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Ecology of the marine mammals of Moreton Bay

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Abstract

The subtropical waters of Moreton Bay support a diverse and abundant marine mammal fauna. Year-round residents include populations of dolphins and dugongs, and winter visitors include humpback and southern right whales. Due to its proximity to a major capital city and relatively sheltered waters, Moreton Bay has been the site of some of the most intensive marine mammal research in Australia over the past twenty years. This chapter gives an up-to-date overview of the biology and ecology of the populations of marine mammals encountered within the Bay, their current status and threats.

Keywords: dugong, dolphin, whale, humpback whale, megafauna, population, conservation, threats

Introduction

Moreton Bay has one of the most diverse and abundant marine mammal faunas of any part of the Australian coast (1, 2). Resident populations of subtropical and tropical species of dugongs and dolphins are joined by seasonal visitors when humpback and southern right whales travel along their coastal migration paths. Whilst Moreton Bay's sheltered waters provide refuge for migrating whales, there are also habitats for those mammals that choose to make it their principal residence.

The distribution and abundance of marine mammals within the Moreton Bay region have changed in the twentieth century as a result of rapid coastal development, an increase in boating traffic, a decline in water quality, the operation of commercial fisheries and burgeoning ecotourism. These impacts saw a depletion of visiting whales, a pronounced shift of dugongs away from the western Bay, and apparent impacts on dolphin feeding regimes. This paper summarises the current status of dugongs and cetaceans (whales and dolphins) in Moreton Bay early in the twenty-first century, with information gathered from research programs conducted on their population biology, ecology and health over the past 20 years. Current and emerging threats to marine mammals are also considered.

Dugongs of Moreton Bay

The most abundant marine mammal in tropical to sub-tropical Australian coastal waters is the dugong *Dugong dugon* (3) and Moreton Bay is no exception. The extensive shallow seagrass beds of Moreton Bay support the largest, southern-most resident population of dugongs on the east coast (4, 5). The vast majority (>95%) of dugongs in the Bay occur in the Eastern Banks area, primarily on the Maroom, Boolong and Coonungai Banks, where the water is relatively clear, seagrass communities comprise the genera favoured by dugongs, boating traffic is light, and deep-water refugia are close (4, 5). In each tidal cycle, grazing herds of dugongs move up over the shallow seagrass beds with the tide. Groups of 10 to 100 animals are common, but herds of 300 have been recorded (5). As the tide ebbs, dugongs drift off the banks but may continue to feed on sparse seagrasses (mostly the low-light tolerant genus *Halophila*) in water as deep as 18–25 m (6). In the winter months, dugongs disperse across the Eastern Banks, foraging widely in response to a decline in abundance and nutritional quality of their seagrass food (4, 5). They also move back and forth between the warmer oceanic waters of South Passage and the cooler Bay waters through Rous Channel. These erratic small-scale movements may be a strategy to reduce exposure to cold water at this extreme of their latitudinal range (4, 7). Small numbers of dugongs are also found elsewhere in Moreton Bay. These animals are associated with shallow seagrasses in the western and southern parts of Moreton Bay (5, 8) and in Pumicestone Passage (9).

The most recent available population estimates of dugongs for Moreton Bay are from aerial surveys: 759 ± 181 in 2013 (8) and 601 ± 80 for 2016 (10). Aerial surveys have been conducted since the 1970s (11–13), initially as a means of examining distribution and movements in defined areas of the Bay (4) and then for population estimation of the entire Bay at a minimum of five-yearly intervals (5, 8, 10, 14–16). Quantitative aerial surveys over the past 20 years have yielded population estimates ranging from as low as 344 ± 88 (17) up to 1019 ± 116 (5), with most estimates between 500 and 1,000 (18). Comparably, population estimates of 700–800 over the years 2002–07 (JM Lanyon, unpubl. data) have been obtained based on a capture-mark-recapture (CMR) program running since 2001 (19). As of 2018, more than 780 individual dugongs had been gene-tagged in Moreton Bay as part of this program, suggesting this as a baseline minimum count.

The apparently fluctuating population size of dugongs in the Bay has been variously interpreted as indicating emigration and/or immigration, implying connectivity between Moreton Bay and other populations to the north (16,18) and/or episodes of dugong mortality (20, 21), but with no significant carcass recovery. More realistically, variation in these population estimates is probably an artefact and related to differences in survey design (including transect intensity and layout, altitude), sighting conditions (poor, good weather), tidal phase (high, low) and/or season (5). Fewer dugongs are sighted when the weather is poor, survey altitude is low (because of their clumped distribution), the tide is low (5) and dugongs are in deeper waters (22). Broad agreement between population estimates obtained from aerial surveys in the 1990s and again within the past five years, and also with population estimates from a CMR program, suggests a stable population with no discernible population decline. Furthermore, there is evidence that the dugong population in Moreton Bay is a resident one with little gene flow in or out (23).

Genetic evidence suggests against regular mass migration of dugongs along the southern Queensland coast. The dugongs of Moreton Bay constitute part of the broader southern Queensland stock (A McGowan, unpubl. data) but are probably a unique breeding population, genetically distinct from the closest, more northern dugong populations of Hervey Bay and the Great Sandy Straits (24). Although studies utilising satellite tags have recorded a few dugongs ranging between Moreton and Hervey Bays (25) only one dugong ‘Jeff’ that was physically tagged in Moreton Bay has been recovered in Hervey Bay (JM Lanyon, unpubl. data). Pedigree reconstruction (family trees) of the southern Queensland dugongs (26) using genetic markers to identify individuals (27, 28) and their offspring, and locations of each, suggests that only small numbers of adults of breeding age undergo true dispersal, i.e., movements coupled with breeding events (23). Other movements into and out of Moreton Bay might more properly be described as ranging movements but with no associated breeding. The level of outbreeding is not sufficient to disrupt these separate breeding units in southern Queensland (23, 24).

Moreton Bay has become the most intensively studied dugong population in the world over the past 20 years, with projects examining movements and distribution (e.g., 6, 25) and a longitudinal CMR program running annually since the summer of 2000–01 (19). As part of this program, more than 120 dugongs are captured (29) and/or skin sampled (30) each summer, their identities established and biological data collected. In addition to studies examining distribution and population structure, aspects of diet (31–33), behaviour (34–36), reproduction (37–40), metabolism and energetics (41–44) and health (45–48) have been examined through this direct hands-on approach. Some of the more interesting results regarding the biology of Moreton Bay dugongs are related to their subtropical environment and proximity to a major city of more than two million people.

The dugongs of Moreton Bay live at the southern end of the species’ range and are consequently prone to marked seasonal shifts in water temperature, seagrass abundance and nutritional quality. Their dependence on seagrass and the dynamic nature of the seagrass environment is reflected in almost all aspects of the life history of dugongs (3) with a pronounced seasonality in their reproductive pattern (49). The dugongs of Moreton Bay are slow to grow to maturity and undergo a protracted pubertal period but appear to achieve larger final adult body sizes than dugongs elsewhere (37, 38). Breeding is also slow and the long periods between successive calves and prolonged lactation (several years) may have its basis in seagrass availability. The onset of the mating season for dugongs coincides with the end of winter and thus at the end of a period of lowest nutrient availability. At this time, adult males spend less time in herds and more time roaming, presumably in search of mating opportunities (39). They participate in numerous conflicts with other males at this time as they compete for females (36, 39). This competitive mating strategy takes its toll. In these conflicts, male dugongs suffer significant injury from tusks of other dugongs, elevated chronic stress, loss of body condition (36, 39, 40), and their relatively low thyroid hormone (T4) levels indicate some physiological (probably nutritional) stress (50). It is possible that they are prone to immune-compromise at this time and may be more susceptible to diseases.

In response to unusual pathologies observed on some free-ranging dugongs during the CMR program, an annual health assessment program of the dugongs in Moreton Bay was established

in 2008 (41), following the basic protocols for manatee health assessment (51). The major aim of this program is to screen for emerging health-related problems in this most urbanised of dugong populations, with a view to detecting and mitigating against health-related threats. To this end, each year a random sample of up to 20 dugongs of both sexes and all ages (except dependent calves and nursing cows) are captured and removed from the water so that clinically valuable samples such as blood, urine and faeces can be collected. Dugongs can also be examined for pregnancy using sonography, and weighed (Fig. 1). At the time of writing, just over 200 dugongs have been medically examined in Moreton Bay. Baseline clinical reference intervals for blood haematology (46), serum biochemistry (45) and stress hormones (39) have been determined for apparently healthy dugongs, and samples have been collected for endocrine, microbial and contaminant analysis, and disease screening.



Figure 1. Wild dugong on the deck of a research vessel for annual health assessment in Moreton Bay. From top left of photograph and clockwise: researchers are measuring nasal temperature with a temperature gun; preparing to douse the animal with a bucket of water; marking the dorsum with a waterproof crayon to prevent short-term recapture; providing shade; palpating the pectoral fin prior to blood collection; filming via a Go-Pro camera; and two attendants wait to receive blood tubes from dugong phlebotomy.

To date, few infectious disease agents have been detected in the live dugongs of Moreton Bay. Immunological evidence of exposure to the disease pathogens *Toxoplasma gondii* and *Neospora caninum* has been demonstrated in these dugongs, but signs of clinical disease or active infection have not yet been recorded (47). The fact that pathogens of terrestrial origin may have been detected in dugongs several kilometres offshore in eastern Moreton Bay and that the associated antibody levels were highest in 2011, the year after a severe flood event in the region, suggests offshore influence of coastal habitation and development. Furthermore, levels of several heavy metals (including mercury, aluminium and cobalt)

were elevated in circulating blood from live wild dugongs sampled in the Bay post-flood (JM Lanyon, unpubl. data). Since levels of chemicals in dugong tissue have been found to reflect local land use and pollutants released into coastal waterways elsewhere (e.g., 52, 53), it is reasonable to assume that the same may be happening in Moreton Bay. The long-term effects of contaminants on dugong health and reproduction are unknown, but are potentially concerning (45, 55).

Threats to dugongs are regionally specific and change through time, but throughout the dugong's range, the main threat is degradation or loss of seagrass habitat on which they depend (3). In the past, major threats to dugongs in Moreton Bay also included hunting (both

commercial and Indigenous) and net entanglement. In the mid-1990s, boat strike appeared to be an emerging threat. This led to reduced vessel speed in areas of critical dugong habitat that were first introduced by the Moreton Parks (Moreton Bay) Zoning Plan 1997 and later extended by the Marine Parks (Moreton Bay) Zoning Plan 2008. However, with increasing frequency and severity of storms and coastal flooding, expected to be exacerbated by global climate change, the focus must now be redirected to the threats caused by physical and chemical degradation of coastal seagrass habitats. An additional potential emerging threat is terrestrial disease-causing pathogen exposure as a result of coastal pollution. It is recommended that monitoring of the health of dugong populations and individuals continue in the Bay, but also on a global scale as coastal and ocean habitats deteriorate and global climate change proceeds.

For Moreton Bay dugongs specifically, their viability and chances of survival in the long term is entirely in our hands. We now know that whilst 25 years ago, the Moreton Bay dugongs' offshore habitats and relative anonymity were thought to be one of their greatest forms of protection (2), their habitats are well within reach of coastal destruction and pollution. Conservation of this unique and genetically discrete population is dependent on timely identification and management of local threats to the health and survival of dugong habitat.

Cetaceans of Moreton Bay

Humpback whales

Humpback whales (*Megaptera novaeangliae*) are found in a number of discrete populations around the world. In the Southern Hemisphere, humpback whales feed primarily on Antarctic krill (*Euphausia superba*) during summer in the Antarctic, and then migrate long distances during autumn to winter breeding grounds in the tropics where they fast. One population of humpback whales migrates along the eastern coast of Australia to breeding areas inside the Great Barrier Reef (56). During their migrations, these whales pass very close to Point Lookout (North Stradbroke Island) and Cape Moreton (Moreton Island) (56, 57), and during the southward spring migration in particular, many whales enter the northern part of Moreton Bay, and some have even been found south of Peel Island.

Eastern Australian humpback whales were subjected to whaling in the 1950s and early 1960s. After World War II, whaling stations were set up at Tangalooma, Byron Bay and Norfolk Island to exploit this large population. Tangalooma on Moreton Island was the largest station and had an annual quota of up to 660 whales (57). Catch per unit effort was steady for most of the 1950s but fell sharply in 1961 with a collapse in the whale population, and all of the east coast whaling stations, suffering the same fate, closed in 1962 (57). It was not until the 1990s that data published by Russian whaling biologists showed that Soviet whaling fleets had operated in the Antarctic region in the summers from 1959–68, impacting this population by illegally taking 22,000 humpback whales in just two seasons (1959–60 and 1960–61) from the waters south of eastern Australia and New Zealand (58). While the original eastern coast humpback whale population is currently thought to have been approximately 26,000 whales (59), it is likely that the population was reduced to no more than a few hundred whales by the mid-1960s (57, 59, 60).

After the whaling stations closed, few whales were sighted until the late 1970s when Robert and Patricia Paterson, keen naturalists at Point Lookout (North Stradbroke Island), began noticing occasional passing whales from their holiday house (56). The Patersons started keeping a log of occasional passing whales, and this turned into an annual survey in the early 1980s. Michael Bryden from The University of Queensland also started a series of surveys around the same time, and these two series of surveys continued until the early 2000s (56, 60–65). Despite using different vantage points at Point Lookout, different watch structures and different data analyses, the two series of surveys showed similar results: a rapid increase in the size of the humpback population over time, which has continued, as demonstrated by more contemporary surveys. The most recent population survey, conducted in 2015, estimated a long-term population growth rate of 11% per annum (95 % CI) (Fig. 2), with an abundance estimate of 25,454 whales (95 % CI) (66). This means that the eastern Australian humpback whale population is likely fully recovered; however, the continued rapid increase in the population is of some concern. It may indicate that either the whales are heading for a higher carrying capacity than previously thought, or that their recovery may follow an irruptive pattern, with an overshooting of carrying capacity followed by a sudden increase in mortality and fall in the population as it fluctuates around the carrying capacity for some time (67).

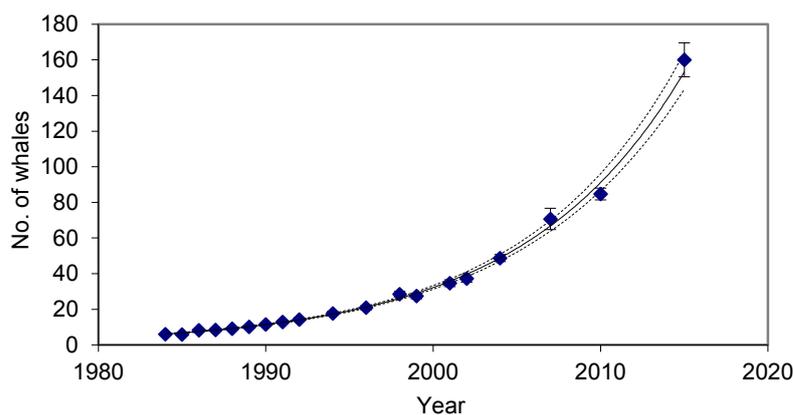


Figure 2. The average number of northbound humpback whales (mean with SE) passing Point Lookout per 10-hour day over the peak four weeks of the migration. Most surveys ran from 0700 to 1700 every good-weather day. The trend line represents an 11.0% per annum increase (95% CI dotted lines). Data prior to 2004 are from Paterson surveys (56, 60–63). SE: standard error, CI: confidence interval.

Southern right whales

Southern right whales (*Eubalaena australis*) were one of the first casualties of European settlement in Australia. Whaling was one of white Australia's first industries. Many small whaling stations sprang up around the southern coastline of the mainland and Tasmania to take advantage of the large numbers of right whales in particular. By

1850, barely 60 years after European settlement, southern right whales had been hunted into commercial extinction (68, 69).

The first likely sighting of a southern right whale in Queensland waters by Europeans was by whalers working from Tangalooma in the 1950s. They radioed their finding back to the whaling station and asked permission to kill it, but permission was denied. The first confirmed and documented sighting of a southern right whale was in 1998 (70). The whale was spotted in waters off the surf club at Point Lookout (outside the Bay) and then moved around the headland and out to sea. A southern right whale, presumably the same one, was sighted later in the season, off Point Lookout. The following year a southern right whale was sighted within

Moreton Bay and since then they have become relatively frequent visitors to the Bay environs and south-eastern Queensland (71, 72). They have also been sighted as far north as offshore from Gladstone (Department of Environment and Science, unpubl. data). This suggests that while the South East Queensland coast was probably part of the normal distribution of these whales, this had not been realised until recently as numbers had been severely depleted prior to European settlement of Queensland (73).

Although the re-colonisation of south-eastern Queensland waters is a welcome sign of the recovery of the southern right whale, it has not been without setbacks. Two southern right whales, a presumed mother and yearling calf, were hit by a passenger ferry just north of Goat Island in 2014 resulting in the death of the younger whale (72). Southern right whales are well known for their vulnerability to ship strike due to their slow swimming speeds and extended periods spent at or near the surface. The previous year, 2013, another southern right whale was found floating dead off the southern Sunshine Coast close to the northern end of the Bay. The whale was towed out to sea but later washed up on Bribie Island. A post-mortem examination of the whale found wounds consistent with a ship strike to the skull, but was not able to determine whether the strike was ante- or post-mortem (72). Ship strike and entanglement are likely to be the most serious threats to southern right whale recovery in Australia (74).

Indo-Pacific bottlenose dolphins

There are two species of bottlenose dolphins inhabiting the Moreton Bay region: the darker larger offshore species found outside the Bay on the seaward side of the barrier islands (75), and the coastal inshore form (lighter grey with speckled belly) found within the Bay (1,76). The larger offshore species is the common bottlenose dolphin, *Tursiops truncatus* and they have not been well studied in the Moreton Bay region. Two common bottlenose dolphins were satellite tracked off Point Lookout in the late 1990s, and appeared to be resident in relatively small home ranges over the continental shelf (77).

Inshore bottlenose dolphins (*Tursiops aduncus*) are found commonly within the Bay and have been studied on and off since the 1970s (78). The most recent population estimate in 2010 has shown that there are approximately 550 animals in two distinct sub-populations: one that lives in the wider, deeper northern part of the Bay, and the other that inhabits waters closer to the central and eastern areas of the southern Bay (79). These sub-populations are genetically distinct with limited mixing, and are adapted to different ecological niches (80, 81). The smaller southern sub-population, estimated at ~200 dolphins, may be under greater ecological and anthropogenic stress due to its more inshore distribution (more exposed to human activities) and foraging preferences. These dolphins prefer to feed in shallow waters along the developed coast and polluted river mouths of the western Bay (79, 81). Whether or not this sub-population is steady or in decline is not known and will require further surveys into the future (79).

In the late 1990s, it was demonstrated that inshore bottlenose dolphins in eastern Moreton Bay formed two distinct but sympatric communities. One group of dolphins followed prawn trawlers and appeared to forage from trawler discards, whilst the other group did not (82). Trawling effort in the Bay underwent a considerable decline from 1999 until 2008. The trawler and non-trawler dolphin community structure disappeared with the changes in fishing practice,

reverting to a more conventional fission–fusion association pattern for dolphins (83). The high rates of shark injuries on bottlenose dolphins in the Bay reported in a study in the 1980s (evidence of injuries in 36.6% of dolphins identified) may have been in part related to a concentration of sharks and dolphins around trawlers (84). Indo-Pacific bottlenose dolphins in Moreton Bay are found in groups that average six members but may number up to 35 (83), and in mixed groups with Australian humpback dolphins (see below).

There is a long history of associations between bottlenose dolphins and people in Moreton Bay, from the early cooperative hunting that occurred between Indigenous fishers and dolphins (85), to tourists handfeeding dolphins over the past 25 years (86). The impact of this feeding regime on the movements, foraging patterns and reproductive success of these dolphins is not fully understood (87), but it is hoped that the positive up-close experience with wild dolphins encourages conservationist attitudes (86).

Australian humpback dolphins

The most southerly resident population of the Australian humpback dolphin (*Sousa sahulensis*) occurs in Moreton Bay. Owing to small, discrete populations, this tropical to subtropical inshore species is listed as ‘Vulnerable’ in Queensland under the Nature Conservation Act 1992 (Qld). In spite of the southerly location, the population size and density of Australian humpback dolphins in Moreton Bay is within the range of other east-coast populations (88–90). The earliest study using photo identification reported two population estimates for the Bay for overlapping time periods, with estimates of 163 (95% CI: 108–251, 1984–86) and 119 humpback dolphins (95% CI: 81–166, 1985–87) (91, 92). A subsequent study reported as few as 100 dolphins in the mid-1990s, but did not provide information on how this estimate was derived (93). From surveys conducted in 2014 to 2016, the population was estimated at between 128 and 139 adult-sized dolphins (95% CI: 67–274) (J Meager & E Hawkins, unpubl. data).

A recent genetic study along the east coast of Queensland indicated that the Moreton Bay group of humpback dolphins is a putative local population with limited gene flow to the nearest population in the Great Sandy Strait, 150 km north (94). However, occasional sightings and strandings along the intervening ocean-exposed coast suggest that some demographic exchange may be occurring (95). Movements of up to 130 km have been recorded further north along the Capricorn Curtis Coast in central Queensland (96).

Australian humpback dolphins have a more restricted inshore distribution than bottlenose dolphins. In Moreton Bay, the core habitat for humpback dolphins extends from the lower reaches of the Brisbane River to Mud Island and north to the Western Banks off Scarborough. Peripheral core habitats for the species include the waters close to the southern shores of Bribie Island and the Amity Channel near North Stradbroke Island (97). A shift in habitat use away from the landward margins of Deception and Bramble Bays since the 1990s has been attributed to a decline in habitat quality that has been exacerbated by periodic floods (97).

Social structure may also play a role in shaping habitat use by Australian humpback dolphins in the Bay. A recent study suggests five distinct social communities of humpback dolphins in

the Bay (E Hawkins, unpubl. data). Two of these communities have comparatively little spatial overlap with the others - one occurring mainly in northern Moreton Bay near Bribie Island and the other near Amity at North Stradbroke Island. As explained above, humpback dolphins in the Bay are often found in mixed groups with Indo-Pacific bottlenose dolphins (91, 95). Little is known of interactions between the species, but bottlenose dolphins appear to be dominant in terms of competition for food (98), and are more numerous (99, 100).

Australian humpback dolphins tend to occur in smaller groups than bottlenose dolphins, with typical group sizes around 3 - 4, although groups of up to 31 have been reported (101). Group sizes tend to be the largest when these dolphins are socialising and smallest when they are travelling. They are mostly generalist piscivores, taking various demersal and pelagic prey, but they also feed opportunistically on trawler bycatch in the Bay (91).

Tiger, bull and white sharks are likely predators of humpback dolphins in Moreton Bay, with evidence of shark attacks in 36% (18 of 50) dolphins examined in a study in the 1980s (91). Anthropogenic threats to humpback dolphins in the Bay are similar to those described elsewhere (102, 103) and include vessel traffic, entanglement in fishing gear/debris, noise, unpermitted provisioning, prey depletion, incidental catch in the shark control program, introduced pathogens, and pollution (95, 104). A comparison of tissue contaminant concentrations in humpback dolphins, stranded/by-caught in the Moreton Bay region, with toxicological thresholds for other marine mammals found that some contaminant groups (polychlorinated biphenyls (PCBs) and the dichlorodiphenyls DDXs) were above or close to the levels where a range of physiological adverse effects can occur (105). There are no known contemporary sources of these chemicals in the Bay, suggesting that the dolphins had been exposed to pollutants that have remained in the environment from past use in industry and agriculture. However, the levels of contaminants reported underscore the need to monitor the health of this important population of humpback dolphins.

Other marine mammals

Although not as commonly seen as humpback whales, dwarf minke whales (*Balaenoptera acutorostrata*) are often seen off North Stradbroke and Moreton Islands and are occasionally seen in the Bay (1), probably during their (as yet poorly defined) migrations. Other occasional visitors to the region include killer whales (*Orca orcinus*), Eden's whales (*Balaenoptera edeni*), sperm whales (*Physeter macrocephalus*), pygmy sperm whales (*Kogia breviceps*), blue whales (*B. musculus*) and Blainville's beaked whales (*Mesoplodon densirostris*) (1). These animals have been sighted primarily offshore and rarely in the Bay. Short-beaked common dolphins (*Delphinus delphis*) are abundant offshore from Moreton Bay and occasionally strand on the eastern oceanic shores of Moreton and Stradbroke Islands, but have not been recorded inside the Bay. Other cetacean species that have stranded on the ocean-exposed coastline of the border islands include the short-finned pilot whale (*Globicephala macrorhynchus*), Risso's dolphin (*Grampus griseus*), Fraser's dolphin (*Lagenodelphis hosei*), false-killer whale (*Pseudorca crassidens*) and Pantropical spinner dolphin (*Stenella longirostris*). In contrast, a mass stranding of 53 melon-headed whales (*Peponocephala electra*) occurred on the sheltered south-west shores of Moreton Island in 1976 (106).

Small numbers of long-nosed fur seals (*Arctocephalus forsteri*) are sighted annually in the Bay from June to September; Subantarctic fur seals (*Arctocephalus tropicalis*) are also occasionally recorded (Department of Environment and Science, unpubl. data). For about a month in winter 2018, a long-nosed fur seal became a regular sight around the southern shores of Bribie Island, earning the moniker of 'Neil the Seal' before disappearing, presumably to travel south again.

Threats to Moreton Bay marine mammals

Unquestionably, the greatest anthropogenic threat to marine mammals in Moreton Bay is habitat loss, which includes loss of food sources (prey or seagrass depletion) and degradation of habitat from reduced water quality that may result from chemical pollution and pathogenic contamination, including from terrestrial sources. Entanglements of dolphins in fishing lines and hooks have also increased in recent years (107), which could be reduced by simple measures such as using corrodible hooks, avoiding fishing near dolphins and not discarding gear into the Bay waters. Although most of the core habitat for dugongs now occurs within designated Go-slow areas within Moreton Bay Marine Park, other marine mammals and dugongs whose home ranges extend far beyond the restricted speed areas are still vulnerable to vessel strikes.

If we want to conserve our Moreton Bay megafauna in a healthy state for the next 20 years, it is time to act now. Limiting boating speed and stepping up patrols of the marine park are small but important steps. We must also consider the quality of water that runs into Moreton Bay, the extent and impact of this outflow and its effects on marine mammal habitat. Significant improvements have been made to water quality through upgrades to wastewater treatment plants, and water quality is monitored collaboratively by the Department of the Environment and Science, and Healthy Land and Water (108). Yet there is still work to do, especially towards revegetating coastal waterways and improving stormwater run-off to reduce sediment discharge into the Bay, and to effectively contain our chemicals and terrestrial debris.

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