Marine Climate Change in Australia

Impacts and Adaptation Responses 2009 REPORT CARD

This report card summarises our current knowledge of marine climate change impacts for Australia, highlighting key knowledge gaps and adaptation responses

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level"

Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report 2007

Key findings:

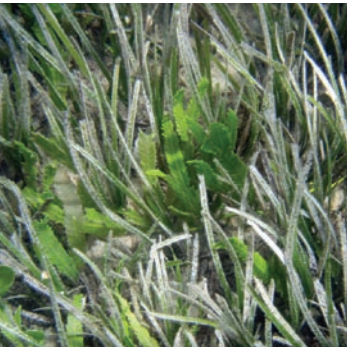
- Australian ocean temperatures have warmed, with south-west and south-eastern waters warming fastest
- The flow of the East Australian Current has strengthened, and is likely to strengthen by a further 20% by 2100
- Marine biodiversity is changing in south-east Australia in response to warming temperatures and a stronger East Australian Current
- Declines of over 10% in growth rates of massive corals on the Great Barrier Reef are likely due to ocean acidification and thermal stress

National Research FLAGSHIPS Climate Adaptation
CSIRO
NCCARF National Climate Change Adaptation Research Facility
www.oceanclimatechange.org.au

Impacts on marine biodiversity

Tidal wetlands	> Expansion of mangroves into salt marsh habitat in south-east Australia and into freshwater wetlands in northern Australia driven by sea-level rise and soil subsidence associated with reduced rainfall (MEDIUM confidence)	> Mangrove areas are likely to expand further landward, driven by sea-level rise and soil subsidence due to reduced rainfall (MEDIUM confidence)	> Assess the state of tidal wetlands in poorly sampled areas of Australia (e.g. Kimberly), measure wetland accretion and subsidence rates in tropical Australia and improve research into how tidal wetland fauna will respond to climate change	> Remove artificial barriers such as seawalls, ditches and buildings to allow tidal wetlands to adapt naturally and allow landward migration of these habitats
Seagrass	> A southern range extension of 300 km into Moreton Bay, Qld, of the tropical seagrass *Halophila minor* consistent with a warming and a strengthening East Australian Current (LOW confidence)	> Declines in seagrass abundance and extent due to sea-level rise, increased storminess and warmer temperatures (MEDIUM confidence)	> Improve understanding of thermal tolerances, coastal catchment runoff under changing climate and responses to increasing rates of habitat fragmentation	> Reduce non-climate related human impacts and maintain seagrass genetic diversity via planting or habitat protection to increase resilience
Macroalgae	> Loss of algal habitat off eastern Tasmania associated with a southward range expansion of a sea urchin assisted by the strengthening of the East Australian Current and warmer temperatures (HIGH confidence)	> Range shifts and local extinctions of cool-temperate species will occur along Australia's temperate coastline (MEDIUM confidence)	> Improve knowledge of the distribution and abundance of indicator species, and consider experimental transplants to recover depleted habitats	> Improve and maintain coastal water quality to increase the resilience of macroalgae to climate change
Phytoplankton	> Expansion of sub-tropical species, including harmful species, into south-eastern waters is driven by warming and a strengthening of the East Australian Current (MEDIUM confidence)	> Increased episodes of harmful algal blooms in south-eastern waters in response to extreme rainfall events and warming temperatures (LOW confidence)	> Maintain and increase monitoring efforts to detect change in indicator species, and provide information to ocean users on bloom species; maintain and utilise ocean colour satellite derived chlorophyll products	> Increase vigilance of harmful algal blooms to allow businesses (such as fish farms) and local agencies to respond rapidly
Zooplankton	> Although there are no long-term data in Australia, species elsewhere are shifting distributions polewards (LOW confidence)	> Changes in community structure resulting from modified productivity regimes, as well as range extensions with warming, such as the potential for venomous jellyfish to extend southward, particularly on the east coast (LOW confidence)	> Monitor zooplankton within the Integrated Marine Observing System and conduct targeted experimental and modelling studies to predict changes in zooplankton dynamics	> Improve and maintain coastal water quality to increase the resilience of coastal Australian zooplankton communities to climate change; alter beach management practices (e.g, closing beaches) in regions newly colonised by venomous jellyfish
Coral reefs	> Sea surface warming has led to extensive coral bleaching events and declines in coral condition on the Great Barrier Reef and on north-western reefs (HIGH confidence). Ocean acidification and increased thermal stress are the likely causes of a >10% reduction in the growth rates of massive Porites corals on the Great Barrier Reef (MEDIUM confidence)	> Frequency and severity of mass coral-bleaching events will increase as temperatures warm, leading to declines in coral reef health (HIGH confidence). Ocean acidification will reduce coral growth rates making reefs more susceptible to erosion and disturbance from storms (HIGH confidence)	> Undertake experimental studies to strengthen predictions of thresholds for coral-algal phase shifts and loss of ecosystem function under climate change	> Improve and maintain coastal water quality and healthy populations of herbivorous reef fishes to help sustain the resilience of coral reefs

Tropical fish	> Numbers of tropical species at sub-tropical and temperate latitudes are increasing as temperatures warm indicating that some species are shifting their ranges southward (LOW confidence)	> Loss of diversity and widespread changes in the composition of coral reef fish communities following degradation of coral reefs (HIGH confidence)	> Understand the effects that changes in temperature, pH and ocean currents have on the physiology and population dynamics of tropical marine fishes, and the capacity for acclimation and genetic adaptation to these rapid environmental changes	> Reduce overfishing and maintain, restore and protect essential fish habitats such as seagrass beds, salt marshes, coral reefs, mangroves and macrolagal beds
Temperate fish	> Southward range expansions in south-eastern waters are linked to warming temperatures and a strengthening of the East Australian Current; estuarine fish abundances are linked to annual fluctuations in freshwater discharge (rainfall), which is declining (MEDIUM confidence)	> Breeding populations of tropical species establish in southern waters; reduction in the abundance of estuarine species as rainfall, therefore riverflow, is reduced (MEDIUM confidence)	> Provide baseline information (ecology, physiology, reproduction, early life history) on many fished stocks, and in particular non-commercial fish, and experiments to test survival in changing habitats	
Pelagic fish	> Replacement of small cool-temperate species in southern waters by sub-tropical and tropical species driven by warmer temperatures (LOW confidence)	> Increased occurrence of tropical species in southern waters (MEDIUM confidence)	> Downscale climate models to investigate the impact of changing prey fields under climate change scenarios on pelagic fish distribution and abundance, and how fishers might respond	> Include climate change projections in fishery management plans to conserve stocks and assist fishers in adapting to changes in species' abundances and distributions
Marine reptiles	> Warmer sand temperatures, from increased air temperature, has increased mortality of sea turtle eggs and hatchlings at the Mon Repos rookery in south-east Qld (HIGH confidence)	> Declines of reef-associated sea snakes as temperatures warm and coral reefs degrade (LOW confidence); some tropical sea turtle nesting beaches will produce 100% females (MEDIUM confidence)	> Identify areas in Australia that have the potential to serve as functional habitats for marine reptiles under projected climate forecasts and investigate potential for artificial beach modification to reduce impacts	> Reduce non-climate threats, protect turtle nesting beaches particularly beaches which are important for producing males, improve and maintain coral reefs and inter-reef habitat to protect sea-snake populations
Seabirds	> Little penguins are altering their breeding time in response to warmer temperatures, and chick growth of tropical and sub-tropical seabirds has slowed in response to less food availability as temperatures warm (LOW confidence)	> Warmer temperatures and an El Niño-like future climate are expected to reduce food availability for breeding seabirds leading to a reduction in breeding success (MEDIUM confidence)	> Maintain and expand monitoring to improve understanding of drivers of change in seabird populations, and investigate the potential of alterative land-use strategies to increase the ability of nesting birds to cope	> Manage breeding habitats and reduce or eliminate non-climate threats to increase resilience and improve the likelihood of natural adaptation; reduce competition from humans for food e.g. through fishery management





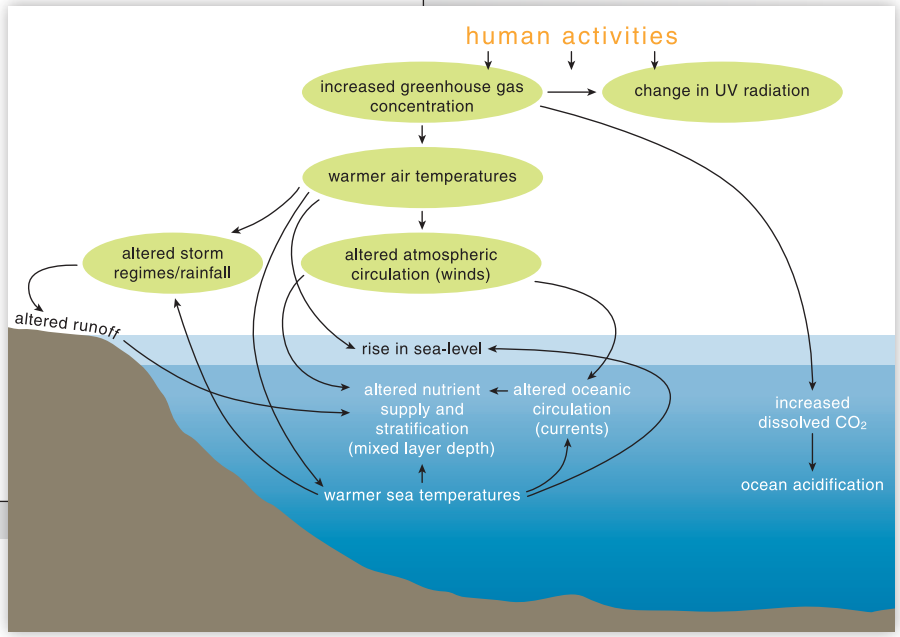

Confidence levels (high, medium, low) for each statement are based on the experts' review of the evidence and consensus, as detailed in each section on the website: www.oceanclimatechange.org.au

We are now observing changes in our marine climate and impacts on our marine biodiversity. We urgently need to reduce our greenhouse gas emissions to stabilise global warming and adopt strategies to allow our natural ecosystems and societies to adapt to unavoidable climate change.

Climate Change

Increasing concentration of greenhouse gases in the atmosphere change the Earth's radiative balance (the balance between incoming solar radiation and outgoing radiated energy) and lead to global warming. Atmospheric concentrations of carbon dioxide have increased markedly since the Industrial Revolution (circa 1750) from 280 ppm to 387 ppm in 2009, as a result of human activities based on fossil fuel use.

Air and ocean warming observed since the 1950s, both globally and across Australia, are attributable to increases in atmospheric greenhouse gas concentrations. For marine ecosystems, rising atmospheric greenhouse gases warm the atmosphere and oceans altering circulation patterns and bringing the additional threat of ocean acidification. Links between human activities and physical and chemical ocean processes are complex and widespread, affecting the coastal, deep and open oceans.



Australia: a maritime country

Australia has a coastline of almost 60,000 km that spans tropical waters of northern Australia to the cool-temperate waters of Tasmania. Our mainland is bounded by the East Australian Current on the east coast and the Leeuwin Current on the west. These major currents carry warm water into southern regions and have considerable influence on our marine flora and fauna. Australia has sovereign rights over around 8.1 million km^2 of ocean (greater than its land area of around 7.7 million km^2), which generate considerable wealth through economic sectors such as fisheries, tourism, and shipping and port industries.