Reef 2050 Plan Independent Expert Panel

Advice to the Great Barrier Reef Ministerial Forum, 1 May 2020

1. The use of aerial surveys.

Aerial surveys of coral bleaching were initiated by the Great Barrier Reef Marine Park Authority and the Australian Institute of Marine Science in 1998 and 2002, to determine the geographic scale and intensity of two previously recorded mass bleaching events (Berkelmans et al., 2004). Aerial assessments are critical to our understanding of the geographic scale of the impact of thermal stress and have also been completed for the GBR in 2016, 2017 and now 2020 (Hughes et al., 2017, 2018; Hughes and Pratchett, 2020).

Aerial surveys are a long-standing element of a suite of field studies that have been applied to understanding mass coral bleaching on the Great Barrier Reef, at a geographic scale that cannot be replicated underwater. They allow observers to assess the extent and intensity of coral bleaching on shallow water habitats (reef flats, crests, lagoons and upper reef slopes) throughout the 2,300km length of the Great Barrier Reef.

Bleaching in deeper water can only be assessed by underwater surveys on individual reefs. Bleaching generally attenuates with depth, and during severe events can extend to depths of 30-40m. (Baird et al 2018; Rogers et al, 2018; Frade et al 2018).

2. Is the unprecedented mass coral bleaching and mortality part of a natural cycle?

There is no evidence that the recent mass coral bleaching and mortality is part of a natural cycle.

Increases in water temperature cause many corals to expel many but not all of their symbiotic zooxanthellae (algae) (Glynn and D'Croz, 1990; Hoegh-Guldberg and Smith, 1989). The resulting loss of pigment may be obvious to even a casual observer; less obvious is the loss of energy and nutrient that can lead to starvation and death of the coral host if the thermal stress is intense enough for long enough. In 2016, for example, 30% of the shallow-water corals on the Great Barrier Reef died due to extreme temperatures (GBRMPA 2017).

Mass coral bleaching and mortality is driven by summer water temperatures that are from 1ºC or more above the long-term average. The impact of temperature has been verified by laboratory experiments (Glynn and D'Croz, 1990; Hoegh-Guldberg and Smith, 1989).

As global temperatures have increased, the frequency, extent and severity of mass coral bleaching and mortality has also increased. Based on hundreds of scientific papers, the consensus of the United Nations Intergovernmental Panel on Climate Change is that recent increases in sea temperature are being driven by increasing human-induced greenhouse gas concentrations in the atmosphere (IPCC, 2014).

3. Does bleaching allow corals to change their algae and thereby adapt to increases in temperature?

The formation of a new algal-coral symbiosis in ecologically relevant time-frames is likely to be an extremely rare event (LaJeunesse et al., 2018; Petay et al., 2015; Stat et al., 2006; Thornhill et al., 2014). There is limited field evidence that coral bleaching may allow corals to swap one type of algae for another that is also symbiotic with the coral (Boulotte et al., 2017; Quigley et al., 2018).

Corals that bleach visibly can still retain 100-1000 algal cells per square centimetre. When they recover from relatively mild temperature stress, the algal population within corals recovers from these remaining internally located cells and not from cells recruited from external environment (Hoegh-Guldberg et al., 1987; Hoegh-Guldberg and Smith, 1989).

Temperature tolerance in corals is also not simply down to the variety of algae in a coral but is equally dependent on the animal host - the coral. The symbiotic partnership, one cell (algal) inside the other (coral), has evolved over long periods of time to enable both to prosper in the prevailing local long-term average temperatures.

4. Will corals simply adapt to higher temperatures at rates that keep up with rising temperatures?

There is no evidence that corals will be able to evolve fast enough to keep pace with current and projected warming. Different corals, however, may have different temperature tolerances and changes to reef composition has been observed as more vulnerable types of corals are killed by thermal stress (e.g. 'winners and losers', Loya et al 2001; Hughes et al. 2018).

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