Potential impacts of changing sea-surface temperatures and sea level rise on seabirds breeding on the Great Barrier Reef

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As the globe warms, information on seabird population trends and whether or not species can adapt is critical. Unfortunately, it is unclear whether the substantial population declines observed for the many species of tropical seabirds breeding on the Great Barrier Reef (GBR) have continued. Recent and systematic data for most important seabird breeding colonies in the region are limited, but the latest research into potential coping strategies of seabirds on the GBR suggests that reproduction, and ultimately species survival, is under threat. Predicted global sea level rise and changes to cyclonic dynamics threaten seabird populations around Australia, but particularly in tropical regions such as the GBR, where colonies are formed on low-lying coral cays and islands. If sea level rises more quickly than coral can grow, then water depth over the live coral will increase, and a decrease in accessibility to prey will result. If climate change kills coral, there will be a change in the abundance and species composition of fish communities; decreased productivity of an area will lead to smaller populations of seabirds inhabiting it. For example, a significant decrease in the population of the Black Noddy in the Capricorn-Bunker Group resulted from the mass mortality of adults and chicks which coincided with coral bleaching over an extensive area during the El Niño Southern Oscillation in 1998.

Potential coping strategies for climatic variation include changes to timing of breeding, foraging behaviour, size and growth rates of offspring, and breeding location. However, when faced with wide variation in sea-surface temperature (SST), species may not have the plasticity to adapt to rapid climate change. Black Noddies, which forage offshore, are unable to modify their foraging behaviour (prey type, feeding frequency or meal size) or chick growth rates greatly. As sea-surface temperatures increase and food becomes limited, adult Black Noddies spend more time foraging but bring back less food. When food is super-abundant, feeding rates are constrained by chick fullness and the chicks’ inability to increase growth rates. These limitations suggest that responses of this species (and similar species) to climate change may take generations.

Another area of concern is the effect of climate change on the preferred habitat of breeding seabirds. On the GBR, the distribution and abundance of seabirds is correlated with the distribution and abundance of coral cays. The biomass of seabirds on the GBR is concentrated in the Far Northern and Capricorn sections of the GBR Marine Park (Table 1), where the majority of coral cays occur (Table 2). Seabird colonies there are threatened by a rise in sea level. In Australia, the sea level is predicted to rise by 0.8 centimetres by 2100.

Most cays are less than three metres above the mean high-water mark. Low-lying coral cays, which are the preferred breeding sites of seabirds on the GBR, will be at risk of being flooded at high tide, while others will be inundated during storm surges from the increased number of intense tropical storms and cyclones.

Generally, cays gradually increase in size and elevation; however, a single storm can rapidly decrease a cay’s size and elevation. Figure 1 shows changes in the vegetated area and position of Michaelmas Cay between 1990 and 1997. The vegetated area was relatively stable for at least seven years, but was then dramatically decreased by Cyclone Justin in 1997. Cays are known to migrate back and forth on the reef crest, as evidenced by changes in the cay’s position relative to the beach rock (Figure 1).

Storm surges have been a major cause of mortality of eggs and chicks of species that nest just above the high water mark, e.g. Lesser Crested (Thalasseus bengalensis), Black-naped (Sterna sumatrana) and Roseate terns. However, with an anticipated sea level rise of almost a metre, combined with storm surges of several metres, species that nest on the interior of cays are also at risk. For example, parts of the nesting areas of Wedge-tailed Shearwaters at cays such as Heron and North West Islands would be inundated by storm surges and storm high tides of more than six metres. Cyclone Hamish in 2006 caused a four metre high tide and surge, and water came up almost to the edge of the vegetation on the north-western side of Heron Island. Most of North West Island is lower than Heron Island. Loss of the Wedge-tailed Shearwater colony on North West Island would affect 80% of its breeding population on the east coast of Australia. Furthermore, flooding of vegetated areas by seawater would lead to the loss of habitat suitable for nesting. Changes in rainfall may also affect the vegetation; for example, decreased rainfall may dry out or kill the vegetation and increase the risk of fire.

The loss of cays would change the distribution of seabirds from the outer parts of the continental shelf to the inner and middle parts, where the continental islands occur. The majority of continental islands are in the MacKay–Capricorn section and the Townsville section of the GBR Marine Park (Table 2), though there are numerous continental...
islands in the Far Northern section for seabirds to nest on provided they have suitable habitat.

Tropical cyclones that occur during the seabirds’ breeding season increase mortality of eggs and chicks, and affect available nesting habitat. For example, choice of Crested Terns, Sooty Terns, Common Noddies (Anous stolidus) and Black Noddies are reported to have died of starvation or exposure during tropical cyclones. The rough sea-surface conditions make it difficult for adult birds to detect prey, or they cannot return to the colony against the wind to feed their young. However, on Michaelmas Cay, although individual cyclones have had substantial impacts on reproduction and nesting space, there has been no noticeable impact on longer term trends in breeding numbers. Predicted increases in the frequency or intensity of tropical cyclones as a result of climate change may have greater impacts to populations in future via increased adult mortality and reduced recovery periods.

The loss of coral cays suitable for breeding seabirds will affect their access to feeding areas. Immature feeders, which breed in small colonies near their feeding grounds, will be affected differently from offshore and pelagic feeders, because they can readily switch their breeding sites between seasons. In contrast, even though offshore and pelagic feeders breed in a few large colonies and can travel large distances to their feeding grounds, they may skip breeding in a given season when problems arise. The loss of coral cays as breeding areas may increase competition between immature species for nesting areas and access to feeding areas near the colony.

Climate change is likely to affect the viability of seabird colonies in two distinct ways: changes to the food supply and suitability of habitat for breeding. First, climate change will decrease the abundance of prey through the loss of corals which provide habitat and sources of food for many of the prey species of immature feeders. Increased sea-surface temperatures decrease the productivity of plankton, in turn causing decreases in the abundance of pelagic fish stocks that are the major prey of the offshore and pelagic feeders. At least some species appear to have little ability to change their foraging behaviour and growth rates to compensate for a decreased food supply. Second, climate change will decrease availability of preferred habitats for breeding seabirds through changes in the mean high-water mark, which, when combined with the increased incidence of storm surges, will flood nesting areas or erode the size and elevation of cays. It seems that seabirds are unlikely to be able to adapt with sufficient rapidity to changes in their environment caused by climate change. That leaves us with the challenge of managing their populations to maximise their chances of survival.

Table 3. Number of six different types of islands in the Great Barrier Reef Marine Park. (Source: D Hayley Island database in Holman 1987)

<table>
<thead>
<tr>
<th>Section of GBRMP</th>
<th>Type of island</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Continental</td>
<td>Low Morted</td>
</tr>
<tr>
<td>Far Northern</td>
<td>65</td>
<td>26</td>
</tr>
<tr>
<td>Coffs</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Townsville</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>Mackay/Osprey</td>
<td>297</td>
<td>10</td>
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<tr>
<td>Total</td>
<td>448</td>
<td>54</td>
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References and further reading