Watch Degree Heating Week (DHW; [NOAA Coral Reef Watch Daily 5km Satellite Coral Bleaching Heat Stress Degree Heating Week Product \(Version 3.1\)](#)) product provides an estimate of accumulated heat stress, which can lead to coral bleaching and mortality. Based on this product and on observations during past mass bleaching events, significant coral bleaching usually occurs when the DHW value exceeds 4 °C-weeks. If the DHW value exceeds 8°C-weeks, severe, widespread bleaching is likely and the risk of coral mortality increases. Aerial surveys were initiated after regions of the GBRMP reached Alert Level 2 (>8°C-weeks) and conducted within 5-10 days of the peak in accumulated DHW's across the GBR ecosystem (23-24 February, 2-5 March, 19-20th March & 26-27th March 2024).

Importantly, aerial surveys quantify reef-scale community bleaching prevalence as an assessment of how much of the living coral community is bleached – not bleaching severity at the individual coral colony level. In-water surveys provide more detailed information on coral colony health, including the intensity of bleaching (not bleached, partially bleached, or fully bleached) and colony mortality. In-water surveys also allow assessment of bleaching in deeper water, which is important as bleaching typically lessens in intensity with depth. In-water surveys on reefs throughout the GBR will be combined with the broad-scale results from the aerial surveys to help document the impacts of this 2024 mass bleaching event.

¹. The aerial bleaching survey method was developed in 1998, in response to the first ever recorded mass bleaching event on the GBR. It continues to be refined and is described in SOP11 found on this webpage: [Reef monitoring sampling methods | AIMS](#)

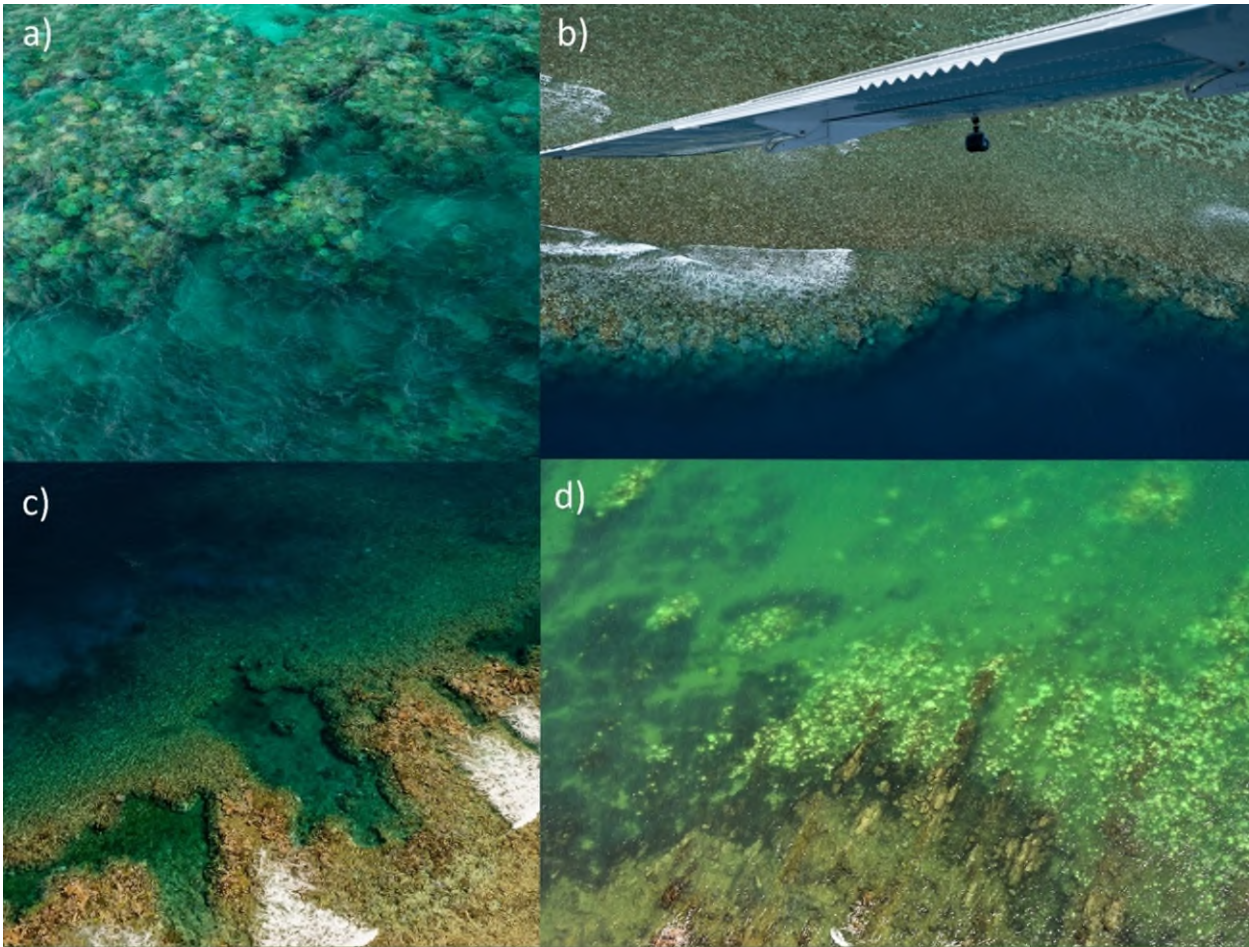


Image 1: Offshore (a,b,c) and inshore (d) reefs in the Southern GBR with very high (60-90% cover bleached; a & c) and extreme (>90% cover bleached; b & d) bleaching prevalence clearly visible from aerial surveys. Image credit: AIMS | Dr Neal Cantin

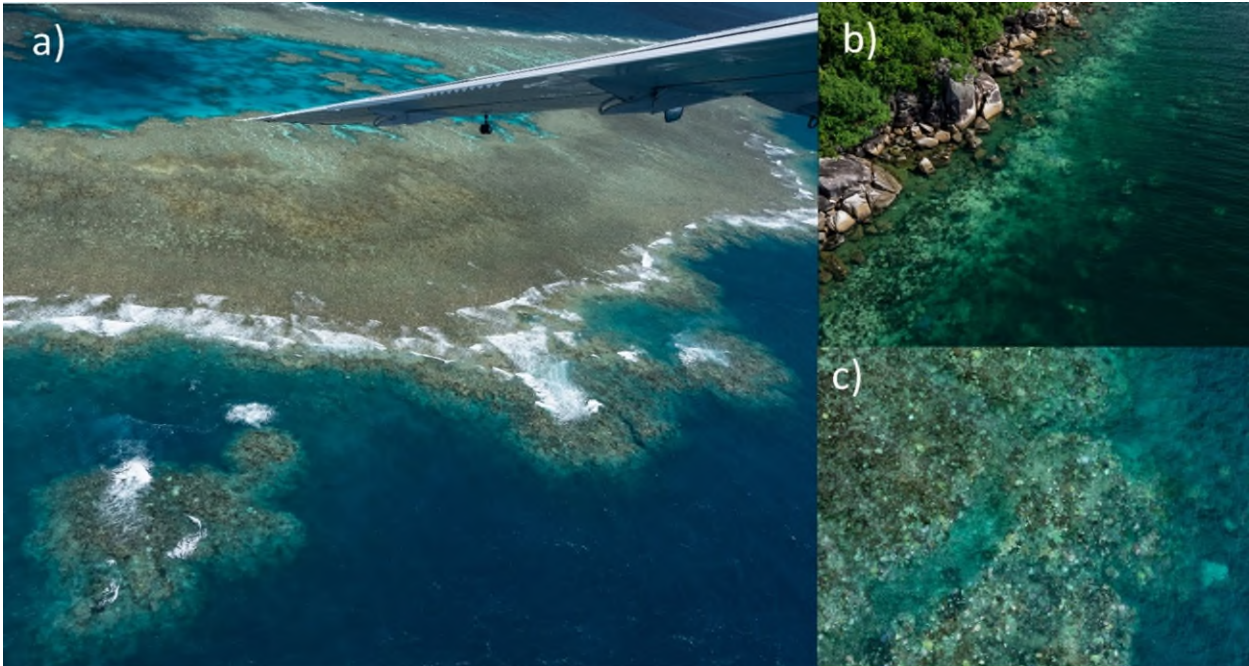


Image 2: Offshore (a & c) and inshore (b) reefs in the Central GBR with very high (60-90% cover bleached; a & c) and extreme (>90% cover bleached (b)) bleaching prevalence clearly visible from aerial surveys. Image credit: AIMS | Dr Neal Cantin

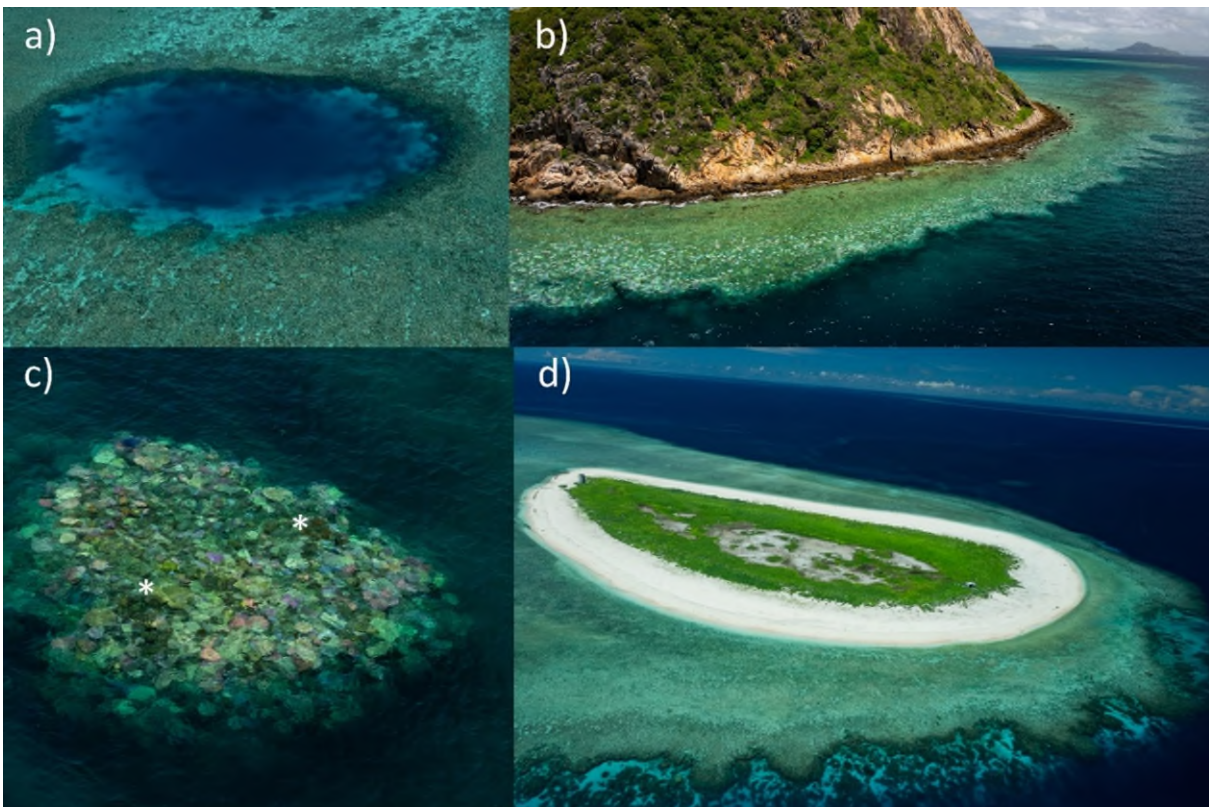


Image 3: Mid-shelf (b & c) and offshore reefs (a & d) in the Northern GBR that displayed variable levels of bleaching prevalence from No Bleaching (a & d) to extreme (>90% cover bleached; b & c) including recent mortality (indicated by the * symbols in panel c) that is clearly visible from aerial surveys. Image credit: AIMS | Dr Neal Cantin

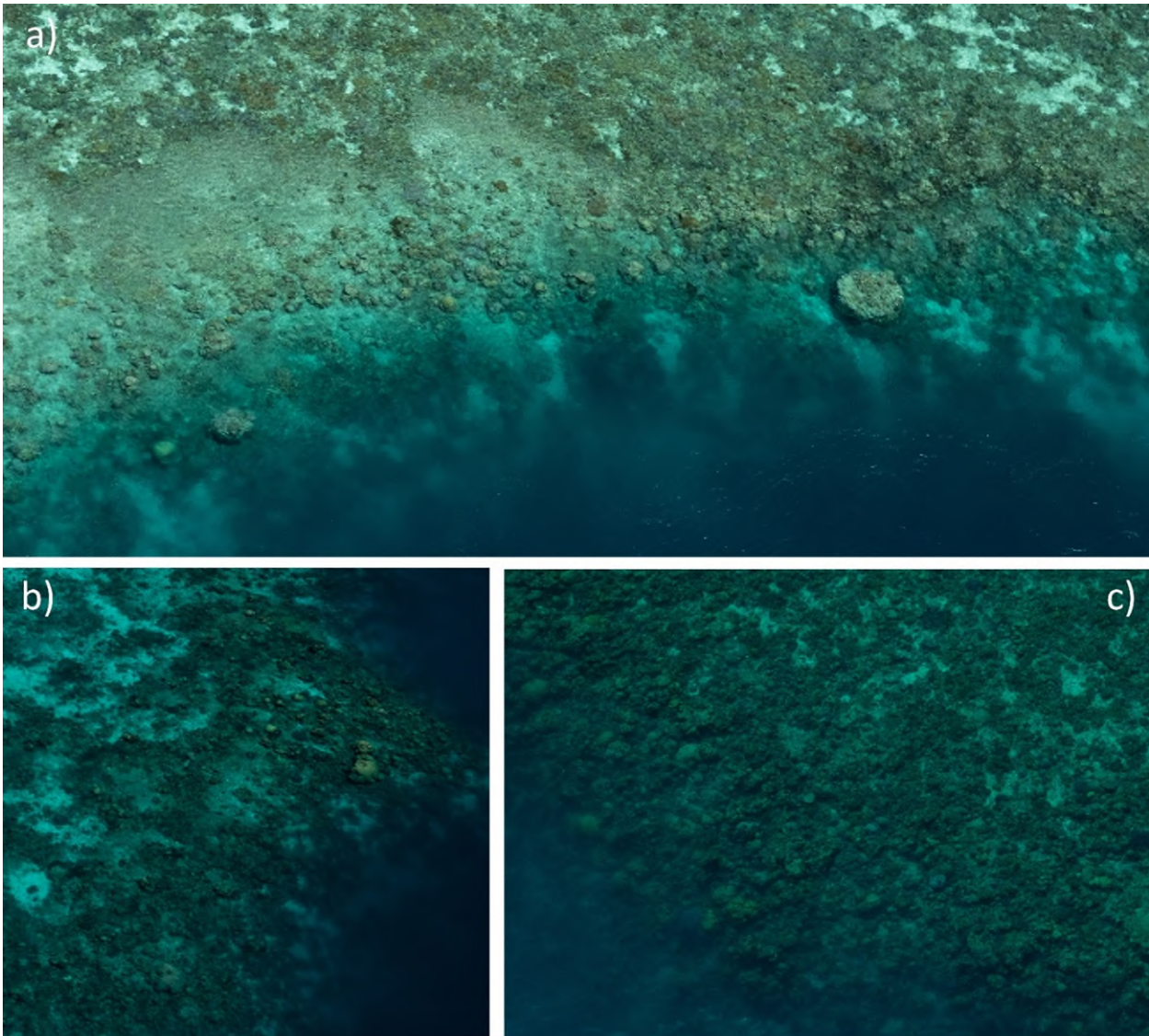


Image 4: Typical examples of reef coral cover and No Bleaching observed throughout 94% of reefs in the Torres Strait Islands region in 2024.
Image credit: AIMS | Dr Neal Cantin