



Australian Government

Great Barrier Reef
Marine Park Authority

Published May 2006

Environmental Status:

Birds

our great barrier reef
let's keep it great



© Great Barrier Reef Marine Park Authority
ISBN 1 876945 34 6

Published May 2006 by the Great Barrier Reef Marine Park Authority

This work is copyright. Apart from any use as permitted under the *Copyright Act 1968*, no part may be reproduced by any process without prior written permission from the Great Barrier Reef Marine Park Authority. Requests and inquiries concerning reproduction and rights should be addressed to the Director, Science, Technology and Information Group, Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville, QLD 4810.

The opinions expressed in this document are not necessarily those of the Great Barrier Reef Marine Park Authority. Accuracy in calculations, figures, tables, names, quotations, references etc. is the complete responsibility of the authors.

National Library of Australia Cataloguing-in-Publication data:

Bibliography.
ISBN 1 876945 34 6

1. Conservation of natural resources – Queensland – Great Barrier Reef. 2. Marine parks and reserves – Queensland – Great Barrier Reef. 3. Environmental management – Queensland – Great Barrier Reef. 4. Great Barrier Reef (Qld). I. Great Barrier Reef Marine Park Authority

551.42409943

Chapter name: **Birds**
Section: *Environmental Status*
Last update: *May 2006*
Primary Author: *Malcolm Turner, Rachel Green and Andrew Chin*

This document should be referenced as:

Turner, M., Green, R., and Chin, A., May 2006, 'Birds' in A. Chin (ed), *The State of the Great Barrier Reef On-line*, Great Barrier Reef Marine Park Authority, Townsville. Viewed on (enter date viewed), www.gbrmpa.gov.au/corp_site/info_services/publications/sotr/latest_updates/birds

Environmental status: birds

Summary

The Great Barrier Reef has an abundant and diverse array of bird life that is important to the ecology, natural heritage, and social and cultural values of the Great Barrier Reef World Heritage Area.

- Approximately 215 species of bird have been recorded in Great Barrier Reef World Heritage Area, including land birds, shorebirds and seabirds — collectively known as ‘coastal birds’.
- Bird populations vary between seasons and years. Migratory species only visit the Great Barrier Reef region at certain times of the year. Many migratory shorebirds fly to Australia and New Zealand along the East Asian-Australasian Flyway.
- The Great Barrier Reef is especially important for seabirds with some 1.4 to 1.7 million seabirds from 23 species breeding on islands and cays. This accounts for more than 25 per cent of Australia's tropical seabird breeding populations and up to 50 per cent of the global population of some species.
- The northern and southern regions of the Great Barrier Reef are the most important areas for breeding seabirds due to the abundance of islands with suitable nesting sites.
- Long-term data from four regions indicate overall declines in seabird numbers and breeding success.
- The causes of the declines are complex but are thought to be linked to reduced breeding success arising from poor climatic conditions, particularly increased sea temperatures, that reduce food availability.
- Direct human pressures include disturbance of seabird rookeries, introduced weeds and feral animals, marine debris and the potential effects of oil spills. Indirect human pressures are mainly exerted through degradation of coastal bird habitats. Fishing may have some impacts on some bird communities but these impacts are not well understood.
- Management efforts are focused on protecting coastal birds and their habitats. Coastal birds are protected under the Queensland [Nature Conservation Act 1992](#), the [Environment Protection and Biodiversity Conservation Act 1999](#), and the [Great Barrier Reef Marine Park Act 1975](#). Migratory species and key habitats are also protected under international conventions.
- The potential impacts of climate change on coastal birds are being examined through the Great Barrier Reef Marine Park Authority’s (GBRMPA) Climate Change Response Programme. This will include identifying potential impacts and management strategies.
- Human visitation and use of seabird rookeries can disturb nesting seabirds. Seabird rookeries are managed under a variety of arrangements that regulate access and human use. Guidelines for managing visitation to seabird breeding islands have been developed.
- The Queensland Government has primary responsibility for the management of coastal bird habitats in catchments adjacent to the Great Barrier Reef. Since 2000, the Queensland Government and Australian Government have introduced new legislation and initiatives to improve land management practices and preserve coastal habitats such as wetlands.
- Introduced species and pests pose a significant threat to coastal birds. The management and control of pest species on islands and cays in the Great Barrier Reef is coordinated



through the [Day-to-Day Management Programme](#) and undertaken primarily by the Queensland Environmental Protection Agency.

- The Great Barrier Reef has one of the most comprehensive set of shipping management arrangements of any water body in the world. These arrangements are designed to reduce the likelihood of an oil spill from occurring. Contingency plans and equipment have been prepared so that an effective response can be mounted should an oil spill occur. These plans include arrangements for caring for oiled wildlife.
- Litter and marine debris can entangle or choke birds. Dumping of litter and marine debris into the Great Barrier Reef is illegal. The Great Barrier Reef Marine Park Authority is working with local governments and communities to educate users of the Marine Park about the threat posed by marine debris, and to reduce the amount of litter entering the Marine Park from local waterways.
- Coastal bird populations vary between sites and years depending on migration patterns, environmental conditions and the condition of the populations. This variability means that intensive long-term monitoring is required to detect and identify trends. Coastal bird monitoring programmes are coordinated through the Coastal Bird Monitoring Strategy developed through the Day-to-Day Management Programme.

Condition

Approximately 215 species of birds have been recorded in the Great Barrier Reef. The islands and cays of the Great Barrier Reef are especially important to seabirds with some 1.4 to 1.7 million seabirds visiting them each year to breed. The birds of the Great Barrier Reef can be divided into three groups based primarily on their habitat use, shorebirds, land birds and seabirds. These are collectively known as coastal birds.

Ecological roles

Coastal birds play an important role in the Great Barrier Reef ecosystem. They are major consumers of marine organisms such as fish, squid and crustaceans, and form an integral part of the marine food web. Seabirds are also an important part of the nutrient cycle by linking reef and island ecosystems.^{20,37} Seabirds enrich island soils by depositing guano and carrion and influence the growth of plants on coral cays. This in turn contributes to the cay's stabilisation and development.³¹ Birds also transport seeds from the mainland to offshore islands, which contribute to the establishment of island plant communities.



The sooty tern is one of the 215 species of birds found within the Great Barrier Reef World Heritage Area. Seabirds play an important role in the Great Barrier Reef ecosystem, influencing the soils and plants present on islands and cycling nutrients through the deposition of guano and carrion.

Variability of bird populations

The number of birds present at a given site at any one time is highly variable. Seabirds may fly offshore to collect food and thus are only present on islands at certain times of the day. Severe weather events, such as cyclones or gales, can cause birds to leave islands or normal rookery sites for extended periods. Birds may also move between different areas or islands at different times depending on the availability of nesting sites, food or amount of disturbance.

Migration patterns and seasonal variation

Some bird populations are seasonal. Migratory shorebirds may travel large distances between their breeding and feeding grounds. For example, the Eastern Curlew (*Numenius madagascariensis*) makes a 7 000 km migration from breeding grounds in Russia and China to Australia where they spend their non-breeding season (see *Condition – shorebirds*).

Many seabirds are also highly migratory. The Common Tern (*Sterna hirundo*) and Little Tern are highly migratory species that visit the cays of the Great Barrier Reef in winter,³¹ and Wedge-tailed Shearwaters (*Puffinus pacificus*) migrate long distances to northern waters during the non-breeding season.³⁰ Recent research has determined that the majority of South-East Asia's migratory population of Roseate Terns (*Sterna dougallii*) over-winter in the Swains Reefs of the Great Barrier Reef.³⁴ Recent studies also indicate that birds banded at Raine Island and other islands in the far northern Great Barrier Reef, such as the Brown Booby (*Sula leucogaster*), Masked Booby (*Sula dactylatra*) and Red-footed Booby (*Sula sula*), disperse across the western Pacific to countries including Indonesia, Papua New Guinea, Tuvalu and the Solomon Islands.¹²

These migration patterns demonstrate the importance of the Great Barrier Reef for migratory species, but also show that the abundance of birds in the Great Barrier Reef may be affected by impacts occurring in other areas of the bird's migration paths.



Migratory shorebirds such as the Eastern Golden Plover (*Pluvialis dominica*) breed in Siberia and Alaska, and migrate down the East Asian – Australasian Flyway to Papua New Guinea, Australia and New Zealand between August and April. These wide-ranging movements present a major challenge to monitoring efforts.

The effect of variation on determining 'Condition'

The large variations in the abundance and distribution of bird populations provide a challenge to monitoring because the number of birds counted at any one time will depend on the timing and location of the census. Consequently, bird monitoring programmes in the Great Barrier Reef identify 'breeding effort' which is represented by the number of breeding birds at major breeding sites. This provides a more accurate description of the overall health of the population. However, monitoring must still be conducted at multiple sites over a long period of time to accurately identify trends. Further, data about environmental conditions at the time may be required to interpret these trends.

Sources of information

Most of the information about coastal birds in Queensland is contained in the Coastal Bird Atlas³⁵ managed by the [Queensland Environmental Protection Agency](#) (EPA). Since 2002, pre-existing archival records have been standardised and entered into the Atlas, increasing the database from 9 000 to 60 000 records. Ongoing bird monitoring is conducted by EPA staff in accordance with the *Great Barrier Reef World Heritage Area Coastal Bird Monitoring Strategy*⁴⁴ and this data is continually added to the Coastal Bird Atlas. Important information on coastal bird populations is also collected by independent research projects and by volunteer and community groups such as [Birds Australia](#) and the [Australasian Wader Studies Group](#). Although comprehensive information is only available for a limited number of species and colonies, the data that has been analysed indicates significant declines in some of the most common seabird species (see *Condition: Seabirds*).

Conservation status of coastal birds

Some coastal birds in the Great Barrier Reef are of significant conservation concern due to their limited numbers or distribution, or because their populations are seriously threatened. The [Environment Protection and Biodiversity Conservation Act 1999](#) and the [Queensland Nature Conservation Act 1992](#), lists species such as the Little Tern (*Sterna albifrons*) and the Yellow Chat (Dawson) (*Epthianura crocea macgregori*) as 'Endangered' or 'Critically Endangered' (Table 1). The [Action Plan for Australian Birds 2000](#)¹⁶ also assessed the status of a large number of birds and made recommendations for their conservation listings.

Table 1. The conservation status of selected birds in the Great Barrier Reef

Species	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	<i>Queensland Nature Conservation Act 1992</i>	<i>Action Plan for Australian Birds 2000</i>
Herald Petrel* (<i>Pterodroma arminjoniana</i>)	Critically endangered	Endangered	Critically endangered
Yellow Chat (Dawson) (<i>Epthianura crocea macgregori</i>)	Critically endangered	Vulnerable	Critically endangered
Red-tailed Tropicbird (<i>Phaethon rubricauda</i>)	Listed marine species	Vulnerable	Near threatened
Little Tern (<i>Sterna albifrons</i>)	Listed marine species	Endangered	Least concern
Sooty Oystercatcher (Northern) (<i>Haematopus fuliginosus</i>)	Listed marine species	Rare	Least concern
Beach Stone Curlew (<i>Esacus neglectus</i>)	Listed marine species	Vulnerable	Least concern

More information about the conservation status of coastal birds in the Great Barrier Reef is available in the document [Fauna and Flora of the Great Barrier Reef World Heritage Area \(2005\)](#).

Condition: Seabirds

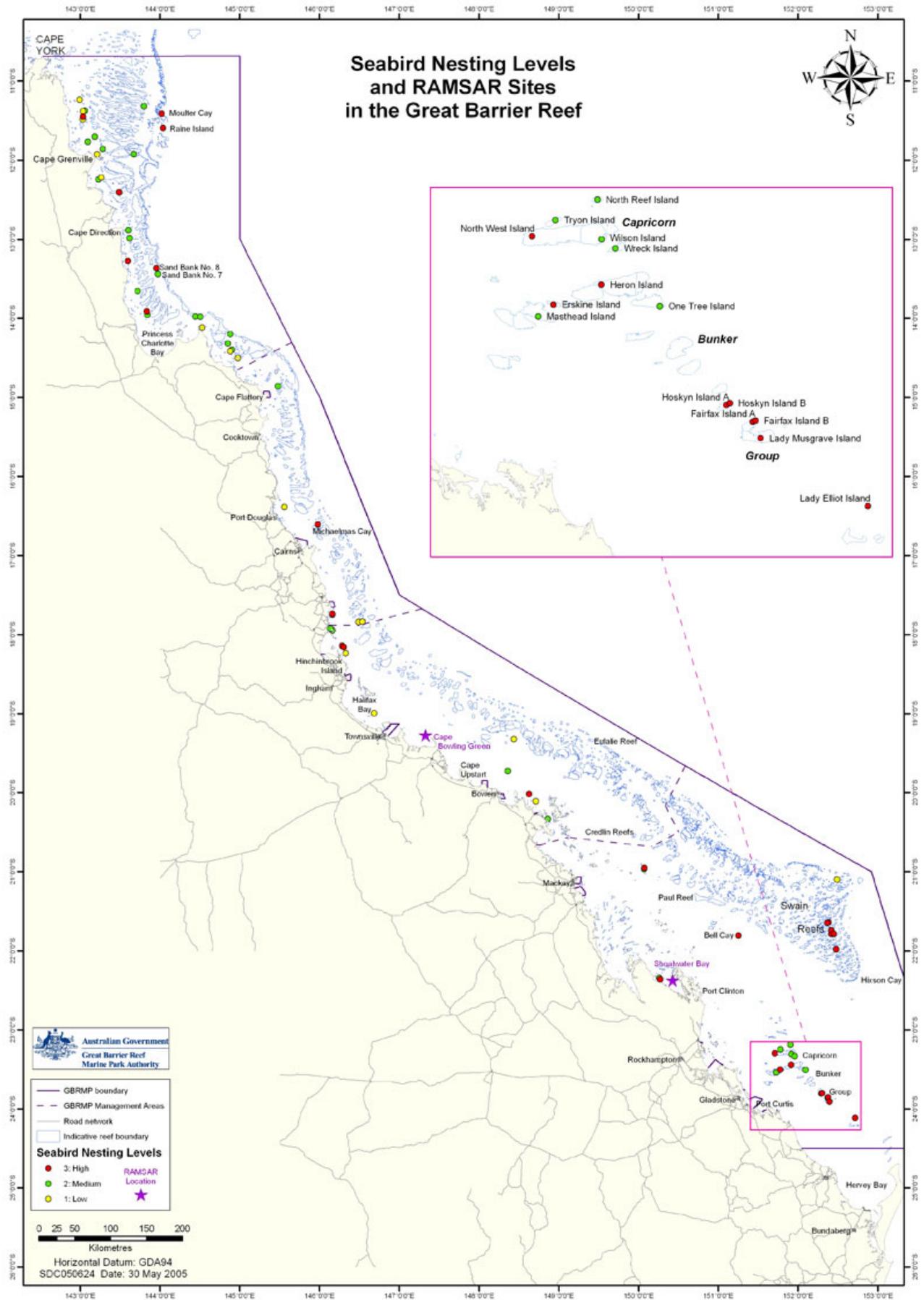
Seabird abundance, diversity and distribution

Between 1.4 and 1.7 million [seabirds](#) from at least 20 species breed on islands and cays in the Great Barrier Reef each year, representing more than 25 per cent of Australia's tropical seabird breeding population.²³ The population of non-breeding birds is estimated at 425 000 individuals, giving a total seabird population that may exceed two million.²⁹ Some of the more common seabird species found on the Great Barrier Reef include [Boobies](#), [Frigatebirds](#), [Gulls](#), [Noddies](#), [Shearwaters](#), [Terns](#) and [Pelicans](#). Many seabirds nest on the ground in shallow scrapes[#] while others nest in open areas, under vegetation, in shrubs, trees or burrows.



The islands and cays of the Great Barrier Reef are important breeding grounds for birds such as the Masked Booby (*Sula dactylatra*).

At least 79 islands and cays have been identified as seabird rookeries^f with 56 of these considered to be key sites.²³ These sites are concentrated in the northern and southern regions of the Great Barrier Reef where islands with suitable nesting habitats are more common (Figure 1). The northern Great Barrier Reef has the greatest seabird diversity with 23 breeding species.^{23,27,28}



**Figure 1. Significant sites for coastal birds including Ramsar sites and major seabird rookeries.
May 2006**

Raine Island in the northern section has the greatest diversity of any island with 16 breeding species including the Herald Petrel, Red-footed Booby and Red-tailed Tropicbird, which are uncommon in Australia. Other important seabird sites in the northern Great Barrier Reef include Moulter Cay, Sandbank No. 7 and No. 8, and Michaelmas Cay (Figure 1).

In the southern Great Barrier Reef, some 22 islands support significant seabird colonies. Of these islands, coral cays in the Capricorn-Bunker group support 73-75 per cent of the Great Barrier Reef's total seabird biomass (inset Figure 1), mainly because large numbers of the Wedge-tailed Shearwater and Black Noddy (*Anous minutus*) found in this area.^{23,45} These two species are the most abundant seabird species found in the southern Great Barrier Reef. The Capricorn Bunker Group supports approximately 50 per cent of the global Black Noddy population and about 30 per cent of the global population of Wedge-tailed Shearwaters.¹⁴

Trends in seabird populations

Long-term monitoring programmes have been on-going at four of the most significant seabird rookery areas on the Great Barrier Reef and significant declines of several species have been observed. These declines are thought to be associated with a range of pressures including weather related phenomena (storms, cyclones and [El Niño](#) events), climate change, reduced food availability and increased human activity. (See *Pressure: Natural pressures*). Trends observed in these four seabird rookeries are summarised below.

Raine Island

Since the 1980s, numbers of breeding seabirds on Raine Island have decreased by 70 per cent. The annual average population observed at Raine Island decreased from 23 445 seen in 1979-1993, to an average of 7 098 in the years between 1993-2003 (Table 2). Declines were evident in 13 of the 16 surveyed species including the Common Noddy (*Anous stolidus*), Brown Booby and Lesser Frigate-bird (*Fregata ariel*)³ which are the most common species in the region. Between December 1995 and December 2000, a more detailed study was conducted on Wedge-tailed Shearwaters that suggested a population decline of over 40 per cent, based on the number of occupied burrows at Raine Island.¹³ No evidence of habitat loss or degradation has been observed and the cause of these declines is unknown. However, the absence of localised impacts suggests that the causes may be related to changes in climatic conditions and/or a reduction in the availability of suitable prey.³



Surveys at Raine Island have found significant declines in seabird numbers, including species such as the Red-footed Booby.

Table 2: Species exhibiting the largest declines in abundance observed by long-term monitoring at Raine Island (Batianoff & Cornelius, 2005).

Species	Mean yearly population estimate 1979 – 1993	Mean yearly population estimate 1993 – 2003	Adult population decline 1979-2003
Common Noddy	11 693	526	- 95.5%
Sooty Tern	840	131	- 84.4%
Bridled Tern	191	59	- 69.1%
Red-footed Booby	467	150	- 67.9%
Lesser Frigate Bird	1 851	599	- 67.6%
Brown Booby	4 435	2 642	- 40.4%
Red-tailed Tropic Bird	104	64	- 38.5%

Michaelmas Cay

Michaelmas Cay is the most intensively monitored seabird site in the Great Barrier Reef due to its ecological importance, high tourism and recreational values and levels of use. The Queensland Parks and Wildlife Service have conducted monthly bird counts on Michaelmas Cay since 1984, providing reliable long-term data for detecting population trends.¹⁰ The Common Noddy and Sooty Tern (*Sterna fuscata*) are the two most abundant seabirds present on Michaelmas Cay. Monitoring data show that the number of birds recorded at Michaelmas Cay decreased during the 1990s, reaching a low point in 1994. Recovery was observed for the Common Noddy in 2000, and more recent analyses indicate some signs of recovery in Sooty Terns.¹⁵ However, for the period up to 2001, the numbers of Sooty Terns and fully fledged young Common Noddies were still well below 1984 levels.

Swain Reefs

Long-term monitoring in the Swain Reefs has shown significant declines in numbers of Brown Boobies and Silver Gulls (*Larus novaehollandiae*), but stable numbers (~1 100 individuals) of Masked Boobies. In the seven years between 1986 and 1993, Brown Booby numbers fell by 41 per cent from 3 200 to 1 300.²⁰ The decline is thought to be a result of inadequate food supplies associated with increased sea surface temperatures (see *Pressure*). Monitoring in 2005 showed that the population has not recovered (P O'Neill 2005, EPA, pers. comm., May 2006). Masked Boobies feed further offshore than Brown Boobies and thus, may have been better able to find food.



Long-term surveys revealed a 41 per cent decline in Brown Boobies in the Swain Reefs between 1986 and 1993.

Capricorn-Bunker Group

The coral cays of the Capricorn-Bunker Group are important seabird breeding sites that support 97 per cent of the Great Barrier Reef's Black Noddy population (~302 000 breeding pairs) and the Pacific Ocean's largest breeding population of Wedge-tailed Shearwaters (~560 000 breeding pairs).^{14,22} Approximately 79 per cent of the Capricorn-Bunker population of Wedge-tailed Shearwaters breeds on North West Island, making the island an internationally important site. The Capricorn-Bunker Group also contains the Great Barrier

Reef's largest breeding population of Silver Gulls which elsewhere nest mostly in isolated pairs or small colonies of less than 20 pairs.²⁸

Monitoring programmes in the Capricorn-Bunker Group recorded declines in Black Noddies and variable trends in Wedge-tailed Shearwaters. The number of Black Noddies reached a low point in 1998-1999 on all surveyed islands. On Heron Island, the number of Noddy nests declined from 72 000 in 1996 to 23 000 in 1998-1999. While some recovery was observed in 2000, numbers are still well below 1996 levels.¹⁴ These declines have correlated with El Nino events and elevated sea surface temperatures (see *Pressure*).

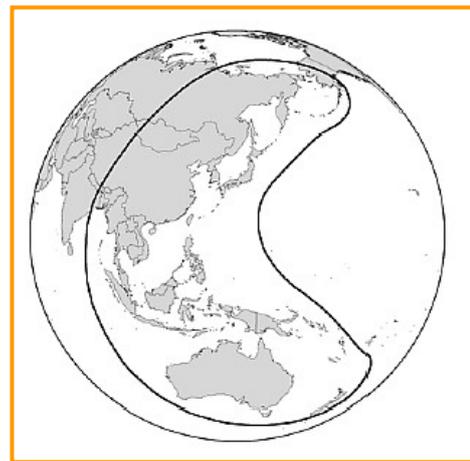


The islands of the Capricorn-Bunker Group are important seabird breeding sites. North West Island (pictured) is an internationally significant site for Wedge-tailed Shearwaters.

Condition: Shorebirds

At least 32 species of [shorebirds](#) have been recorded in the Great Barrier Reef region, including both residents and migrants. Some shorebirds may form large aggregations such as those found in Shoalwater Bay and Bowling Green Bay. Many shorebirds are commonly found in coastal estuaries and tidal mudflats although some species also occur further inland. Resident shorebirds can usually be found throughout the year, but some [shorebirds](#) such as the Sooty Oyster Catcher and Beach Stone-curlew only breed in pairs on isolated islands or beaches and are less conspicuous.

[Migratory shorebirds](#) may travel thousands of kilometres from their breeding grounds in the northern hemisphere to feed and rest in the southern hemisphere during their non-breeding phase. These birds migrate along the [East Asian–Australasian Flyway](#) that stretches from breeding grounds of Siberia and Alaska, through east and south-east Asia, to non-breeding sites in Australia and New Zealand.¹¹ Consequently, these species are usually only encountered during a few months of the year. There are two internationally recognised migratory shorebird areas (both listed as Ramsar sites) in the Great Barrier Reef World Heritage Area, Shoalwater Bay and Bowling Green Bay (see Fig 1). Shoalwater Bay contains the world's largest aggregation of Whimbrels (*Numenius phaeopus*), and the second largest aggregation of Terek Sandpipers (*Xenus cinereus*).²⁹



Migratory shorebirds traverse the East Asian – Australasian Flyway that links breeding grounds in the northern hemisphere to non-breeding grounds in Australia and New Zealand. Image from [DEH 2005](#)

There is very little information available to reliably assess the status and trends of shorebird populations in the Great Barrier Reef. The [Australian Action Plan for Birds 2000](#) describes some shorebirds as stable while others show decreasing trends, but the variability in shorebird populations due to their seasonal patterns and wide distribution makes it very difficult to effectively monitor their condition or interpret trends.

Condition: Land birds

The land birds of the Great Barrier Reef inhabit the Great Barrier Reef's coastal habitats, continental islands and coral cays. The bird communities on continental islands often resemble those found in adjacent habitats on the mainland. The Great Barrier Reef is particularly important to a number of land birds, including the Capricorn White-eye (*Zosterops lateralis chlorocephalus*), the Yellow Chat (Dawson) (*Epthianura crocea macgregori*), Pied (Torresian) Imperial Pigeon (*Ducula bicolor*), [Bush Stone-curlew](#) (*Burhinus grallarius*) and raptors such as the [White-bellied Sea Eagle](#) (*Haliaeetus leucogaster*).



The Capricorn white-eye, found on islands in the Capricorn Bunker Group, has been nominated as a new species.

The Capricorn White-eye is the only endemic^ϕ bird found within the Great Barrier Reef. Recent research suggests that the Capricorn White-eye may be a distinct species.²⁶ Its distinctive morphology and genetic isolation from other forms of the White-eye support its nomination as a new and separate species '*Zosterops chlorocephalus*'.

The [Yellow Chat](#) (Dawson) is the most vulnerable land bird found in the Great Barrier Reef region. The Australian east coast population was previously thought to have been extinct but in the 1990s, QEPAs officers discovered a small population on Curtis Island in Central Queensland. [Recent surveys](#) have located further individuals on the mainland near Rockhampton and the known population is now estimated to be over 250 individuals.³³ Nevertheless, the total population numbers are low and pressures from habitat degradation have resulted in the bird being classified as Critically Endangered under the [Environment Protection and Biodiversity Conservation Act 1999](#) (EPBC Act 1999).

The Pied Imperial Pigeon is a migratory species that visits the Great Barrier Reef during summer and returns to Papua New Guinea during the winter. The greatest numbers of Pied Imperial Pigeons on the Great Barrier Reef occur between Cooktown and Cape York. In this region, Pied Imperial Pigeons make daily migrations from coastal islands to rainforests on the mainland to feed on rainforest fruits. After feeding, the Pigeons return to the islands in the evening to roost and in doing so, carry the seeds of rainforest plants to the islands. Over-hunting by early European settlers depleted populations resulting in their protection in the 1960s. This species has been monitored since the 1964, mostly by community groups with assistance from the EPA. Since protection was introduced the population has increased and stabilised. It is thought that numbers are unlikely to increase further as the population has stabilised and the available food and habitat resources are fully utilised.



The white-bellied sea eagle is one of the raptors occurring in the Great Barrier Reef region.

Three species of fish-eating raptors are found on islands in the Great Barrier Reef, the Osprey (*Pandion haliaetus*), Brahminy Kite (*Haliastur indus*) and White-bellied Sea Eagle.³¹ Although these species are also widely distributed along the Queensland coast, little is known about their population size and trends. A recently published study suggests that numbers of White-bellied Sea Eagles in coastal regions of north Queensland are declining but the cause for the decline is not clear.³⁹

Pressure

Many of the Great Barrier Reef's coastal birds (shorebirds, land birds and seabirds) use the same habitats and are affected by the same pressures. Consequently, the pressures and responses discussed are generic to all coastal birds unless it is indicated that they apply to a specific group.

Coastal bird populations are affected by both naturally occurring pressures and pressures arising from human activities. Pressures associated with human activities include the direct disturbance of birds, and indirect pressures from habitat loss and deterioration.

Pressure: natural pressures

Coastal habitats, continental islands and coral cays are critical habitats for many coastal birds. These habitats are influenced by ongoing geophysical processes such as erosion and deposition, and are periodically affected by severe weather events such as cyclones.

Geophysical processes

Coral cays are the least stable type of island in the Great Barrier Reef as they typically do not protrude far above sea level and greatly affected by erosion and deposition. Consequently waves, winds and storms have a major influence over a cay's shape, size and longevity.²¹ Strong winds, waves and storm surges can erode beaches and wash over the islands, damaging important nesting habitats on coral cays such as *Pisonia* forests, beaches and sand dunes. As a result, the availability of suitable nesting sites on coral cays may change dramatically over a short time.^{4,28} For example, since the 1990s, erosion and sand movement at Sudbury Cay have resulted in the cay becoming completely submerged during high tide. Seabirds can no longer use Sudbury Cay as a permanent roosting site.

Storms and cyclones

The effect of cyclones and extreme weather events on seabirds may depend on the nature of the cyclone, the stage of the breeding cycle and the species involved.²³ In some instances, cyclones only temporarily displace adult birds. In 1986 and 1988, cyclones caused short-term reductions of 34 per cent and 47 per cent respectively in the breeding population of Common Noddies at Michaelmas Cay. Monthly monitoring by Queensland Parks and Wildlife Service staff suggested that these reductions were not caused by bird mortality, but by the birds avoiding the island during and immediately after the cyclones. Further, the cyclones did not affect all species equally with no observed decline in numbers of Sooty Terns (*Sterna fuscata*) and [Crested Terns](#) (*Sterna bergii*). In 1997, Cyclone Justin passed over Michaelmas Cay causing an estimated two-thirds of the seabird population to be displaced and burying 80 per cent of the island's vegetation under sand. Subsequent monitoring by the Queensland Parks and Wildlife Service showed that most of the adult seabirds returned after the cyclone passed.



Cyclones may only temporarily displace adult seabirds from an area, as observed with crested terns (pictured) at Michaelmas Cay. However, chicks are more vulnerable to severe weather events than adults, and severe weather events can have devastating effects on breeding success and population size.

The impacts of cyclones may be much more severe if they occur during sensitive periods of the breeding cycle, especially when large numbers of eggs or chicks are present. Severe weather can prevent adults from leaving nesting sites to search for food, and rough seas can make it more difficult for adults to capture prey or return to their nests to feed their young. This may lead to starvation of chicks. Furthermore, adults have been known to leave the nesting sites during severe weather events, exposing the chicks and eggs to wind, rain and lower temperatures.²⁸ In 1976, Cyclone David struck Heron Island and cyclonic conditions persisted for four to five days. While adults were able to return to the island after the cyclone had passed, many Black Noddy chicks were too weak to take food from their parents and large numbers died from starvation.²³

El Niño-Southern Oscillation events

[El Niño](#)-Southern Oscillation (ENSO) events may affect coastal birds, particularly seabirds, by reducing the availability of suitable prey. ENSO events typically result in major changes in current patterns and increased sea surface temperatures in the eastern tropical Pacific Ocean. These changes may affect the movement and behaviour of baitfish, and reduce the activity of pelagic predatory fish. This causes a flow-on effect as baitfish may become harder to locate, and the predatory fish stop driving them towards the surface where they become accessible to birds. The loss of available prey is known as ‘provisioning failure’. This may severely affect breeding success and chick growth, and in some cases may cause the death of large numbers of immature and adult birds.⁴⁰

Between 1982 and 1983, a severe ENSO event resulted in reproductive failure and high adult mortality of several seabirds colonies in the Central Pacific.³⁸ In the Great Barrier Reef, periods of unusually warm water have been linked with poor breeding seasons observed in Black Noddy colonies¹⁴ in the Capricorn-Bunker Group, Brown Boobies in the Swains Reefs,²⁰ and Sooty Terns and Common Noddies on Michaelmas Cay.⁸ In 2002, abnormally high sea-surface temperatures in the Southern Great Barrier Reef coincided with the reproductive failure of the Wedge-tailed Shearwaters in the Capricorn Bunker Group, including the almost complete reproductive failure of the Shearwater population on Heron Island.⁴⁰



El Niño events and subsequent rises in sea temperatures can result in provisioning failure. These events have been linked with poor breeding seasons of Black Noddies (pictured) in the Capricorn-Bunker Group.

Pressure: disease

There are no known incidences of disease outbreaks causing widespread mortality or sickness in bird populations on the Great Barrier Reef. Nevertheless, disease remains a potential risk for coastal birds. The Avian influenza virus commonly occurs in birds, but most strains do not pose serious risks to either the birds or humans. Outbreaks of a highly pathogenic strain of avian influenza (H5N1) have occurred overseas including countries visited by migratory shorebirds and seabirds. There is a risk that either migratory birds or humans may introduce disease to the Great Barrier Reef. However, the risk of a virulent strain of avian influenza being introduced to Australia by migratory birds is considered to be small. Wild bird species involved in H5N1 outbreaks include ducks, geese and swans that feed in waterbodies, scavenging species such as crows and raptors, and species that scavenge in waterways such as gulls and herons. None of these species regularly migrate to Australia.⁵

Pressure: climate change

There is scientific consensus that [climate change](#) is occurring on a global scale, and that the evidence linking these changes to human activities is stronger than ever.^{24,41} Over the 20th century, Australia's average air temperature rose by 0.7 °C while the average sea surface temperature has increased at a rate of 1-2°C per century. It is predicted that the annual national average temperatures will increase between 0.4° and 2.0°C by 2030, and by 1.0° and 6.0°C by 2070.¹ These changes may have significant effects on Australia's climate including changes in oceanic circulation patterns, more frequent ENSO events, increased frequency and intensity of severe storms, changes in rainfall patterns and rising sea levels.¹

Climate change may cause ecological changes such as changes in the geographic range, movement and migration patterns, physiology, abundance and community composition of coastal birds.⁷ These changes may result from changes in the availability of prey and/or suitable habitats. Increases in the frequency and severity of ENSO events may reduce the abundance of prey in oceanic ecosystems (see *Pressure: [El Niño](#)*-Southern Oscillation events). An increase in the frequency and intensity of severe storms associated with climate change could magnify the impact of these events on seabird populations.

Changing rainfall patterns could alter the productivity of coastal and estuarine systems as many coastal species, such as barramundi and mud crabs, have reproductive cycles linked to rainfall and river flow.^{32,36} Consequently, changes in coastal productivity may change the availability of food for coastal birds. Changing temperatures and rainfall patterns may also lead to changes in island vegetation and could increase the spread of weed species that are unsuitable for birds.

The Great Barrier Reef's breeding seabird populations are heavily dependent on coral cays as nesting sites. As most of these cays are less than 2.5m above the high water mark, even slight increases in sea level and greater storm activity could have significant impacts through increased erosion, more frequent wave wash-over and increased storm damage. Seabirds nesting on the ground or in burrows could lose critical nesting habitat, and the loss of vegetation could affect the breeding success of birds that nest in trees.²³

Pressure: habitat degradation and disturbance

Habitat degradation and disturbance includes both direct and indirect pressures. Direct pressures usually arise from disturbance of birds from human visitation or use of an area, while indirect pressures are caused by the degradation or loss of nesting, foraging or roosting habitats sites such as islands or wetlands.

Habitat degradation

Queensland's coastal [wetlands](#) (including mangroves, creeks and rivers, tidal mudflats and swamps) cover some 71 000km².¹⁵ While the extent of wetland habitat lost since European settlement is unknown, it is evident that large areas of the Queensland coast have been



Climate change may have a number of impacts on coastal birds, including an increase in the frequency and severity of severe storms and cyclones.

modified for human use, particularly for agriculture. Developments such as ports, marinas, expansion of coastal towns and aquaculture, may also result in habitat degradation.⁴³ For example, the clearing of coastal rainforest habitat in the Cardwell region is thought to be a limiting factor in the growth of the Pied Imperial Pigeon population (J Hicks 2005, pers. comm., September). Some islands and cays have been significantly degraded by activities such as guano mining. For example, Lady Elliot Island was extensively mined in the 1800s, resulting in the loss of almost all vegetation, nutrients and soil. For more information about islands and coastal habitats see [Environmental status – water quality](#)

Disturbance

Disturbance is a direct pressure and is of particular concern on islands with high levels of visitation or development. Disturbance can be caused by people walking near nesting areas, unrestrained pets that harass birds, noise and movement of boats, and aircraft activity such as take offs and landings and low level flights. These disturbances can disrupt feeding activity and displace birds from their natural habitats. At breeding sites, disturbance can cause nesting birds to abandon their nests and eggs, exposing eggs and chicks to heat stress and predators such as Silver Gulls and Egrets. Some birds are more sensitive to disturbance than others. Shorebirds are very easily disturbed by human activities whilst feeding on mudflats or beaches, and are particularly sensitive to disturbance at their high tide roosts. When shorebirds are disturbed and take flight, they use significant amounts of energy. Repeated disturbances could reduce the ability of migratory shorebirds to build up enough fat reserves to undertake their annual migration. Beach Stone-curlews and Roseate Terns are extremely sensitive to human disturbance tend to only breed successfully isolated sites with minimal human activity. Declines in the number of Pelicans breeding on islands in the northern Great Barrier Reef have also been attributed to human disturbance.²⁸ However, some bird communities may become habituated to human presence over time.¹⁸ In these instances, irregular human disturbance probably results in greater impact than regular visitation.



Visitors to islands may disturb birds, resulting in chicks being more susceptible to predation.

Michaelmas Cay is considered the second most important site for seabird breeding on the Great Barrier Reef. However, over the past decade there have been long-term declines in breeding populations of coastal birds. It has been suggested that tourism is a contributing factor to this decline, with visitation to Michaelmas Cay exceeding 70 000 people per year in the early 1990s.²² However, visitation is now tightly controlled (see *Response*) and the declines observed are thought to have been caused by a combination of factors, including human disturbance, El Niño events and a reduction in the size of Michaelmas Cay due to geophysical processes.¹⁸

Pressure: introduced species, pest animals and plants

Introduced species, pest outbreaks and feral animals have both direct and indirect impacts on coastal birds. Many islands in the Great Barrier Reef have evolved a delicate ecological balance of animal and plant communities that is easily disrupted by introduced animals and plants.

Feral animals such as foxes, pigs and feral cats directly affect bird populations by eating eggs and chicks and/or the adults themselves. Birds that feed or nest on the ground such as Terns, Oyster-catchers and Curlews are especially vulnerable to introduced predators. Introduced black rats are a serious threat to island birds worldwide as they eat the eggs and chicks. Rats now occur on several islands in the Great Barrier Reef.

Feral goats were introduced on some islands as a source of food. Goats destroy vegetation by eating native plants, and accelerate soil erosion and help to spread weeds. These disturbances are a serious problem on many islands of the Great Barrier Reef. Weeds can over-grow and out-compete native species, reducing the abundance and diversity of native flora. The resulting loss of native vegetation reduces the availability of suitable nesting sites and food for coastal birds. Once established, introduced weeds reduce the ability of native plants to recover from disturbances such as storms and fires.

Outbreaks of scale insects on coral cays in the Capricorn Bunker Group have been linked to the introduction of the pest African Bighead Ant. The ants feed off the sugary secretion produced by the scale insects and carry them from plant to plant. Outbreaks of scale insects have caused *Pisonia* trees to lose their leaves and eventually die. This has altered the vegetation communities of some cays in the Capricorn-Bunker Group. The loss of *Pisonia* trees has reduced the amount of nesting habitat for tree nesting birds such as the Black Noddy. *Pisonia* die off can also lead to an increase in grasses and shrubs that grow thickly over the ground, reducing the amount of suitable nesting habitat for burrowing species such as Shearwaters.



The defoliation of *Pisonia* forests results in the loss of critical nesting habitat for species such as the Black Noddy.

Some islands that are important bird habitats have been identified as priority islands by the EPA for pest species management. These islands include Curtis Island, the cays of the Capricorn Bunker Group, Hinchinbrook Island, the Frankland Islands, the Barnard Islands and Magnetic Island.

Pressure: oil spills

Shipping is a major commercial activity in the Great Barrier Reef region and the main threat posed by shipping to coastal birds is that of a major oil spill. Floating oil can have a number of direct [impacts on seabirds](#). The oil can degrade the waterproof and insulating properties of feathers, causing hypothermia and subsequent loss of body weight. Sticky oils may cause feathers to stick together and add weight, causing oiled birds to drown and/or making them more vulnerable to predators. Birds may also ingest oils when attempting to preen and clean their feathers. Ingested oil is toxic and can result in altered behaviour and reduced feeding



Oil spills may have various impacts on coastal birds. Pelicans are one of the birds most likely to be at risk from an oil spill.

and breeding success.⁹ Severe poisoning can result in organ damage and death. Oil may also indirectly affect coastal birds by affecting their habitats. Oil can smother and contaminate important nesting or foraging sites such as mangroves, inter-tidal mudflats or seagrass beds. Collectively, these effects may result in significant long-term effects on coastal bird populations. In Queensland, the birds most likely to be at risk from oil spills are shorebirds and birds that swim through the water such as Cormorants, Boobies, Terns, Silver Gulls and Pelicans.⁹

Between 1987 and 2004, 33 significant shipping incidents were recorded. While none of these incidents resulted in the death of large numbers of birds, the accidental release of fuel or cargo resulting from grounding, collision or structural failure of a vessel has the potential to cause serious environmental damage. Consequently, management efforts are focused on reducing the risk of shipping incidents from occurring as much as possible, and ensuring that contingency plans, trained staff and equipment stockpiles are maintained and ready for rapid deployment should an oil spill occur (see [Management status - Shipping and oil spills](#)).

Pressure: garbage and marine debris

[Marine debris](#) consists of a variety of objects and comes from a number of sources, but the main sources of [litter and rubbish](#) are vessels and coastal runoff. Most of the litter found on remote and sparsely populated areas appears to be from vessels.^{19,25}



Entanglement and ingestion of marine debris is a significant risk to a variety of marine wildlife, and is listed as a *Key Threatening Process*.

A survey of twelve vegetated sand cays and three continental islands in the far northern Great Barrier Reef found over 2 000 items of marine debris, most of which were plastics.¹⁹ Birds may mistake marine debris for food and ingest foreign objects, resulting in stomach and intestinal blockages. Entanglement in marine debris such as discarded fishing line may prevent birds from flying, swimming and feeding properly, and in some cases birds may become so entangled that they drown. Nesting birds and chicks may ingest or become entangled in debris washed up on beaches, resulting in decreased chick survival. The number of birds killed by marine debris in the Great Barrier Reef is unknown.

The disposal of garbage at sea may benefit certain species that are able to take advantage of garbage as a food source. It has been suggested that in the past, the dumping of garbage on islands contributed to an increase in numbers of silver gulls in some areas. This has led to increased predation pressure on nearby seabird colonies, especially on colonies that are experience human disturbance.²⁸

Pressure: hunting

The hunting or collecting of coastal birds is illegal in Queensland unless the birds are taken for traditional use. The hunting of coastal birds in the Great Barrier Reef is uncommon. However, there have been anecdotal reports of shooting occurring on islands with large populations of Pied Imperial Pigeons that may indicate some hunting by Indigenous communities. There are also anecdotal reports of bird egg harvesting throughout the Great Barrier Reef and Torres Strait, and Boobies are sometimes known to be trapped for pets and as food in some neighbouring countries.¹²

Pressure: fishing activities

Fishing activities can affect coastal birds by reducing the availability of prey species, by providing a supplementary food source for particular species, or by accidentally catching birds that dive for fish.

The reduction of prey and other fishes by fisheries has been identified as a significant pressure on seabirds in some areas of the world. In Peru, anchovy fishing directly affected seabirds by severely depleted the amount of prey available. In Hawaii, seabirds were indirectly affected by the depletion of tuna. The birds relied on schools of feeding tuna to drive baitfish to the surface where the birds could catch them and when stocks of tuna were depleted, the amount of baitfish near the surface declined.²³ The effects of prey depletion on seabirds in the Great Barrier Reef are unknown, but are probably minor compared to the effects of “provisioning failure” related to weather and climate factors.

Fishing activities may provide a supplementary food source for some coastal birds in the form of bycatch⁴. Prawn trawling generates large amounts of bycatch with as much as 10 kilograms of bycatch taken for one kilogram of prawns.⁶ Research suggests that trawl bycatch in northern Queensland may have supported a tenfold increase in the population of Crested Terns in the northern Great Barrier Reef, which in turn, has placed pressure on other seabirds through increased competition for nesting sites and food.⁶

Fishing may also directly effect seabirds when they are caught as bycatch. Seabird bycatch is a significant problem in some long-line fisheries where seabirds are accidentally hooked when they dive onto baited hooks. Long-line fishing does not occur within the Great Barrier Reef Marine Park (Marine Park) and is not considered to be a serious threat to seabird populations in the Great Barrier Reef.⁴² Nevertheless, some seabirds, particularly in the northern and southern Great Barrier Reef, may forage into waters where long-line fishing does take place. The impact of long-line fishing on these birds is not known.

Response

The management of coastal birds is undertaken by a variety of agencies, and efforts are directed towards protecting the birds themselves, preserving important habitats and addressing threatening processes. Throughout all of Queensland and the Marine Park, coastal birds are protected under the Queensland [Nature Conservation Act 1992](#) (NC Act 1992), the Australian [Environment Protection and Biodiversity Conservation Act 1999](#) (EPBC Act 1999) and the [Great Barrier Reef Marine Park Act 1975](#) (GBRMPA Act 1975). Under this legislation, it is illegal to harm, interfere with or disturb coastal birds except for traditional use.

The long-term conservation of coastal birds also requires an assessment of the status of individual species, identification of key threats, and actions to address these threats. In 2000, the Australian Government released the [Action Plan for Australian Birds 2000](#) that provided an assessment of over 1 300 bird varieties. The Action Plan described the conservation status, key threats and existing conservation measures for a large number of species, and made recommendations for further actions. In the Great Barrier Reef, coastal bird risk assessments and management priorities are developed through the [Day-to-Day Management Programme](#) that coordinates these activities between the Great Barrier Reef Marine Park Authority

(GBRMPA) and the QEPA. This includes the management of important coastal bird habitats (see *Response – habitat degradation and disturbance*).

Several coastal birds in the Great Barrier Reef are also listed as threatened species under the *EPBC Act 1999* and the *NC Act 1992* (see *Condition – conservation status of coastal birds*). Under the *EPBC Act 1999*, [recovery plans](#) may be developed to promote the recovery of these species. In 2005 the Department of the Environment and Heritage released a [Recovery Plan for ten seabirds, including the Herald Petrel](#), and a recovery plan for the Yellow Chat (Dawson) is currently being prepared.

Protection of migratory species

Effective conservation of highly migratory species requires the cooperation of all the countries where the population occurs. Australia works with other countries to implement measures at an international level to complement national efforts to protect migratory birds. These arrangements are implemented through the following international agreements that commit the governments involved to protect the listed species from harvesting or trade, and to preserve their habitats:

- [Convention for Conservation of Migratory Species of Wild Animals](#) (Bonn Convention)
- [Ramsar Convention](#) on wetland protection
- [Asia Pacific Migratory Waterbird Conservation Strategy](#) to conserve waterbirds and their habitats in the Asia-pacific region
- [Bilateral migratory bird agreements](#) with Japan and China.



The protection of migratory species such as the Bar-tailed Godwit requires international co-operation. Australia is a signatory to a number of conventions to protect migratory shorebirds along the East Asian-Australasian Flyway.

A bilateral migratory bird agreement is also being developed with the Republic of Korea. Australia is also developing a multilateral partnerships for the conservation and sustainable use of sites of international importance for migratory waterbirds across the East Asian-Australasian Flyway. The Flyway Partnership will build on the actions implemented under the *Asia Pacific Migratory Waterbird Conservation Strategy* that concludes at the end of 2006.

An [Action Plan for the Conservation of Migratory Shorebirds in the East Asian-Australasian Flyway: 2001-2005](#), has also been developed to guide and coordinate the conservation of migratory birds throughout the region. The Department of the Environment and Heritage has also prepared a [Wildlife Conservation Plan for Migratory Shorebirds](#) to guide implementation of the Action Plan for the Conservation of Migratory Shorebirds in the East Asian-Australasian Flyway: 2001-2005 and future arrangements under the Flyway Partnership. Collectively, these plans and agreements provide a framework for the various countries along the East Asian-Australasian Flyway to conserve migratory birds and their habitats. These plans will also help to fulfill Australia's obligations under the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) and the Convention on Migratory Species.

Within Australia, species listed under the JAMBA and CAMBA, and sites listed under the Ramsar Convention are classed as matters of '[National Environmental Significance](#)' and are protected under the *EPBC Act 1999*.

Commitments to the Ramsar Convention

Under the Ramsar Convention, individual countries are urged to conserve wetlands of international significance by committing to:

- Designate at least one site that meets the Ramsar criteria for inclusion in the List of Wetlands of International Importance
- Protect the ecological character of listed sites
- Include wetland conservation within their national land-use planning
- Establish nature reserves on wetlands and promote wetland training
- Consult with other Contracting Parties about the implementation of the Convention.

As of May 2006, there were [1 609 Ramsar sites](#) designated around the world, including 64 [Australian Ramsar sites](#) that cover 7.3 million hectares. There are two Ramsar sites adjacent to the Marine Park: Bowling Green Bay (35 000 hectares) and Shoalwater Bay/Corio Bay (239 100 hectares). Across Australia, Ramsar sites are listed as a matter of ‘National Environmental Significance’ under the *EPBC Act 1999* that protects these sites from activities that could degrade their ecological values. The [Bowling Green Bay](#) Ramsar site is also a Queensland National Park, and the Australian Government and Queensland Government have implemented new measures to protect wetlands (see *Response: Habitat degradation and disturbance*).

Response: natural pressures

Pressures such as cyclones, severe storms and El Niño events are natural events that cannot be ‘managed’ or ‘controlled’. Consequently, the management of bird populations and their respective habitats is focused on managing pressures arising from human activities.²³ Reducing human pressures helps to maintain the resilience⁶ of bird populations, thereby increasing their capacity to recover from natural pressures.

Nevertheless, managers need to have an understanding of how natural events are affecting bird populations to make informed decisions about managing human related pressures. The Day-to-Day Management Programme coordinates a [Stranding Response Programme](#) which provides a system for the public to report dead, sick and injured marine mammals and turtles. This system also alerts Marine Park managers to mass mortalities or sickness in coastal birds that could complement long-term monitoring programmes (see *Response – Research and monitoring*).

Response: climate change

Climate change is a global issue that is beyond the scope of the GBRMPA to manage directly. At a national level, the Australian Government has committed \$1.8 billion to address climate change issues including investment in climate change research and is implementing national [programmes](#) to reduce greenhouse gas emissions and support low emissions technology, renewable energy and energy efficiency initiatives. Within the Great Barrier Reef, the GBRMPA has forged a partnership with the Australian Greenhouse Office to develop and implement a [Climate Change Response Programme](#). The programme aims to identify the potential impacts of climate change on the animals, plants and habitats of the Great Barrier Reef, to identify strategies to mitigate these impacts, and to develop a Climate Change Action Plan for the Great Barrier Reef.

The resilience of habitats and populations is a critical factor in determining how organisms such as coastal birds cope with climate change. Consequently, a key element of the GBRMPA's response to climate change is to maintain the Great Barrier Reef's resilience. This requires the reduction of human impacts and disturbances, and the preservation of the Great Barrier Reef's biodiversity and ecological processes. Two major initiatives that will help achieve this include the [rezoning](#) of the Marine Park and the [Reef Water Quality Protection Plan](#) (Reef Plan).

In July 2004 a [new Zoning Plan](#) for the Marine Park came into effect. In line with the best available scientific advice, the new Zoning Plan provides high levels of protection for at least 20 per cent of every region of biodiversity in the Marine Park within a network of 'no-take' zones. This increased the area no-take 'green' zones from less than five per cent to some 33 per cent of the Marine Park.

The Reef Plan is a joint Australian Government and Queensland Government initiative designed to halt and reverse the decline of water quality entering the Great Barrier Reef in ten years. Achieving the Plan's objectives will significantly reduce a key human pressure on the Great Barrier Reef ecosystem, particularly on the inshore habitats most affected by declining water quality. For more information on the water quality and the Reef Plan see [Environmental status – water quality](#).

Response: habitat degradation and disturbance

Management of Great Barrier Reef islands and cays

The islands and cays of the Great Barrier Reef are managed under a variety of arrangements. Some islands are classified as Commonwealth Islands and are managed by the Australian Government as part of the Marine Park. Other islands come under the jurisdiction of the Queensland Government and are managed by the EPA. Islands or specific areas on them may be zoned as National Parks, unallocated crown land, freehold land, or may be leased.

Designation as a National Park means that the EPA can directly manage visitation, development and the activities of users. The level of access permitted to island National Parks varies. Some especially sensitive sites are closed and can only be accessed by people who have been granted permission to access the site for a specific purpose. Some islands have designated campsites that allow access by limited numbers of campers with camping permits, while other islands may have tourism resorts operating under lease arrangements. Some islands have no restrictions on access and numbers.

Most of the major seabird rookeries are provided with some form of protective tenure²⁸ that regulate visitation and development. The Cairns, Whitsunday and Hinchinbrook [Plans of Management](#) and [State Management Plans for National Parks in the Capricorn Cays, Brook Islands](#) and Family Islands include specific provisions to protect coastal birds such as setting minimum approach distances and operational restrictions on vessels and aircraft accessing significant bird sites. Important seabird rookeries may also have annual and seasonal closures as well as restrictions on visitor numbers. For example, access to the Brook Islands is prohibited during the summer months to protect the thousands of pied imperial pigeons that migrate to these islands from Papua New Guinea.

The GBRMPA has produced [guidelines for managing visitation to seabird breeding islands](#) to inform site planning initiatives in areas that contain seabird rookeries. The GBRMPA has also developed [Best Environmental Practices](#) for reef visitors to minimise their impacts when observing birds or visiting nesting sites. A more detailed list of [Responsible Reef Practices](#) has also been developed to educate tourism industry staff about minimising the impacts of their operations on birds.

Management of land use and development in the Great Barrier Reef coast

The Great Barrier Reef coast includes rainforests and woodlands, and [wetland](#) habitats such as mangroves, billabongs, mud flats and swamps. Land use arrangements in these areas are managed by Queensland Government and local governments through agencies such as the [Queensland Environmental Protection Agency](#) (EPA) and the [Queensland Department of Natural Resources and Mines](#). Collectively these agencies [administer legislation](#) that cover regional development planning, natural resource protection and the regulation of land use, water allocation and vegetation clearing. In recent times there have been significant changes in land management policies across Australia and Queensland. For example, the *Queensland Vegetation Management Act 1999* will phase out [broadscale clearing of remnant vegetation](#) by December 2006, and in October 2005, the Queensland Government introduced the [Wild Rivers Act 2005](#) to help preserve river systems in Queensland that are still relatively pristine.

The Australian Government [Environment Protection and Biodiversity Conservation Act 1999](#) also contains provisions that help to protect coastal bird habitats. Under the Act, migratory species and Ramsar sites are protected as matters of ‘[National Environmental Significance](#)’. Further, the Act provides protection for [threatened species and ecological communities](#) that may provide additional protection to habitats used by coastal birds. For example, land clearing has been listed as a [Key Threatening Process](#) and the Australian Government has committed support for habitat conservation, planning and land management at the State level.

Michaelmas Cay: a case study in managing sensitive island environments

Michaelmas Cay provides an example of site-specific management to protect coastal birds. Michaelmas Cay is an important seabird nesting site that is within a few hours travel by boat from Cairns. Long-term declines in populations of the Sooty Tern and Common Noddy led the EPA and the tourism industry to jointly develop new management arrangements.⁴⁶ Visitor access was restricted to a 50 m wide area below the 3 m tidal limit and these boundaries were clearly marked for visitors. Under the *Michaelmas Management Plan* developed in 1986, the number of people allowed on the cay at one time was also reduced from 100 to 50. Additionally, aircraft are not allowed to fly lower than a certain height in the area around Michaelmas Cay to reduce aircraft impacts on seabirds.¹⁷



Special measures have been taken at Michaelmas Cay to reduce the impact of visitors on seabirds.

Protecting wetland habitats

[Wetlands](#) form important habitats for coastal birds and some wetland areas are protected under international agreements (see *Response – Protection of migratory species*). Healthy wetlands are also crucial to the healthy functioning of the Great Barrier Reef ecosystem. In October 2003, the Australian Government and Queensland Government released the [Reef Water Quality Protection Plan](#) (Reef Plan). Under the Reef Plan, three major wetlands programmes have been initiated:



Wetlands are critical habitats for many coastal birds. Some wetlands are protected under international agreements and the Great Barrier Reef Coastal Wetlands Protection Programme will help to preserve these habitats

- [Great Barrier Reef Coastal Wetlands Protection Programme](#)
- [Queensland Wetlands Programme](#)
- [Queensland Natural Heritage Trust Wetlands Programme](#)

These programmes will assist in achieving the goals of Reef Plan and will help conserve and restore wetland habitat. Key initiatives under these programmes include:

- Developing incentives for land holders to protect or restore wetlands
- Developing decision support systems for managers to prioritise wetland management
- Establishing a pilot programme to implement on-ground wetland protection
- Addressing knowledge gaps about wetlands
- Mapping and describing Queensland's wetlands in a statewide inventory
- Developing Wetland Management Profiles to help land managers and communities preserve or restore wetlands in their areas.

Wetlands education and community awareness

The Australian Government and Queensland Government recognise the need to better educate the community about the value of wetlands and the need for their conservation. As part of the [Queensland Wetlands Programme](#), the GBRMPA has undertaken a range of initiatives to help educate the community about the importance of wetlands, particularly to the Great Barrier Reef ecosystem. The initiatives include:

- A new wetlands exhibit at [Reef HQ](#)
- [Interactive wetlands information kiosks](#)
- [Reef Beat poster series](#)
- An interactive [web quest](#) for school students
- Wetlands [curriculum unit](#) for teachers.

During [World Wetlands Day](#) in February 2006, the Australian Government and Queensland Government jointly launched the interactive wetland information booths across the Queensland. A new wetlands exhibit has opened at [Reef HQ](#).

For more information land use and management in the Great Barrier Reef catchment, see [Environmental status – water quality](#), and the [GBRMPA Water Quality and Coastal Development website](#).

Response: introduced species, pest animals and plants

The management of introduced species and pests on islands in the Great Barrier Reef is coordinated through the [Day-to-Day Management Programme](#), and implemented through the EPA which is the lead agency for pest management on islands. Priority islands for managing pest animals and plants include Curtis Island, the Capricorn-Bunker Group, Hinchinbrook Island, the Frankland Islands, Orpheus Island, Magnetic Island, the Keppel Bay islands, Lindeman Island and Gloucester Island.

Eradication programmes have been implemented on some islands. On Lady Elliot Island the goats were eradicated between 1969-1970, leading to enhanced re-colonisation, growth and expansion of all trees within the island.² In 2006, the EPA implemented a programme to eradicate introduced foxes, horses, pigs and goats on Curtis Island.

A monitoring programme has been established in the Capricorn Bunker Group to document the monitor scale insect infestations and detect outbreaks on adjacent islands. A Tryon Island Revegetation Plan has been developed to restore the *Pisonia* forests through the translocation of already established flora from other islands, and controlling the African Big Headed Ants if required. The potential application of biological controls for African Big Headed Ants involving commercially available wasp and ladybird predators is also being assessed.



Field operations in the Great Barrier Reef are coordinated through the Day-to-Day Management Programme. Pest eradication programmes have been carried out on some islands but on-going management is required to prevent the further introduction of pest species.

The most effective option to reduce the spread of pest species is to minimise the opportunities for their translocation. This can be achieved by controlling access to sites and maintaining the policy of minimal disturbance. Should a pest species be introduced to a site, early detection and eradication will be crucial as once a species is established it is often difficult and expensive to control.⁴

At a national level, the impacts of introduced pests such as pigs, foxes, feral cats and feral goats have been listed as [Key Threatening Processes](#) under the *EPBC Act 1999*. The Department of the Environment and Heritage has prepared [Threat Abatement Plans](#) for pigs, foxes, feral cats and goats. These plans outline the necessary research and management actions required to address these threats.

Response: oil spills

The management of shipping in the Great Barrier Reef involves a variety of agencies, articles of legislation and international agreements. These arrangements are designed to maximise shipping and navigational safety in order to reduce the risk of shipping incidents from occurring. The Great Barrier Reef has one of the world's most comprehensive sets of shipping management systems and arrangements.

Nevertheless, a major oil spill could cause serious environmental damage. Consequently, managing agencies have prepared detailed contingency plans and stockpiled oil spill response equipment at various locations in order to quickly respond to any incidents. The EPA

coordinates the response to oiled wildlife and District Oiled Wildlife Plans have been developed through the Day-to-Day Management Programme. A large number of EPA staff and volunteers have been trained to care for oiled wildlife and [workshops](#) have been conducted to help develop appropriate response procedures.

More detailed information about shipping and responses to shipping incidents is included in the chapter [Management Status - Shipping and Oil Spills](#).

Response: garbage and marine debris

One of the most common sources of litter in the Great Barrier Reef is from [ships](#) and recreational vessels. It is illegal to dump litter into the Marine Park and under the [International Convention for the Prevention of Pollution from Ships](#), the disposal of plastics into the sea is prohibited anywhere in the world. The convention also prohibits the dumping of garbage (for example food scraps) within 12 nautical miles from the nearest land. These restrictions [apply to all vessels](#) including recreational vessels, yachts, dinghies and fishing vessels. Offenders may be fined up to A\$1.1 million for companies and up to \$275 000 for individuals.

[Marine debris](#) has been listed as a *Key Threatening Process* under the *EPBC Act 1999* and a [Threat Abatement Plan](#) is being developed for marine industries to reduce the incidence of marine debris. For more information about shipping and marine debris in the Great Barrier Reef, see [Management status – shipping and oil spills](#).



Under international agreements, Australian and Queensland law, it is illegal dump plastics or litter into the Marine Park.

Litter can also enter the Marine Park from land-based sources such as drains and waterways. The management of waterways and urban runoff is regulated by the Queensland Government and local governments, and is outside the GBRMPA's jurisdiction. Nevertheless, the GBRMPA is working with State and local governments on a wide range of water quality issues specifically designed to minimise the impacts of pollution and runoff from the land on the marine environment (see [Environmental status – water quality](#)). In recent years, some local councils and communities have taken steps to reduce the amount of litter washing into the Marine Park by installing gross pollutant traps in stormwater systems and encouraging residents to reduce the use of plastic bags. Some local councils such as Townsville City Council, have implemented [stormwater management plans](#) and similar plans are being developed by other councils.

The GBRMPA has produced [Best Environmental Practices](#) to educate reef users about the correct disposal of waste, and has implemented public education campaigns and education programmes such as the [Reef Guardians](#) Programme. These programmes encourage students and communities to take local action to reduce the amount of litter and pollution entering the Great Barrier Reef from their local areas.



Some local governments such as Townsville City Council have installed storm water traps to reduce the amount of litter flowing into local waterways and the Great Barrier Reef.

Response: hunting

It is illegal to hunt birds in the Marine Park except for traditional use. Aboriginal and Torres Strait Islanders have strong cultural connections with the Great Barrier Reef and a long history of traditional use. The GBRMPA is working with Traditional Owners and other agencies [to manage the traditional use of marine resources](#). In July 2004, a [new system](#) for managing traditional use of marine resources came into effect as part of the [new zoning](#) provisions for the Marine Park. Under the new system, some traditional resource use will continue to be 'as of right' while other traditional uses may be conducted in accordance with a Traditional Owner-developed and GBRMPA-accredited Traditional Use of Marine Resources Agreement (TUMRA), or with a permit.

Some hunting of migratory birds may occur outside of Australia. The protection of migratory shorebirds from hunting and trade is enacted through international conventions and agreements (see *Response – Protection of migratory species*).

Response: fishing activities

The management of fisheries in the Marine Park is undertaken through joint management arrangements between the Australian Government and the Queensland Government. Under these arrangements, the GBRMPA manages use of the Marine Park through Zoning Plans while the [Queensland Department of Primary Industries and Fisheries](#) (DPI&F) is responsible for management of fisheries. In 2001, the DPI&F introduced the *East Coast Trawl Fishery Management Plan* which made it compulsory for trawlers to use bycatch reduction devices. Reducing bycatch levels will reduce the amount of surplus food available to some seabirds, and hence return their population size to more natural levels. The DPI&F have also produced [guides](#) for commercial and recreational anglers to reduce their impacts on protected species including seabirds.

Long-line fishing is not permitted in the Marine Park. Nevertheless, long-line fishing has been listed as a *Key Threatening Process* under the *EPBC Act 1999* that could potentially impact upon seabirds feeding in oceanic waters outside the Marine Park. The Department of the Environment and Heritage has developed a [Threat Abatement Plan for the Incidental Catch \(or bycatch\) of Seabirds During Oceanic Longline Fishing Operations](#). Threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of these processes on threatened species or communities.

Response: research and monitoring

There is concern over the lack of long-term data on coastal bird populations. The variability in bird populations caused by movement patterns, seasonal migrations, climate and weather, make it very difficult to determine population estimates and trends, assess risks and gauge the effectiveness of conservation efforts. Consequently, long-term monitoring at many sites over many years is needed to identify population trends, assess risks and inform management decisions.

Seabird monitoring programmes are carried out by the EPA at key nesting sites through the Day-to-Day Management Programme. The data collected are archived in the Queensland Coastal Bird Atlas housed at the EPA in Rockhampton.³⁵ A Coastal Bird Monitoring Strategy has been prepared through the Day-to-Day Management Programme to identify the key

information needs and coordinate bird monitoring in the Great Barrier Reef. The GBRMPA has also identified priority areas of research concerning coastal birds and their habitats through the GBRMPA [Research Information System](#). Priority areas for research and monitoring include:

- Continued long-term monitoring of bird populations
- The causes of declines in seabird populations and breeding success and links to food supply, feeding areas and elevated seawater temperatures
- The impacts of introduced animals, plant and pest species on bird breeding success within the Great Barrier Reef
- The impacts of direct human disturbance on birds.

The Research Information System will help to communicate information needs to research community, and track the progress of research activities addressing these needs.

Further reading

About coastal birds, their conservation and management

- About seabirds (Reef ED)
- <http://www.reefed.edu.au/explorer/animals/marine Vertebrates/seabirds/index.html>
- About shorebirds (Reef ED)
- <http://www.reefed.edu.au/explorer/animals/marine Vertebrates/shorebirds/shorebirds.html>
- The Australian Birds Birdfinder
- <http://www.birdsinbackyards.net/finder/birdlist.cfm>
- Fact sheets about Australian birds from the Australian Museum
- <http://www.amonline.net.au/factsheets/#birds>
- About migratory birds (Department of the Environment and Heritage)
- <http://www.deh.gov.au/biodiversity/migratory/waterbirds/>
- Shorebird migration poster (Department of the Environment and Heritage)
- <http://www.deh.gov.au/biodiversity/migratory/waterbirds/shorebird-poster/index.html>
- Flora and Fauna of the Great Barrier Reef World Heritage Area
- http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub/fauna_flora
- The Australian Waders Study group
- <http://www.tasweb.com.au/awsg/index.htm>
- Birds Australia
- <http://www.birdsaustralia.com.au/index.html>
- The Australian Action Plan for Birds 2000
- <http://www.deh.gov.au/biodiversity/threatened/action/birds2000/>
- The State of Australia's Birds 2003-2005
- <http://www.deh.gov.au/biodiversity/publications/>
- About recovery plans (Department of the Environment and Heritage)
- <http://www.deh.gov.au/biodiversity/threatened/recovery/index.html>
- *Best Environmental Practices* for observing birds (GBRMPA)
- http://www.gbrmpa.gov.au/corp_site/key_issues/tourism/recreation/best_environmental_practice/bird_watching
- Guidelines on Managing Visitation to Seabird Breeding Islands (GBRMPA)
- http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub/seabirds

About climate change

- Climate change (Australian Greenhouse Office)
- <http://www.greenhouse.gov.au>
- About climate change and the Great Barrier Reef
- http://www.gbrmpa.gov.au/corp_site/info_services/science/climate_change
- Climate change in Queensland (Queensland Environmental Protection Agency)
- http://www.epa.qld.gov.au/environmental_management/sustainability/climate_change_and_greenhouse/

About introduced species and pests

- Brochures on feral animals
- <http://www.deh.gov.au/biodiversity/publications/>
- Information on weeds and their control
- <http://www.deh.gov.au/biodiversity/publications/index.html#weeds>

About wetlands

- About Wetlands and the Great Barrier Reef (including Sunfish wetlands report)
- http://www.gbrmpa.gov.au/corp_site/key_issues/water_quality/wetlands
- About wetlands in Australia (Department of the Environment and Heritage)
<http://www.deh.gov.au/water/wetlands/index.html>
- About wetlands in Queensland (Queensland Environmental Protection Agency)
http://www.epa.qld.gov.au/nature_conservation/habitats/wetlands/wetlands_habitats/
- The Queensland Wetlands Programme
- <http://www.deh.gov.au/water/wetlands/qwp/index.html>
- About the Ramsar Convention (Department of the Environment and Heritage)
- <http://www.deh.gov.au/water/wetlands/ramsar/index.html>

Bibliography

1. Australian Greenhouse Office 2005, *Climate Change Risk and Vulnerability, Promoting an efficient adaptation response in Australia*, Department of the Environment and Heritage, Canberra, 159pp.
<http://www.greenhouse.gov.au/publications/index.html#science>
2. Batianoff, G.N. 1998, 'Coral cay terrestrial flora changes at Lady Elliot Island, Great Barrier Reef, Australia', *Proceedings of the Royal Society of Queensland* 107: 5-14.
3. Batianoff, G.N. and Cornelius, N.J. 2005, 'Birds of Raine island: population trends, breeding behaviour and nesting habitats', *Proceedings of the Royal Society of Queensland* 112: 1-29.
4. Batianoff, G.N. and Hacker, J.L.F. 2000, 'Vascular plant portrait of Wilson Island, Great Barrier Reef, Australia', *Proceedings of the Royal Society of Queensland* 109: 31-38.
5. Birdlife International, *Birdlife Statement on Avian Influenza*, viewed on 10 March 2006:
http://www.birdlife.org/action/science/species/avian_flu/index.html.
6. Blaber, S.J.M., Milton, D.A. and Smith, C.G. 1998, 'Seabird breeding populations on the far northern Great Barrier Reef: trends and influences', *EMU* 98: 44-57.
7. Chambers, L.E., Hughes, L. and Weston, M.A. 2005, 'Climate Change and it's impact on Australia's avifauna', *Emu* 105: 1-20.
8. Congdon, B.C. 2004, *Changes in tropical pelagic-foraging tern populations at Michaelmas Cay precede ENSO events.*, Unpublished Report, James Cook University, Townsville.
9. Dann, P. and Jessop, R. 1994, 'The effects of oil on birds', in *Workshop on Oiled Seabird Cleaning and Rehabilitation*, Workshop on Oiled Seabird Cleaning and Rehabilitation eds J. Lash and S. Raaymakers, GBRMPA, Townsville, 37-43pp.
http://www.gbrmpa.gov.au/corp_site/info_services/publications/workshop_series/ws015/index.html
10. De'ath, G. 2001, *Population changes from 1984-2001 in a sea bird colony at Michaelmas Cay, Queensland*, Unpublished Report, James Cook University, Townsville.
11. Department of the Environment and Heritage, *Background Paper to the Wildlife Conservation Plan for Migratory Shorebirds*, Department of the Environment and Heritage, Canberra, viewed on 10 October 2005:
<http://www.deh.gov.au/biodiversity/migratory/waterbirds/shorebird-plan/index.html>
12. Dobbs, K. 2005, 'Recoveries of seabirds banded between 1978 and 1987 at Raine Island, Maclennan and Moulter Cays and Sandbanks No. 7 and 8., Northern Great Barrier Reef Australia', *Corella* 29 (3): 65-72.
13. Dyer, P.K. 2003, 'A decline in the number of wedge tailed shearwaters breeding on Raine Island', *Corella* 27 (1): 13-17.

14. Dyer, P.K., O'Neill, P. and Hulsman, K. 2005, 'Breeding numbers and population trends of Wedge-tailed Shearwater (*Puffinus pacificus*) and Black Noddy (*Anous minutes*) in the Capricorn Cays, southern Great Barrier Reef', *Emu* 105: 249-257.
15. Fisk, G., Hodge, J., Hurse, L., Steven, A., Turner, L., Waldron, J. and Zeller, B. 2003, 'The Coastal Zone', in *State of the Environment*, eds Environmental Protection Agency, Environmental Protection Agency, Brisbane,
http://www.epa.qld.gov.au/environmental_management/state_of_the_environment/state_of_the_environment_2003/main_report/
16. Garnett, S.T. and Crowley, G.M. 2000, *The Action Plan for Australian Birds 2000*, Environment Australia, Canberra, 673pp.
<http://www.deh.gov.au/biodiversity/threatened/publications/action/birds2000/index.html>
17. Great Barrier Reef Marine Park Authority 1999, 'Radar Protection for Birds', *Reef Research: Reef Management News* 9 (3): 1-4.
http://www.gbrmpa.gov.au/corp_site/info_services/publications/reef_research
18. Gyuris, E. 1997, 'Conservation of seabird populations at Michaelmas cay: Review and evaluation of existing information', in *Report to the Department of Environment, Far Northern Region*, Department of Tropical Environmental Studies and Geography, James Cook University, Townsville.
19. Haynes, D. 1997, 'Marine Debris on Continental Islands and Sand Cays in the Far Northern Section of the Great Barrier Reef Marine Park, Australia', *Marine Pollution Bulletin* 34 (4): 276-279.
20. Heatwole, H., O'Neill, P., Jones, M. and Preker, M. 1996, 'Long-term population trends of seabirds on the Swain Reefs, Great Barrier Reef', in *Technical Report No. 12*, CRC Reef Research Centre Ltd, Townsville.
<http://www.reef.crc.org.au/publications/techreport/TechRep12.html>
21. Hopley, D. 1982, *The Geomorphology of the Great Barrier Reef: Quaternary Developments of Coral Reefs*, John Wiley and Sons, New York.
22. Hulsman, K., O'Neill, P., Stokes, T. and Warnett, M. 1997, 'Threats, status, trends and management of seabirds on the Great Barrier Reef', in J. Campbell and Dalliston, C. (eds) *The Great Barrier Reef: Science, Use and Management*, 1: 164-177.
http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub
23. Hulsman, K., O'Neill, P.O. and Stokes, T. 1997, 'Current status and trends of seabirds on the Great Barrier Reef', in *State of the Great Barrier Reef World Heritage Area Workshop, Townsville, Queensland, Australia, 27-29 November 1995*, eds D. Wachenfeld, J. Oliver and K. Davis, 259-282.
http://www.gbrmpa.gov.au/corp_site/info_services/publications/workshop_series
24. Intergovernmental Panel on Climate Change, *Climate change 2001: impacts, adaptation and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.
viewed on 24 June 2003: http://www.grida.no/climate/ipcc_tar/wg2/index.htm.

25. Kiessling, I. 2003, *Finding solutions: Derelict fishing gear and other marine debris in northern Australia*, National Oceans Office, Hobart.
<http://www.deh.gov.au/coasts/mbp/publications/marine-debris-report.html>
26. Kikkawa, J. 2003, 'The Capricorn White-eye *Zoesterops chlorocephalus*', *Sunbird* 33 (2): 64-76.
27. King, B.R. 1993, 'Status of Queensland seabirds', *Corella* 17 (3): 65-92.
28. King, B.R. 1996, 'The status of seabirds in Queensland', in Ross, G.J.B., Weaver, K. and Greig, J.C. (eds), *The status of Australia's seabirds: proceedings of the National Seabird Workshop, Canberra, 1-2 November 1993*, Biodiversity Group, Environment Australia.
29. Lucas, P.H.C., Webb, T., Valentine, P.S. and Marsh, H. 1997, *The Outstanding Universal Value of the Great Barrier Reef World Heritage Area*, Great Barrier Reef Marine Park Authority, Townsville.
30. Marchant, S. and Higgins, P. 1990, *Handbook of Australia, New Zealand and Antarctic Birds*, Oxford University Press, Melbourne.
31. Mather, P. and Bennett, I. 1993, *A Coral Reef Handbook: A Guide to the geology, flora and fauna of the Great Barrier Reef*, Surrey Beatty & Sons Pty Ltd, Chipping North, 205-218.
32. Milton, D.A., Yarrao, M., Fry, G. and Tenakanai, C. 2005, 'Response of barramundi, *Lates calcarifer*, populations in the Fly River, Papua New Guinea to mining, fishing and climate related perturbation', *Marine and Freshwater Research* 56: 969-981.
33. Olsen, P. and Weston, M., *The State of Australia's Birds 2004 - Water, wetlands and birds*, Birds Australia, viewed on December 2004,
<http://www.deh.gov.au/biodiversity/publications/birds-04/index.html>.
34. O'Neill, P., Minton, C., Ozaki, K. and White, R. 2005, 'Three populations of non-breeding Roseate Terns *Sterna dougallii* in the Swain Reefs, Southern Great Barrier Reef', *EMU* 105: 57-66.
35. O'Neill, P. and White, R. 2001, *Custodians Guide to the Coastal Bird Atlas (CBA)*, QPWS / GBRMPA / Marine Parks.
36. Pittock, B. 2003, *Climate Change: an Australian guide to the science and potential impacts*, Australian Greenhouse Office, Canberra, 239pp.
37. Schmitd, S., Dennison, W.C., Moss, J.G. and Stewart, G.R. 2004, 'Nitrogen ecophysiology of Heron Island, a subtropical coral cay of the Great Barrier Reef, Australia', *Functional Plant Biology* 31: 517-528.
38. Schrieber, R.W. and Schrieber, E.A. 1984, 'Central Pacific Seabirds and El Niño-Southern Oscillation 1982-83 perspectives', *Science* 225: 713-716.
39. Shephard, J.M., Catterall, C.P. and Hughes, J.M. 2005, 'Long-term variation in the distribution of the White-bellied Sea-eagle (*Haliaeetus leucogater*) across Australia', *Austral Ecology* 30: 131-145.

40. Smithers, B.V., Peck, D.R., Krockenberger, A.K. and Congdon, B.C. 2003, 'Elevated sea-surface temperature, reduced provisioning and reproductive failure of wedge-tailed shearwaters (*Puffinus pacificus*) in the southern Great Barrier Reef, Australia', *Marine and Freshwater Research* 54: 973-977.
41. Steffen, W., *Stronger Evidence but New Challenges: Climate Change Science 2001 - 2005*, Department of Environment and Heritage, Canberra, viewed on <http://www.greenhouse.gov.au/science/publications/science2001-05.html>.
42. Stokes, T., Dobbs, K., Mantel, P. and Pierce, S. 2004, *Fauna and Flora of the Great Barrier Reef World Heritage Area*, Great Barrier Reef Marine Park Authority, Townsville, 98pp. http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub/fauna_flora
43. Stokes, T., Hulsman, K., Ogilvie, P. and O'Neill, P. 1996, 'Management of human visitation to seabird islands of the Great Barrier Reef Marine Park Region', *Corella* 20(1): 1-13.
44. Turner, M. 2002, *Coastal Bird Monitoring Strategy for the Great Barrier Reef World Heritage Area*, Internal Report, Great Barrier Reef Marine Park Authority and Queensland Parks and Wildlife Service, Townsville.
45. Walker, T. 1994, 'Seabird distribution on the Great Barrier Reef', in J. Lash and S. Raaymakers (eds), *Workshop on Oiled Seabird Cleaning and Rehabilitation*, GBRMPA Workshop Series No. 15, Great Barrier Reef Marine Park Authority, Townsville, 24-36. http://www.gbrmpa.gov.au/_data/assets/pdf_file/4125/ws015_full.pdf
46. WBM Oceanics Australia and Claridge, G. 1997, *Guidelines for Managing Visitation to Seabirds Breeding Islands*, Great Barrier Reef Marine Park Authority, Townsville, 92pp. http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub

End notes

* Note: The Great Barrier Reef's [Herald Petrel](#) population is listed as 'Endangered' or 'Critically endangered' in Australia as the breeding population is less than 50 individuals and only breeds on Raine Island. The main Herald Petrel breeding population is found further east in the Pacific.

A scrape is a shallow depression in the sand that seabirds excavate to form a nest

^f A breeding and nesting ground

^φ 'Native' species confined to a given region (e.g. a species endemic to the Great Barrier Reef is not found anywhere else).

[≠] animals and plants that are caught accidentally and discarded while fishing for target species.

[∅] The ability of an organism or habitat to absorb and/or recover from impacts