Information Statement on: Coral Bleaching

What is coral bleaching and what causes it?

Coral bleaching is a stress response when coral polyps expel their symbiotic algae (zooxanthellae) primarily in response to elevated sea temperatures. This breaks down the symbiotic relationship corals rely on for their nutrition. The white coral skeletons can be seen through the transparent coral tissue after the colourful zooxanthellae are lost, hence the term "bleaching". Corals tend to live within narrow thermal limits that often characterise the world's tropical oceans, so a persistent temperature rise of as little as 1ºC above normal summer time levels can trigger bleaching. It can also be exacerbated by other environmental factors or stressors. For example high light levels, being too cold, freshwater and a deterioration of water quality. If the stress is removed in time, the zooxanthellae can re-establish and the coral can recover; otherwise, the coral will die.

Figure 1. Australian Institute of Marine Science (AIMS) diver and research scientist Neal Cantin surveying coral bleaching severity on the Great Barrier Reef with a severely bleached Platygyra coral colony. Photo credit: Sam Noonan, AIMS.

The 2015-16 event

In October 2015 NOAA declared the possibility of a global, mass coral bleaching event—given that the Northern Hemisphere had already experienced widespread bleaching in the boreal summer. Seasonal forecasts from the Bureau of Meteorology's POAMA model also provided warnings of coral bleaching several months in advance.

El Niño events typically result in warmer than normal sea surface temperatures across large parts of the tropical oceans where coral reefs occur. Seasonal outlook models by NOAA and the Bureau of Meteorology predicted the 2015–16 El Niño to produce anomalously warm sea surface temperatures surrounding Australia through the austral summer into 2016. Subsequently, the most severe mass coral bleaching on record occurred in northern Australian waters, peaking in March 2016. Aerial and in-water surveys found that bleaching had affected the majority of the Great Barrier Reef (GBR), with bleaching and subsequent mortality most severe at lower latitudes north of Cairns with up to 50% mortality north of Lizard Is., reducing to 16% southwards from Lizard to Tully. In Western Australia, extensive bleaching was observed for the first time across fringing reefs in the coastal Kimberley, as well as at offshore reefs in the Timor Sea such as Scott Reef, which had largely recovered from previous bleaching in 1998. Very recent reports suggest incidences of coral bleaching in isolated reefs and shoals across the north, too.

The ocean surrounding Ningaloo Reef in Western Australia this year was much cooler than further north due to a weaker southward transport of heat associated with the Leeuwin Current and coastal upwelling, and so was not affected by this event. Ningaloo did, however, experience bleaching in the 2011 marine heatwave whilst the 2010–2012 La Niña was strong.

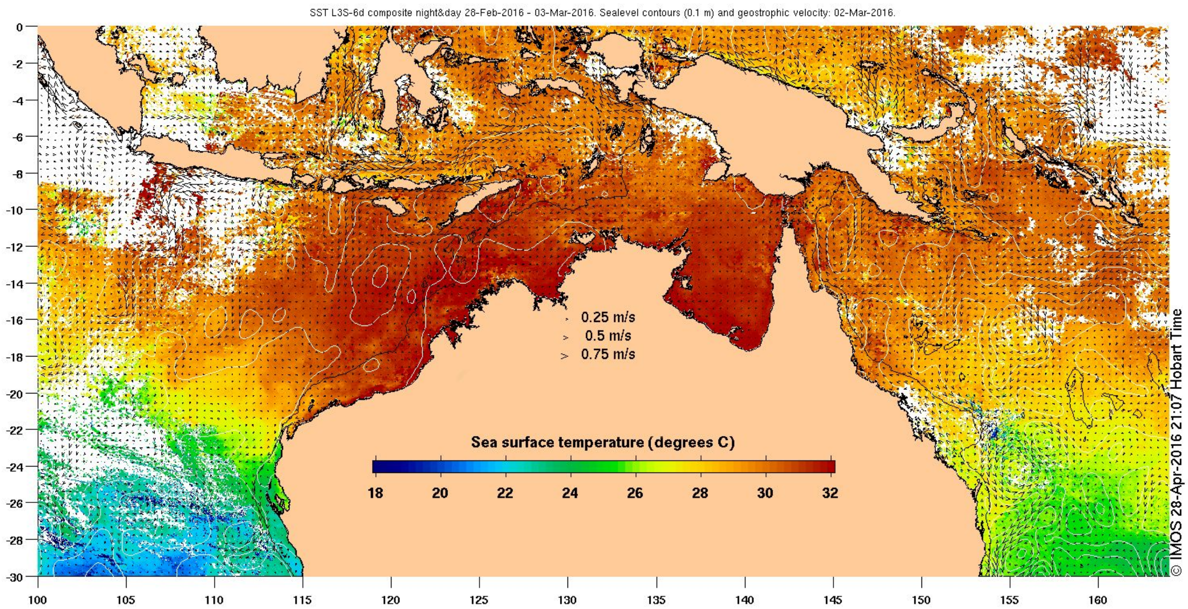

Figure 2. Ocean current 6-day Sea Surface Temperature composite 28 Feb – 3 Mar, 2016 of Northern Australia. Credit: Integrated Marine Observing System (IMOS).

What is the history of coral bleaching in Australia and how does it relate to past climate variations?

Whilst this year's bleaching was linked to the 2015–2016 El Niño, both local weather and oceanographic processes also played an important part in the observed bleaching patterns. While ocean temperatures of only about 1–2ºCabove the climatological summer time maximums will trigger coral bleaching, local and regional weather patterns producing calm and cloud free days (doldrums) will reduce flow and mixing and increase light exposure to further enhance local ocean temperatures during El Niño events—quickly increasing the bleaching threat.

Global warming, however, is clearly a determining factor in the increase in frequency, spatial scale and severity of these massive bleaching events that only started to occur in the late 20th century.

Past events

The GBR has experienced less severe and patchy bleaching events since the early 1980s. The largest global event observed by satellite before 2015/2016 was in 1998. In Australia, the 1998 event was most severe at Scott Reef, in WA and bleaching and mortality occurred to a depth of 30m. An estimated 50% of GBR reefs were also affected, but it was mainly found in the central GBR coastal areas. In 2002, more than 60% of reefs were affected in the GBR, although it was more prevalent in the offshore regions as the entire Coral Sea experienced elevated temperatures. Significant mortality occurred in the remote Coral Sea Territories. There have been some minor events in the last 15 years; however, these have been much more localised and can also be due to other stressors, such as exposure at low tide, freshwater, and anomalously cold conditions that can also lead to bleaching.

What do climate projections suggest for the future frequency and intensity of bleaching?

Climate is changing rapidly for tropical coral reef ecosystems, which are already showing their vulnerability. Even with the relatively modest increases in global average temperatures observed to date, corals are now living very near their upper thermal tolerances. This means when temperatures increase again, particularly during summer months, corals will exceed these thresholds and move to a state of thermal stress. It is becoming clear that if we are to avoid increases in the number and severity of bleaching events, we need to limit global warming to well below 1.5ºC.

In the meantime, researchers are investigating the potential for reef corals to recover after bleaching events and their ability to acclimatise or adapt to water temperature increases in the longer term. Persistently cooler refugia for corals are also being identified from local micro-climates controlled by physical oceanographic processes that include upwelling, tidal mixing processes and internal waves. By modelling reef connectivity of coral spawn from less affected areas to other parts of the reef, researchers will help determine how long reefs take to re-establish. Reefs are dynamic ecosystems and can recover if there is sufficient time between disturbance events, and if the surviving corals at colder depths or reefs from upstream can supply new larvae. Long-term monitoring studies of the isolated Scott Reef in WA showed a recovery back to pre-98 baseline cover levels of fast growing *Acropora* species after a period of 10 years. During recent bleaching events, however, we are starting to see an increase in bleaching severity and mortality of long-lived massive corals that are centuries old and will need much longer recovery periods to remain into the future.

Further information:

http://www.gbrmpa.gov.au/media-room/coral-bleaching
http://www.aims.gov.au/docs/research/climate-change/coral-bleaching/bleaching-events.html
http://www.bom.gov.au/environment/doc/marine-heatwave-2016.pdf
http://www.bom.gov.au/environment/activities/reeftemp/about.shtml