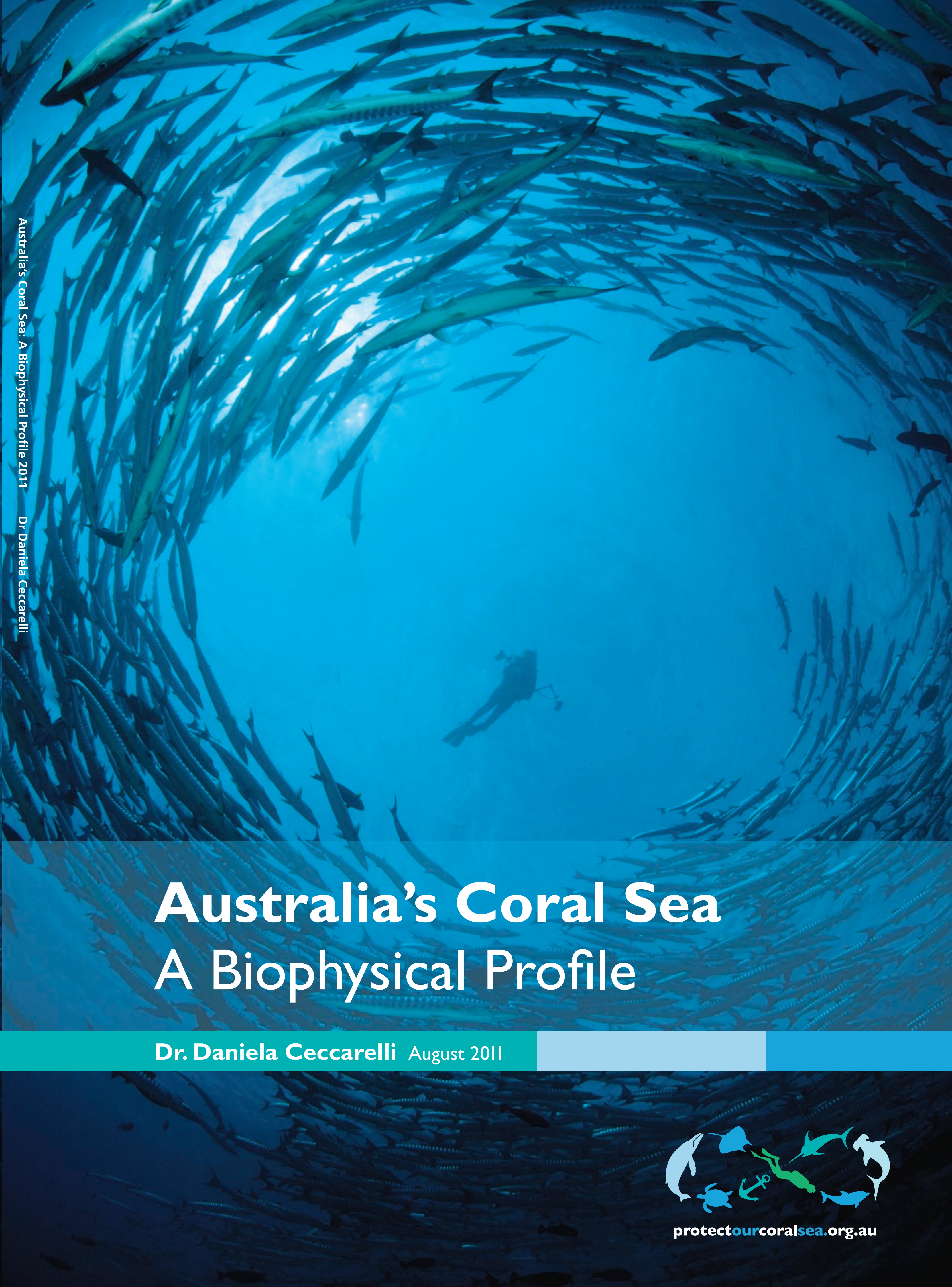

Australia's Coral Sea: A Biophysical Profile 2011 Dr Daniela Ceccarelli

Australia's Coral Sea
A Biophysical Profile

Dr. Daniela Ceccarelli August 2011

protectourcoralsea.org.au

Australia's Coral Sea: A Biophysical Profile

Author: Dr. Daniela M. Ceccarelli

Dr. Daniela Ceccarelli is an independent marine ecology consultant with extensive training and experience in tropical marine ecosystems. She completed a PhD in coral reef ecology at James Cook University in 2004. Her fieldwork has taken her to the Great Barrier Reef and Papua New Guinea, and to remote reefs of northwest Western Australia, the Coral Sea and Tuvalu. In recent years she has worked as a consultant for government, non-governmental organisations, industry, education and research institutions on diverse projects requiring field surveys, monitoring programs, data analysis, reporting, teaching, literature reviews and management recommendations. Her research and review projects have included studies on coral reef fish and invertebrates, seagrass beds and mangroves, and have required a good understanding of topics such as commercial shipping impacts, the effects of marine debris, the importance of apex predators, and the physical and biological attributes of large marine regions such as the Coral Sea. She also continues to collaborate with colleagues in academic institutions to further her research interests on coral reefs.

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Australian Conservation Foundation, Australian Marine Conservation Society, Pew Environment Group, Project AWARE Foundation, Humane Society International, International Fund for Animal Welfare, Queensland Conservation Council, National Parks Association of Queensland, Wildlife Queensland, Cairns and Far North Environment Centre and North Queensland Conservation Council.

For more information: **www.protectourcoralsea.org.au**

Executive Summary

The Coral Sea Conservation Zone (referred to in this report as the Coral Sea) is bounded on the west by the Great Barrier Reef Marine Park, on the east by the edge of Australia's Exclusive Economic Zone, on the north by the Torres Strait Protection Zone and on the south by the same southern latitude line as the Great Barrier Reef Marine Park. The area comprises 972,000 km^2.

The Coral Sea hosts a high diversity of habitats, ecosystems and species. Only a small portion of this area has been studied, but knowledge gained to date indicates that there are important habitats, migration corridors and ecological processes that sustain unique biological communities. This review draws together the available scientific research to provide a comprehensive description of the physical and biological characteristics of the Coral Sea.

The seabed of the Coral Sea is characterised by a vast plain over 4,000 m deep to the northeast, several plateaux and slopes etched by undersea canyons and separated by deep ocean trenches, and, to the south, the northern end of a chain of undersea volcanoes. Eighteen coral reef systems, many with multiple small reefs, emerge from structural high points on the plateaux or from the tops of the volcanoes. Forty-nine small islands and cays form the only terrestrial habitats.

At the ocean's surface, the westward-flowing South Equatorial Current enters the Coral Sea as a series of jets between the network of islands that form the Solomon Islands, Vanuatu and New Caledonia. As this current approaches the Great Barrier Reef, it splits in two to form the Hiri Current to the north and the East Australian Current to the south. This latter current brings warm, low-nutrient water and tropical species southward as a series of eddies. Very little is known about how small-scale circulation patterns affect the Coral Sea's ecology, but slow eddies, which may retain fauna and promote the development of species that do not occur anywhere else, have been discovered over some of the plateaux.

South West Herald Cay, Coringa-Herald Nature Reserve

The islets and cays of the Coral Sea support a variety of life, ranging from simple food chains based on carrion and detritus to well developed thick forests of *Pisonia* trees. The cays provide habitat for nesting and roosting seabirds (many of which are of conservation significance) and nesting endangered green turtles.

In general, highly exposed reef zones in the Coral Sea are dominated by species that are robust enough to withstand strong wave action, while more sheltered reef habitats have a greater amount of live coral cover (30–50%) and host a larger abundance of fish and invertebrates. Coral, fish and invertebrate populations show key differences from those on the Great Barrier Reef and some affinities with those on the reefs of the western Pacific and the Arafura and Timor Seas. Recent research has uncovered coralline sponges, considered 'living fossils,' in the shallow caves of Osprey Reef. Some reefs support high densities of sharks (~4.4 individuals per hectare) and other predators, and protection in existing no-take Commonwealth Reserves in the Coral Sea has led to healthy populations of otherwise exploited species.

Preliminary explorations of deeper Coral Sea reef ecosystems (from 30–40 m to over 150 m) have revealed a great diversity of geological formations along with coral communities that have adapted to low light. Soft corals are an important feature of these deeper coral communities, and gorgonians (sea fans) tend to be very abundant. These mesophotic (low light) communities may act as refugia during disturbance events such as cyclones and bleaching, and may provide larvae during the recovery of these highly isolated reefs.

Executive Summary

Coral Sea

In the deep ocean (below the mesophotic zone) of the Coral Sea, diverse cold-water coral communities have been discovered, as well as a high abundance of predatory fish and sharks in the deeper reaches of coral reefs. The Coral Sea's pelagic (open sea) realm is frequented by numerous threatened and migratory cetaceans, turtles and sharks, as well as tunas and billfish. The southern Coral Sea has large densities of fish and squid that occupy the middle of the food chain and play an important role in regulating food web stability.

The Coral Sea provides habitat for a number of iconic species:

- Common cetaceans documented in the Coral Sea include humpback whales (*Megaptera novaeangliae*) and dwarf minke whales (*Balaenoptera acutorostrata*), and a number of toothed whale species that have sometimes been recorded in pods of hundreds of individuals.
- The cays function as critical habitat for green turtles (*Chelonia mydas*), providing important nesting areas for turtles arriving from foraging grounds as far away as the Torres Strait and Papua New Guinea. Hawksbill (*Eretmochelys imbricata*) and loggerhead turtles (*Caretta caretta*) forage around the shallow Coral Sea reefs, and the Coral Sea currents underlie important migratory routes for many turtle species.
- The cays of Lihou Reef and Coringa-Herald provide habitat for 36 species of seabirds. These cays host a significant proportion of Australia's breeding population of several species, including the red-footed booby (*Sula sula*), lesser frigatebird (*Fregata ariel*), great frigatebird (*Fregata minor*) and red-tailed tropicbird (*Phaethon rubricauda*). The Coral Sea also provides feeding grounds for seabirds that nest on Great Barrier Reef islands.
- The southern edge of the Coral Sea is considered a global biodiversity hotspot for ocean predators such as sharks, tunas and billfish. Oceanic and reef sharks have been documented in large numbers in some parts of the Coral Sea, especially in areas protected from exploitation. Deep-water sharks are known to dwell on the deep continental slopes and plateaux. Fifty-two species of deep-water sharks, rays and chimaeras have been recorded in the Coral Sea, 18 of which are known only from there.

The Coral Sea hosts 341 species that are recognised by the International Union for the Conservation of Nature for their conservation significance. The list includes 26 species of cetaceans, 219 species of corals, 21 species of fish, 46 species of sharks and rays, 5 species of marine turtles and 24 species of birds. Over half (51%) of these species show declining population trends.

The waters over the Queensland and Townsville Troughs appear important for attracting aggregations of large pelagic species, either to feed or spawn. A spawning aggregation of lanternfish periodically attracts feeding schools of tunas, billfish and whale sharks. The northwestern Coral Sea hosts the only confirmed spawning aggregation of black marlin (*Makaira indica*) in the world.

The Coral Sea also provides migratory corridors for numerous highly mobile species. The primary migration pathways are likely to be associated with major ocean currents; species may enter the Coral Sea via the South Equatorial Current, and some may continue north towards the Arafura Sea, while others – such as black marlin, loggerhead turtles, freshwater eels and humpback whales – may turn south and follow the East Australian Current. One of the most remarkable migrations is undertaken by freshwater eels. All species of freshwater eels from New Zealand and eastern Australia spawn in the northern Coral Sea, at depths between 200 m and 300 m. Larval eels mature as they are transported south by the East Australian Current, and then migrate toward estuaries along the Australian or New Zealand coastline, a journey that can total 3,000 km.

The existing knowledge about the Coral Sea serves to establish the following points:

1. The Coral Sea Conservation Zone is large enough to conserve wide-ranging pelagic and deep-water species, a high proportion of which are found only in the Coral Sea and are particularly vulnerable to anthropogenic impacts.

2. In terms of scientific rigor, policy development and implementation, Australia is probably the only tropical pelagic environment not markedly impacted by fishing, where an area of very large scale can be established and effectively managed.

3. Although the Coral Sea contains a number of critical shallow reef and terrestrial habitats, these represent less than 1% of the total area. Their small size, isolation from each other and high exposure to cyclones and storms make them more vulnerable to catastrophic impacts of natural disturbances than the contiguous reef systems of the Great Barrier Reef. These precarious conditions increase the area's ecological fragility and the risk of local extinctions.

4. The only attempt to examine the cost effectiveness of management of tropical protected marine areas suggested that economies of scale function more effectively for single large areas than numerous small ones.

The Coral Sea offers a valuable scientific reference site, as it is close to the global centre of coral reef biodiversity – the Coral Triangle – but is not subject to the human pressures that affect much of Southeast Asia's marine ecosystems. In addition, recent research indicates unique biological communities that are still intact.

While continuing these studies, we must extend investigations of the Coral Sea, especially to the spatial scale relevant to ecological communities and individual organisms. Significant knowledge gaps must be identified and addressed before we can form a clearer understanding of the Coral Sea's overall biodiversity, patterns of connectivity, and the drivers of ecosystem health. With many of the world's marine systems in decline, knowledge of patterns of connectivity and the genetic structure of the Coral Sea's populations will enhance our understanding of how this ecosystem (and others) may respond to environmental variation over evolutionary and ecological time scales.

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Introduction

The Coral Sea is a body of water bounded by the Great Barrier Reef to the west, Papua New Guinea to the North, the Solomon Islands, Vanuatu and New Caledonia to the east and the Tasman Front to the south. The Coral Sea Conservation Zone (referred to as the Coral Sea in this report) lies within Australia's Exclusive Economic Zone (EEZ), is bounded to the north by the Torres Strait Protection Zone and shares the Great Barrier Reef Marine Park (GBRMP)'s southern boundary (Figure 1).

The declaration of this area as a Conservation Zone in May 2009 recognised the international significance of its physical, ecological and heritage values. It is ecologically distinct from the adjacent Great Barrier Reef, provides habitat for a range of protected species and serves as a migration corridor and as a system of 'stepping-stones' for the dispersal of species from the western Pacific to the Great Barrier Reef (Bode et al. 2006).

Two no-take Commonwealth Marine Protected Areas are located in the Coral Sea: the Lihou Reef National Nature Reserve (referred to in this review as Lihou Reef), the Coringa-Herald National Nature Reserve (referred to as Coringa-Herald). The remaining areas within the Coral Sea are subject to fisheries management specific to the Coral Sea Fishery and the Eastern Tuna and Billfish Fishery.

Knowledge of the Coral Sea's physical and ecological attributes is patchy. Some of the general principles of ecosystem functioning can be inferred from knowledge gathered in adjacent tropical marine regions, but this may change once more research is conducted in the Coral Sea itself. It is therefore difficult to define the physical forces, evolutionary pathways and adaptive mechanisms that have shaped the region's ecosystems, and even more difficult to predict the responses of these ecosystems to future disturbances and pressures. This study aims to review existing research conducted in the Coral Sea to provide an overview of its physical and biological attributes.

The Coral Sea Conservation Zone represents one of the few attempts globally to manage and conserve an oceanic pelagic system on a large scale. The historic focus of management and conservation agencies wordwide on nearshore habitats and shallow water coral reef systems has resulted in numerous marine protected areas that protect species associated with these habitats. The capacity to manage pelagic species is hampered both by the lack of ecologically relevant areas from which fishing is excluded and the absence of fishery-independent data on species' life history and abundance (Game et al. 2009; Koldewey et al. 2010).

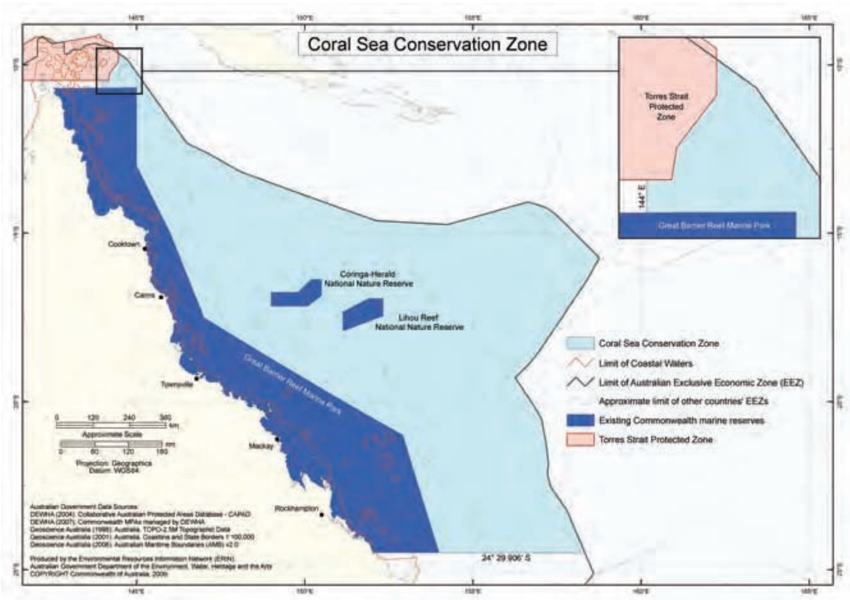


Figure 1. Boundaries of the Coral Sea Conservation Zone.
http://www.environment.gov.au/coasts/coral-sea.html

Masked booby

The proposal to conserve the pelagic biota in 970,000 km^2 of pelagic ecosystem in the Coral Sea (Zethoven 2008) is unique, as it is the only large area of tropical pelagic ecosystem where policy, research and management can be combined with a high probability of sustaining and conserving pelagic populations (Mora et al. 2009). Its large size is ecologically relevant to pelagic species of fish and elasmobranchs that are in global decline due to their high market value (Myers and Worm 2003; Worm and Tittensor 2011).

The probability of success is enhanced because the Coral Sea Conservation Zone lies entirely within Australian waters and is therefore free of inter-jurisdictional issues, and because its proposed size encompasses numerous areas critical to the life cycles of wide-ranging pelagic species, such as spawning, breeding, nesting and feeding areas (Ceccarelli 2011).

Methods

This review synthesised knowledge about the Coral Sea from publicly available papers, reports and web pages. Information from similar or adjacent areas was sometimes included if this was deemed to add value or provide useful background to information gathered in the Coral Sea.

The information used in this study includes:

- Peer-reviewed publications,
- Management plans and reviews prepared for the East Marine Region Bioregional Profile,
- Unpublished reports to Government Departments where available,
- Unpublished reports and profiles provided by the Pew Environment Group,
- Direct liaison with authors and researchers, and
- Online sources and databases.

This report is organised into two broad sections, relating to either the physical or biological characteristics of the Coral Sea. Physical characteristics include oceanography, climate, geology, geomorphology, sedimentology and related disciplines, and a summary of the individual ecophysical sub-regions that make up the Coral Sea. Biological characteristics include broad descriptions of different Coral Sea ecosystems, available information on individual taxa (groups) of organisms, and a general understanding of ecological patterns and processes. Special attention is given to iconic species and species of conservation significance. Additionally, knowledge gaps were identified where they posed a barrier to a more comprehensive understanding of the Coral Sea.

Physical Characteristics

Physical Overview and Habitat Dimensions

The Coral Sea basin lies east of the edge of the Australian continental shelf, characterised by deep ocean trenches, a series of carbonate plateaux, a section of abyssal seafloor in the north-eastern portion and the northern end of the Tasmantid Seamount Chain in the south (Brewer et al. 2007). These major structures are interspersed with smaller, more localised and less well-known features such as canyons, ridges, knolls, pinnacles, saddles and terraces. The most notable of the large plateaux are the Eastern, Queensland, Marion and Kenn Plateaux, all of which host emergent reefs and cays. The major water mass of the Coral Sea is known as the Pacific North-West Tropical Warm Pool, and its major currents include the westward-flowing South Equatorial Current, which crosses the Coral Sea and then, east of the continental shelf, splits into the Coral Sea Coastal Current (or Hiri Current) to the north and the EAC to the south (Lyne and Hayes 2005).

Together, the geomorphic and oceanographic features have driven the development of distinct ecological regions in the Coral Sea, including the Cape Province, Coral Sea Abyssal Plain, Queensland Plateau, Marion Plateau and Northern Seamounts Field ecophysical sub-regions (Figure 8) (Heap et al. 2005; Brewer et al. 2007). Coral Sea waters are generally identified as nutrient-poor, sustaining low pelagic productivity (Lyne and Hayes 2005). At the southern edge of the Coral Sea is a tropical-temperate transition zone of highly unique ecological communities, many at the edges of their geographic range (Brewer et al. 2007).

The Coral Sea is composed primarily (almost half of its total area) of pelagic environments in the relatively deep water over the major plateaux (Table 1). Most of the remaining area (30.4%) is taken up by the pelagic realm that covers the abyssal plain, the troughs, and the rises and slopes of the plateaux and Australian continental margin. The most frequently studied areas, the reefs and cays, collectively make up only a little over 0.3% of the Coral Sea's area. Given the focus of existing knowledge on these shallow-water habitats, it is understood that they serve as critical habitat for a wide range of episodically pelagic, reef and cay associated species. Such areas may include nesting sites for birds and habitats for terrestrial invertebrates and plants, shallow water coral reef systems that support benthic invertebrates and reef fishes and deeper reef pinnacles and sea mounts that concentrate nutrients, planktonic and small pelagic species that attract larger predatory fish. The shallow water reef systems have also acted as stepping stones for transfer of reef associated species from Pacific archipelagoes to the north-eastern Australian coast over ecological time scales and as evolutionary reservoirs on geological time scales. The geological history of the Coral Sea (Davies et al. 1989) confirms that the reef systems of the three major plateaux provided extensive reef habitats during low stand sea level over the past 400,000 years and replenishment sites for the emergent Great Barrier Reef.

Coral Sea Habitat	km^2	%
Total Area	972,000	100
Major Plateaux	472,300	48.5
Abyssal Plain	2,960	0.3
Troughs	86,890	8.9
Seamounts	9,250	0.96
Rise	15,920	1.6
Slopes	190,040	19.6
Reef Banks	15,351	1.6
Coral reefs	2,998	0.3
Cays	9	0.0092

Table 1. Dimensions of major Coral Sea habitat types within the Coral Sea Conservation Zone. 'Rise' and 'Slopes' are relevant to both the Australian continental margin and the plateaux. The missing ~19% includes isolates such as terraces, ridges, saddles, etc. Source: Heap and Harris (2008). Data on individual reef systems obtained from Quickbird Images (www.oceandots.com) integrated into Google Earth Pro, courtesy of Professor J. H. Choat.

Key Geomorphic Features

The Coral Sea is dominated by fault-bounded slopes, ridges and four major plateaux, or undersea plains that rise hundreds to thousands of metres above the abyssal seafloor (Keene et al. 2008). The plateaux are known as (from north to south) the Eastern Plateau, the Queensland Plateau, the Marion Plateau and the Kenn Plateau (Figure 2, Figure 3) (Harris et al. 2003). The troughs that separate the plateaux from each other and from the Australian continental shelf can be up to 4,000 m in depth. The slopes of the plateaux and the undersea troughs are punctuated by seamounts, canyons, ridges, knolls, pinnacles, saddles and terraces (Figure 3). From the plateaux rise emergent reefs, atolls, islets and cays, including Osprey, Bougainville, Holmes, Flinders, Lihou, Marion, Kenn, Tregrosse and Saumarez Reefs (Figure 4). Recent mapping work has begun to classify the geomorphology of the Coral Sea (Beaman 2010a) (Figure 3), and patterns in the sedimentology of the region have been identified (Keene et al. 2008) (Table 2). However, very few of the smaller geomorphic features have been explored or described.

The Coral Sea is dominated by fault-bounded slopes, ridges and four major undersea plains that rise hundreds to thousands of metres above the seafloor, separated by troughs up to 4,000 m deep. The slopes of the continental shelf, the plateaux and the undersea troughs are punctuated by seamounts, canyons, ridges, knolls, pinnacles, saddles and terraces. From high points in the plateaux, emergent reefs, atolls, islets and cays break the ocean’s surface.

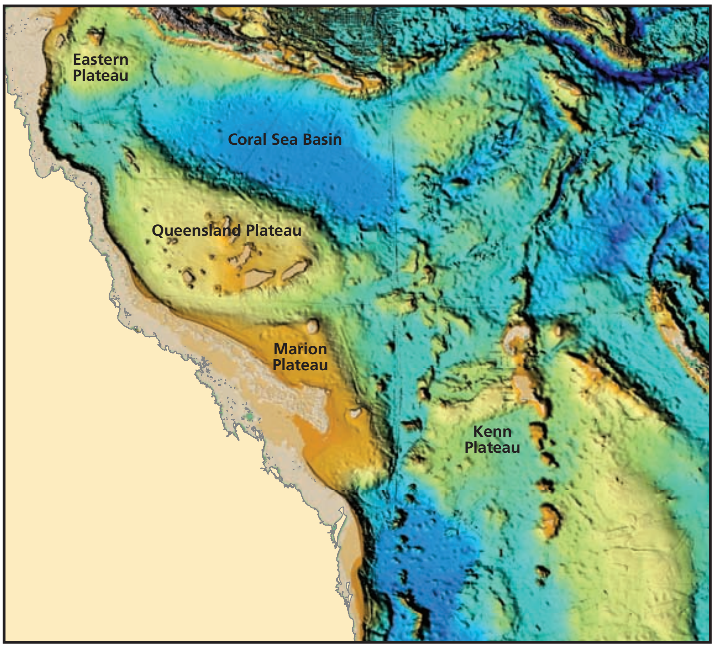


Figure 2. National Marine Bioregionalisation of Australia. From Commonwealth of Australia (2005).

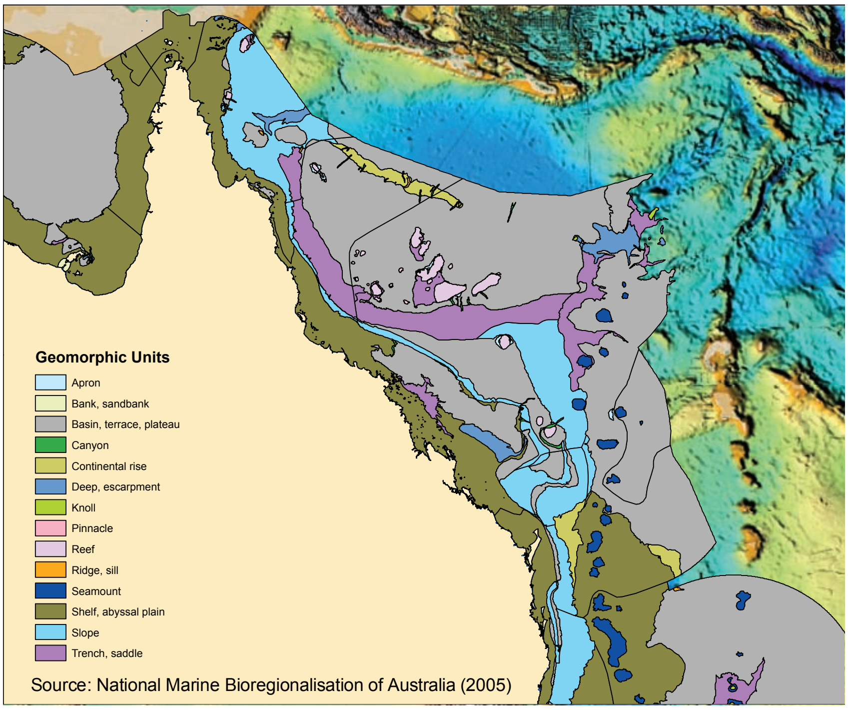


Figure 3. Geomorphic features of the Coral Sea, from Beaman (2010a).

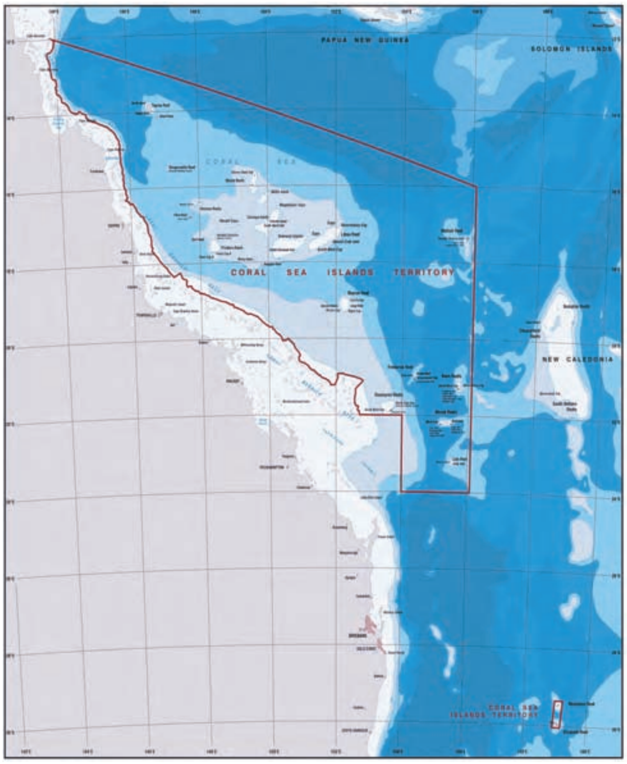


Figure 4. Coral Sea islands and reefs. From http://www.regional.gov.au/territories/coral_sea/coralmap.gif (29 July 2011).

It is believed that the Coral Sea basin was formed through seafloor spreading between approximately 110 and 52 million years ago, and that the plateaux subsided from the continental shelf as the basin spread.

It is believed that the Coral Sea basin was formed through seafloor spreading between approximately 110 and 52 million years ago (Keene et al. 2008), and that the plateaux were formed through the subsidence and faulting associated with the formation of the basin (Davies et al. 1989; Brewer et al. 2007). Only a small part of the northernmost plateau – the Eastern Plateau – lies within the Coral Sea; Ashmore and Boot Reefs rise from this platform close to the outer Great Barrier Reef (Keene et al. 2008). The Queensland Plateau to the south, one of the best-studied areas, began to subside approximately 40 million years ago and reached its current level about 25 million years ago.

Location	Trends
Australian continental margin	• Quartz clays and minerals derived from terrigenous sources • Banks, mounds and 'hardgrounds' • Seabed sediments are lithified by carbonate, phosphate and iron oxide minerals
Plateaux, seamounts and slopes	• Primarily unconsolidated carbonate oozes • Living and/or fossil carbonate platforms, atolls and banks • Limestone platforms • Coarse sediments inshore, finer mid-shelf and offshore
Abyssal depths	• Calcareous silts and clays • Significant areas of Mn-nodules • Sand in troughs and ridges
General	• Faulted basement highs • Volcanic seamounts
Slopes, seamounts, ridges, canyon sides	• Outcrop and boulder/scree material of basement rocks, coated with thick Fe-Mn crusts

Table 2. Primary sedimentary trends occurring in the East Marine Region, which includes the Coral Sea. From Keene et al. (2008).

The international and multi-disciplinary Ocean Drilling Program led to a detailed exploration of the sedimentology of the Marion Plateau, including the chemistry, mineralogy, grain size and other attributes of sediments from below the seafloor (ODP 2007). Observations from the Marion Plateau were used to date the development of the reef framework in the southern part of the Great Barrier Reef, placing this occurrence at between 560 and 670 thousand years ago (Dubois et al. 2008). The carbonate base of the Marion Plateau is covered in pelagic carbonate ooze and biogenic particles that have been scoured over time by strong tidal movements (Ehrenberg et al. 2006). Marion Reef and Saumarez Reef lie along the plateau's eastern margin (Keene et al. 2008).

The Kenn Plateau lies in deeper waters to the east of the Marion Plateau, and consists of a series of ridges shallower that 2,000 m and troughs or basins that lie between 1,800 and 3,000 m. The margins of the Kenn Plateau are steep, with many small canyons and other indentations, and fields of sand dunes occur in ~1,000 m on one of the main ridges. The Kenn Plateau coincides to some degree with the northern seamounts of the Tasmantid Seamount Chain (see below). Cato Island and Kenn Reef rise from the western edge of the Kenn Plateau, while Wreck Reef rises as a seamount to the west of the Plateau. In the north, Mellish Reef has formed as a volcanic seamount from where the plateau is shallower than 2,500 m.

Volcanic activity shaped the Tasmantid Seamount Chain, the northern end of which extends into the southern Coral Sea. These northernmost seamounts are the oldest in the chain.

The Tasmantid Seamounts form a chain of submarine volcanoes that extend over 1,300 km in the Tasman Basin, with the northernmost seamounts reaching into the southern end of the Coral Sea. Its formation coincides with a volcanic 'hotspot' developed during the seafloor spreading that formed the Coral and Tasman Seas (McDougall and Duncan 1988). Some of the volcanoes have become eroded, flat-topped undersea mountains, called guyots, while others reach the surface with limestone caps supporting reefs and cays, including Cato Island, Bird Island, Wreck Reef, Kenn Reef and Frederick Reef (Keene et al. 2008). The ages of the volcanoes have been estimated at between 6.4 and 24 million years, and the oldest seamounts occur in the northern portion of the chain in the Coral Sea (McDougall and Duncan 1988).

Unlike the volcanic seamounts in the south, the reefs and cays on the Queensland Plateau grew on structural high points of the carbonate plain. Reef growth kept pace with rates of plateau subsidence and sea level rise in the past.

During half of the past 300,000 years, sea level has fluctuated between 70 and 120 m below its present level, and the carbonate platforms, reefs and shoals in the Coral Sea were exposed as islands. During these lower sea levels, the Marion Plateau, which is essentially a deeper extension of the Australian continental shelf (Harris et al. 2003), would have been only partly submerged as an extensive promontory along the coastline. A shallow carbonate platform would have formed the connection between the plateau and Saumarez Reef and Marion Reef – then islands – at the shelf edge, even when sea levels rose. East, west and north of the Cato Trough, Mellish, Frederick, Kenn, Wreck and Cato Reefs would have been slightly enlarged and exposed as islands (Keene et al. 2008). Only the tops of the reefs and cays remained exposed when sea levels rose again, and the structure of present-day reefs suggests that reef growth kept pace with the ancient sea-level rise (Davies et al. 1989).

Recent explorations of the Queensland Trough have revealed a multitude of smaller-scale geological features such as canyons and gullies, and a series of 200–300 m high 'knolls' supporting cold-water coral communities (Beaman 2010b). The knolls, named Gloria Knolls, were formed during a massive landslide of the Queensland continental slope, which is incised by a network of deep canyons (Beaman and Webster 2008). Ongoing research aims to provide high-resolution bathymetric maps of the whole Coral Sea, and provide more detailed information on the structure of the canyons and the taxonomy of the live, dead and fossilised cold-water coral communities, found to date as far back as 45,000 years, on the Gloria Knolls (Beaman et al. 2009; Beaman 2010a).

Humphead wrasse

The reefs and cays of the Queensland Plateau began to develop around 25 million years ago on structural high points of the plateau, rather than through volcanic activity (Keene et al. 2008), suggesting that coral growth has kept up with the ongoing subsidence of the plateau (DiCaprio et al. 2010). It also suggests that the reefs were resilient to past sea level fluctuations (Keene et al. 2008). Global climate and regional tectonic history were the main drivers of reef initiation and growth in the Coral Sea. Analysis of past climatic conditions suggests that the rapid development of modern coral reefs occurred only during the last 400,000 years (Davies et al. 1989). Rising and high sea levels have been associated with periods of high carbonate production, resulting in overall reef growth, and falling sea levels have generally restricted carbonate production (Isern et al. 1996). During periods of lower sea level, a line of shelf edge reefs developed along the continental shelf – what is now the outer edge of the Great Barrier Reef – to be drowned as sea levels rose to present levels (Beaman et al. 2008). These drowned reefs now provide habitat for a rich benthic flora and fauna, and, together with the reefs of the wider Coral Sea, most probably provided the source of recolonising a newly flooded Great Barrier Reef between 8,000 and 6,000 years ago (Planes et al. 2001).

The geomorphic shape and zonation of the coral reefs and cays reflect the constant exposure to high energy wind and wave conditions. The reef around Herald Cay, which is probably representative of other Coral Sea cays, has an outer ridge made of cemented coralline algae, a wide reef flat surf zone with deep scour pools dominated by low-lying turf algae, and an inner belt of large reef blocks closer to the cay (Neil and Jell 2001). The cay itself has well-developed beachrock on the windward side where the beach appears to be in long-term retreat, and a back reef sand wedge on the leeward side, with highly mobile sand spits. Soil development on Coral Sea cays appears to be relatively rare, and is associated with the development of vegetation. North East Herald Cay may host one of the most complex vegetation assemblages of the Coral Sea, and consequently its soil development has attracted some scientific research. The soils are classified as "Inceptic Coral Calcarosols", and are composed primarily of calcareous sediment (Batianoff et al. 2008b). Organic content of the soils increases towards the centre of the cay and under the cover of well-developed plant communities (e.g. Pisonia forests). Burrowing wedge-tailed shearwaters and terrestrial invertebrate communities also contribute to soil development (Batianoff et al. 2008b; Greenslade 2008).

Climate and Oceanography

Climate and climate drivers

The prevailing climate in the Coral Sea has a 'wet' tropical weather pattern in the north and a 'dry' tropical climate in the central part. To the south, a subtropical element extends down to the Tasman Front, the oceanographic boundary between the Coral Sea and the Tasman Sea. Rainfall is highly seasonal and tends to be concentrated in the austral summer months, and temperature variability increases with latitude. Predominant south-easterly trade winds and seasonal tropical cyclones (Figure 5) play a large role in shaping the Coral Sea's terrestrial and shallow marine ecosystems (Wolanski 1982; Downey 1983). Climate and oceanography are closely linked in the Coral Sea, following the large-scale gradients in atmospheric pressure across the Pacific Ocean (see Text Box 1). Prevailing weather and current patterns are governed by the Interdecadal Pacific Oscillation (IPO) over decadal timescales, and by the El Niño-Southern Oscillation (ENSO) on an annual basis (Tudhope et al. 2001).

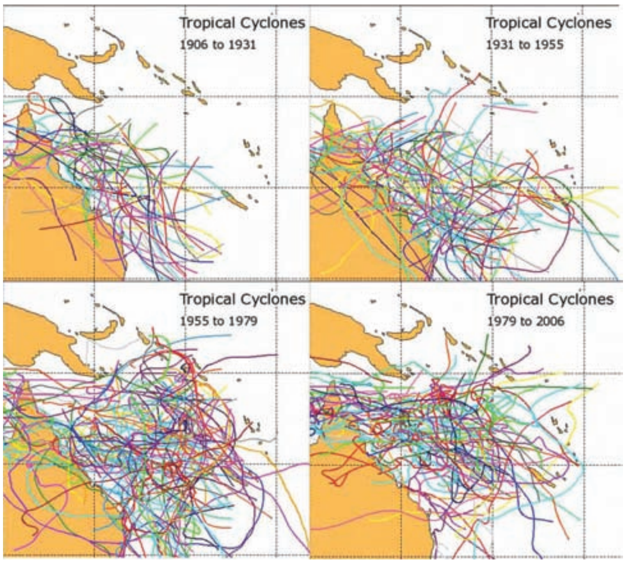


Figure 5. Cyclone track maps over the last 101 years, in 25–28 year intervals. From http://www.bom.gov.au/cgi-bin/silo/cyclones.cgi?region=ause&syear=1906&eyear=2006&cyclone=all&loc=0

Southern Oscillation Index (SOI): A cyclic pattern of Pacific-wide climate variability, calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin. Negative values of the SOI are consistent with 'El Niño' episodes, when there is sustained warming of the central and eastern tropical Pacific Ocean, a decrease in the strength of the Pacific Trade Winds, and a reduction in rainfall over eastern and northern Australia. Positive values of the SOI are associated with stronger Pacific trade winds and warmer sea temperatures to the north of Australia, popularly known as 'La Niña'. Waters in the central and eastern tropical Pacific Ocean become cooler during this time, and there is an increased probability that eastern and northern Australia experience higher rainfall than normal.

El Niño – Southern Oscillation (ENSO): In regular usage just called 'El Niño', translated from the Spanish for 'the boy-child'. The term El Niño refers to the extensive warming of the central and eastern Pacific that leads to a major shift in weather patterns across the Pacific. In Australia (particularly eastern Australia), El Niño events are associated with an increased probability of drier conditions. Changes to the atmosphere and ocean circulation during El Niño events include warmer than normal ocean temperatures in the central and eastern tropical Pacific Ocean, the eastward migration of cloud cover, weaker than normal easterly trade winds and low (negative) values of the SOI (Southern Oscillation Index).

Interdecadal Pacific Oscillation (IPO): A pattern of Pacific-wide climate variability that shifts in a cycle of 15–30 years, and affects both the north and south Pacific. During a "warm", or "positive", phase, the west Pacific becomes cool and part of the eastern ocean (around the Coral Sea) warms; during a "cool" or "negative" phase, the opposite pattern occurs.

Relevant Coral Sea research: Chemical (Sr/Ca) ratios and $\delta^{18}O$ measurements from a *Porites* coral core from Flinders Reef were used to reconstruct sea surface temperature (SST) and salinity fluctuations over the past 280 years (Calvo et al. 2007). Past variability in SST can help to explain past and current patterns in both the IPO and ENSO. A long-term trend towards warmer temperatures during the 20th century was detected, at a warming rate of approximately 1°C in 150 years, both on the GBR and in the Coral Sea. Cold phases of the IPO are associated with lower salinity in the Coral Sea, and also with higher rainfall over northeast Australia, suggesting stronger La Niña events during negative IPO phases. The reverse appears to occur during positive IPO phases. The decrease in rainfall during warm IPO phases translated into higher salinities in the Flinders Reef region. The most prominent feature registered at Flinders Reef, aside from the 20th century warming trend, was a prolonged period of raised average temperatures and salinities during most of the 18th century, possibly caused by lower wet season rainfall in Australia. On decadal timescales, northeast Australia has experienced alternate periods of warm/dry versus cool/wet conditions in phase with changes in the IPO (Calvo et al. 2007).

Text Box 1. General information on the closely related SOI, ENSO and IPO, with results of research from the Coral Sea from Calvo et al. (2007).

Weather and ocean current patterns in the Coral Sea are driven by Pacific-wide climate cycles such as the El Niño-Southern Oscillation (ENSO) Index.

Major ocean currents

The dominant ocean current of the Coral Sea is the South Equatorial Current, which travels westward and enters the Coral Sea as a series of 'jets' between southwest Pacific island groups (Figure 6) (Brewer et al. 2007). In the central Coral Sea (between ~14°S and ~18°S), the South Equatorial Current bifurcates to generate the southward-flowing East Australian Current (EAC) (Boland and Church 1981), and the Coral Sea Coastal Current (also known as the Hiri Current) that forms a strong clockwise gyre in the northern Coral Sea (Lyne and Hayes 2005; Schiller et al. 2008) (Figure 6). Around the zone of the South Equatorial Current's bifurcation point, there is an area of strong current inflow into the Great Barrier Reef (Andrews and Clegg 1989; Brinkman et al. 2001). The strength of the three major currents varies seasonally (Rochford 1958) and is dependent upon the annual strength of the Southern Oscillation Index (SOI) (Downey 1983).

There is also a seasonal component to the relative strength of the different jets of the South Equatorial Current (based on the effect of the tradewinds), but it is quite variable from year to year (Steinberg 2007). Most years, the westerly South Equatorial Current continues north through the Coral Sea to feed the Indonesian Throughflow in the Timor Sea during the winter months (April to November) (see also Scully-Power 1973). This flow is reversed during the summer (December to March), sending currents eastwards through the Timor Sea (Wyrtki 1960). Additionally, the EAC weakens during the austral autumn, and the bifurcation point of the South Equatorial Current moves from around 14°S during the austral summer to 18°S during the austral winter (Benzie and Williams 1992).

Geomorphic features interact with the ocean currents to alter flow speeds and directions (Dunn and Ridgway 2002; Ridgway and Dunn 2003). For instance, the Queensland Plateau interacts with the westward flow of the South Equatorial Current to create a zone of weak and highly variable currents between 14°S and 18°S in its lee, between the Queensland Plateau and the GBR shelf (Choukroun et al. 2010). Valleys at the Great Barrier Reef's northern shelf edge funnel cool and saline upwelled Coral Sea water onto the continental shelf (Harris and Hughes 2002). A deep (>100 m) clockwise eddy, originating from the EAC, circulates around the Marion Plateau (Midddleton et al. 1994).

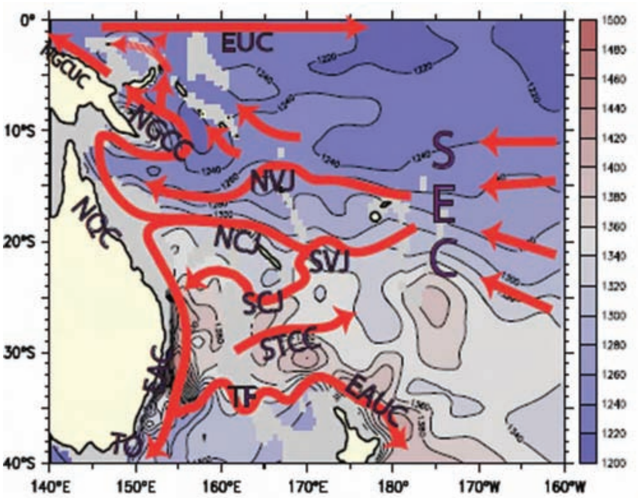


Figure 6. Major currents and jets of the Coral Sea. SEC: South Equatorial Current (SEC), splits into jets as it enters the region: North/South Vanuatu Jet (NVJ/SVJ), South/North Caledonian Jet (NCJ/SCJ). Currents within the region are the North Queensland Current (NQC), New Guinea Coastal (Under) Current (NGCC/NGCUC), and, to the south, the East Australian Current (EAC). The northern trajectory of the water is the Equatorial Undercurrent (EUC) through the Solomon Straits, and the southern pathway is the Subtropical Countercurrent (STCC), the Tasman Front (TF) and the East Auckland Current (EAUC), and the Tasman Outflow (TO). From Ganachaud et al. (2007).

Pink anemonefish

The dominant ocean current of the Coral Sea is the westerly South Equatorial Current, which enters the Coral Sea as a series of 'jets' between southwest Pacific island groups. In the central Coral Sea, the South Equatorial Current bifurcates to generate the southward-flowing East Australian Current, and the Hiri Current that forms a strong clockwise gyre in the northern Coral Sea.

The Coral Sea is widely known as being low in nutrients and productivity (oligotrophic) (Figure 7). However, interactions between oceanographic and topographic features create patches of higher productivity by directing cool water masses upwards, increasing planktonic activity and attracting higher-order consumers and predators. Productivity also changes seasonally and is higher in the dry season (the austral winter, coinciding with the migration of humpback whales through the region) than the summer wet season, especially in the northern Coral Sea (Lyne and Hayes 2005; Messie and Radenac 2006). Additionally, there are 'nutriclines' or subsurface layers rich in nutrients, at depths of between 50 and 140 m (Brewer et al. 2007).

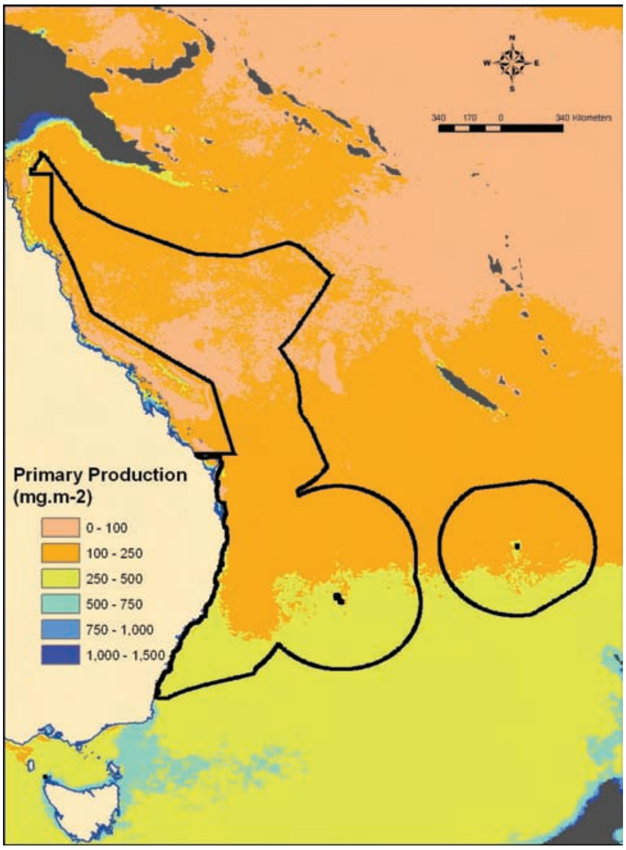


Figure 7. Spring estimates of primary productivity in the East Marine Region, including the Coral Sea. From Brewer et al. (2007).

The waters of the Coral Sea are generally low in nutrients, but high-productivity patches can occur in areas where ocean currents and seafloor topography interact. Marine life is attracted to waters around seamounts and reefs, or over troughs and canyons.

Discrete areas of enhanced local productivity are likely to occur in the lee of islands and reefs (Rissik et al. 1997), around seamounts (Morato et al. 2010), along the length of the EAC (Young et al. 2011), and over deep-sea canyons and shelf breaks (Hyrenbach et w al. 2000). Productivity is driven by different organisms in these areas; for instance, diatoms are the primary producers in the EAC and over seamounts, while flagellates are more abundant offshore (Hobday et al. 2011). Knowledge of the location of topographic and oceanographic features that typically attract marine life (Hyrenbach et al. 2000) exists for the Coral Sea, and initial research has mapped the broad distribution of pelagic aggregations and seabird foraging grounds that coincide with these features (Congdon et al. 2007; Morato et al. 2010).

Predicted climate change impacts

Climate change predictions for the eastern marine region of Australia include warming air and ocean temperatures, increasing sea levels and ocean acidification, changing sediment transport regimes around reefs and cays, increasingly intense storms and the possibility of changes to the major ocean currents (Hobday et al. 2006b; Lough 2008). Decadal trends analysed in 1979 already identified a warming Coral Sea (Edwards 1979), and more recently, long-term data from Willis Island show an 80-year trend of increasing minimum winter temperatures by +0.7 °C (Batianoff et al. 2008b). Precipitation has also changed: since 1990 there have been eight years with rainfall more than 100 mm below the long-term average, and a tendency for increased drought conditions has been documented at Coringa-Herald (Batianoff et al. 2008b).

Lawrence and Herbert (2005) suggest that sea surface temperature (SST) in the western Coral Sea changed by up to 1.5 °C during the past 800,000 years. Conditions in the austral summer months can be hot and still, causing ocean temperatures to rise dramatically (Oxley et al. 2003), and a recent 'State of the Climate' report identified the Coral Sea as having gained heat since 2008 (Arndt et al. 2010). Widespread coral bleaching took place in the Coral Sea in 1998 and in 2002 during periods of extremely high SST (Schiller et al. 2009), and recovery was variable among the only two reefs that have been comprehensively surveyed (Ceccarelli et al. 2008; Ceccarelli et al. 2009). Concerns about coral bleaching related to rising SST on the Great Barrier Reef and in the Coral Sea has led to the recent development of ReefTemp, a forecasting tool that monitors changes in temperature across the whole region (Maynard et al. 2007), and can be accessed by the public (http://www.cmar.csiro.au/remotesensing/reeftemp/web/).

Changes to storm regimes and current characteristics have also been noted. The Coral Sea is already host to the highest frequency of tropical cyclones in eastern Australia (Brewer et al. 2007). Analysis of the last 100 years' cyclone tracks (Figure 5) indicates a slight decline in the number of tropical cyclones in the Australian region, but a slight increase in the number of more intense cyclones (Emanuel 2005; Webster et al. 2005). The EAC is expected to experience a gradual poleward extension, changing its role in dispersal pathways within and beyond the Coral Sea (Ridgway 2007). A poleward range extension of marine organisms is expected closer to the shelf, because of a combination of the predicted strengthening of the current itself (Ridgway 2007) and the warming of the water mass it carries (Banks et al. 2010).

Climate change predictions for the eastern marine region of Australia include warming air and ocean temperatures, increasing sea levels and ocean acidification, changing sediment transport regimes around reefs and cays, increasingly intense storms and the possibility of changes to the major ocean currents. Minimum winter temperatures have already increased over the last 80 years. There are concerns that these changes will put further pressure on vulnerable marine species.

Sea level rise, which has not yet been measured in the Coral Sea, is expected to threaten low-lying cays and islets, therefore threatening significant nesting and roosting habitat for seabirds and marine turtles (Hobday et al. 2006b). Specific effects include erosion of the shoreline, inundation of low-lying areas and saline intrusion into the freshwater lens (Woodroffe 2008). The effects of increasing ocean acidity are not well understood, but may also have serious implications for the Coral Sea reefs, as reef-building organisms may suffer decreased rates of calcification and growth. Much of the exposed reef front habitat of the Coral Sea reefs is cemented together with crustose coralline algae (Ceccarelli et al. 2009). Recent work highlights that higher acidity would prove detrimental to the calcification of these algae (Lough 2008); higher acidity in the Coral Sea may therefore threaten the very framework of these reefs.

Code	Ecophysical sub-region	IMCRA4 region
1a	Cape Province sub-region	Cape Province Bioregion
1b	Coral Sea Abyssal Basin sub-region	Northeast Province (eastern half) and Northeast Transition (western half)
1c	Queensland Plateau sub-region	Northeast Province (eastern half) and Northeast Transition (western half)
1d	Marion Plateau sub-region	Northeast Province (northern two-thirds) and Central Eastern Transition (southern third)
1e	Northern Seamounts Field sub-region	Kenn Province and Kenn Transition

Table 3. Ecophysical sub-regions after Brewer et al. (2007) and relationship to previously established IMCRA4 regions.

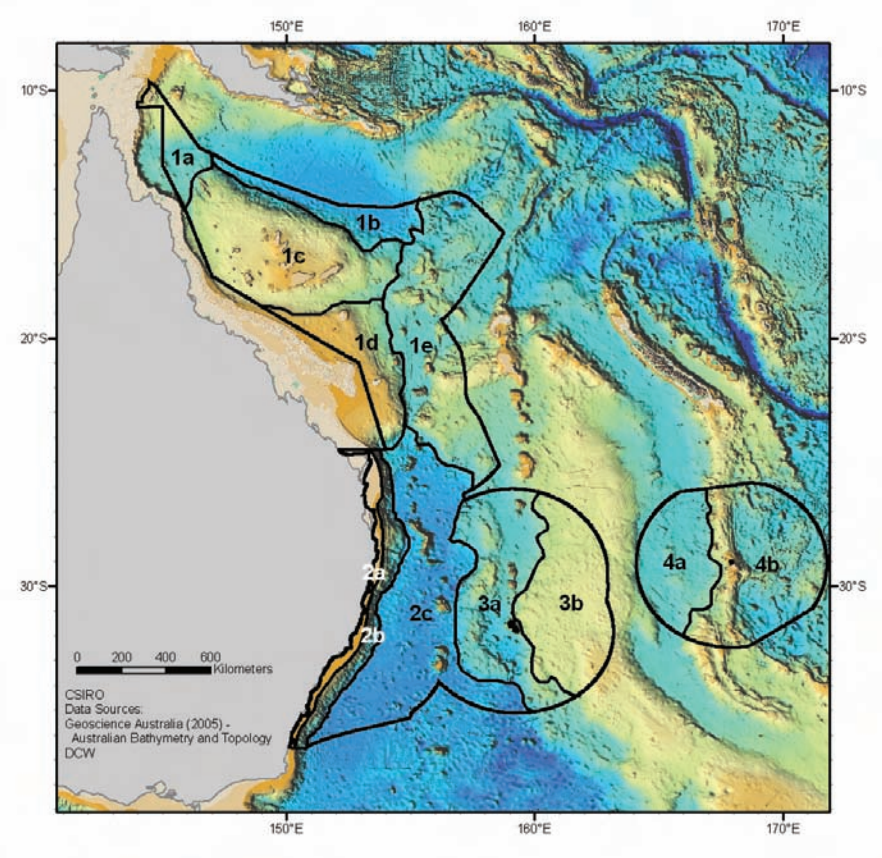


Figure 8. Sub-regions of the East Marine Region as defined by Brewer et al. (2007). Sub-regions relevant to the Coral Sea are 1a (Cape Province), 1b (Coral Sea Abyssal Basin), 1c (Queensland Plateau), 1d (Marion Plateau) and 1e (Northern Seamounts Field).

Bioregions and Provinces

Extensive reviews undertaken as part of the Australian Government's bioregional marine planning process have identified and described the bioregions of the East Marine Region, which includes the Coral Sea (Brewer et al. 2007). The ecophysical sub-regions developed by the authors were based on previous pelagic, demersal and benthic bioregionalisations (Last et al. 2005; Lyne and Hayes 2005). The Coral Sea includes the Cape Province, Coral Sea Abyssal Plain, Queensland Plateau, Marion Plateau and Northern Seamounts Field ecophysical sub- regions (Figure 8). These sub- regions bear some resemblance to the previously established IMCRA4 regionalisation (Table 3). The following sections present a summary of these sub-regions as described by Brewer et al. (2007), with additional information from current research.

Cape Province sub-region

The northernmost Coral Sea bioregion lies in the tropics between the boundary of the Great Barrier Reef Marine Park and Australia's Exclusive Economic Zone, extending north from around the latitude of Cooktown. On the seabed this sub-region is dominated by deep abyssal slope with widely spaced submarine canyons. The only shallow-water habitats are provided by Ashmore Reef and Boot Reef, rising from the Eastern Plateau in the far northern portion of the sub-region. Available habitats for demersal species therefore range from near-surface coral reefs to abyssal troughs and canyons exceeding 3,000 m. Demersal fish communities include 302 species, 24 of which were believed to be endemic during the latest assessment (Last et al. 2005). Undersea canyons can channel deep ocean currents upwards and create localised upwellings of high productivity (Hyrenbach et al. 2000).

The sponge communities found here represent a biogeographic transition between Cape York Peninsula and the Queensland Plateau (Hooper and Ekins 2004), but some shallow-water taxa show a strong affinity with the Torres Strait and the Arafura and Timor Seas further west (Endean 1957; Benzie 1998). Seasonal shifts in the South Equatorial Current (see Major ocean currents section above) are likely to enhance this connectivity.

In the deep sea, sediment grain size and the availability of nutrients through particulate organic matter from the pelagic system ('marine snow') are likely to be the strongest predictors of ecological communities. The cycling of this marine snow through bacterial and detrital food webs is likely to provide the primary trophic pathway in the deep slope environments. There is a distinct depth zonation in the dominant organisms that live in and on the sediments, and those that can tolerate the low-nutrient conditions (e.g. foraminiferans) tend to dominate the deep-sea detrital trophic webs (Alongi and Pichon 1988).

The type of substratum available is also thought to influence the nature of the benthic community, especially in deep-sea environments, making ecological communities typically sparse and patchy (Sarano and Pichon 1988). Smaller sediments may harbour burrowing and mobile taxa such as filter-feeders and detritivores (e.g. echinoderms, polychaetes, sea-pens), while coarser grain sizes and hard substrata may host attached taxa such as suspension-feeding, cold-water corals and sponges (Brewer et al. 2007). Fish and cephalopod species that associate with these benthic communities are usually strongly stratified by depth, based on studies conducted in the south-east marine region (Koslow et al. 1994), and are likely to include species that migrate vertically such as lanternfish (Myctophidae), hatchetfish (*Argyropelecus spp*.), dragonfish (*Melacosteus spp.*), viperfish (*Chauliodus spp*.) and a number of squid and eel species.

Hawksbill turtle

Pelagic communities in this sub-region are subject to warm (~27 °C) water, and pelagic species inhabiting this sub-region are primarily migratory predators (e.g. billfish, tuna, sharks and seabirds), with any resident populations restricted to the two coral reefs. Productivity in summer is slightly higher than in the central Coral Sea (Jitts 1965; Messie and Radenac 2006). The Hiri Current has been found to transport lobster larvae from the Gulf of Papua lobster spawning grounds into the Coral Sea Gyre and then by surface onshore currents into the Torres Strait (Dennis et al. 2001). Trophic webs in the pelagic realm are likely to be driven by phytoplankton, which is consumed by vertically migrating zooplankton (crustaceans, larval molluscs and fish), as well as jellyfish and salps. In shallower waters, near-surface pelagic species may also migrate vertically to access deeper-dwelling prey, which may in turn consume demersal or benthic prey or primary producers, depending on depth (Brewer et al. 2007).

The primary pathways of connectivity between this and surrounding sub-regions occur through the South Equatorial Current and its northern bifurcation. Depending on the season, larvae and adults may be transported to the Torres Strait and beyond into the Arafura and Timor Seas, while more mobile species such as tunas and billfish are known to enter the Coral Sea through this region and then travel south (Bromhead et al. 2004).

Coral Sea Abyssal Basin sub-region

To the east of the Cape Province sub-region, the Coral Sea Abyssal Basin sub-region covers a part of the abyssal basin that lies in tropical waters between Papua New Guinea and Australia's EEZ. The silt-covered abyssal plain that dominates this sub-region is over 4,000 m deep and is the least explored habitat. While the margins of the plain and the sparse deep-sea canyons may have scattered areas of hard substrate, fine silt derived from continental runoff and marine snow predominates. Very little is known about demersal and benthic ecological communities in this sub-region, but they are likely to be low-density, patchy and influenced by the distribution of sediment particle size and the availability of nutrients from marine snow and the carcasses of pelagic animals. These nutrients are likely to pass through trophic webs driven by detrital and bacterial pathways. Deep-sea communities of the abyssal plain are likely to be characterised by lower density and greater patchiness than slope communities, with research suggesting that foraminiferans and nematodes might dominate these assemblages (Alongi 1987). These benthic communities are likely to support very low abundances of bioluminescent, vertically migrating fish such as lanternfish (Myctophidae) and Grenadiers or rattails (Macrouridae) and hatchetfish (*Argyropelecus spp*.) (Brewer et al. 2007).

The South Equatorial Current and its seasonal shifts drive the pelagic habitat in this sub-region, and there are no shallow topographic features to interact with the flow of this major current. Productivity is generally low and the warm temperature (~26 °C) varies little with the seasons. Pelagic species found here are likely to be predominantly migratory, and made up of predators such as billfish, tunas and sharks, which rely on small cephalopods and fish that in turn feed on jellyfish, salps and vertically migrating plankton (see Text Box 2). The occasional presence of deep-sea canyons may occasionally serve to aggregate large migratory pelagic species (Brewer et al. 2007).

Queensland Plateau sub-region

The Queensland Plateau sub-region, particularly its shallow reef and island habitats, has drawn the bulk of the research effort. This sub-region lies in tropical waters and includes the Queensland Plateau, its outer slopes and large parts of the Queensland and Townsville Troughs, the deepest parts of which descend beyond 4,000 m. Most of the Queensland Plateau is less than 1,000 m deep, and emergent coral reef systems cover 10-15% of its area (Davies et al. 1989). The Coringa-Herald complex and Lihou Reef rise directly from structural high points of the plateau, while other reefs of this sub-region are the summits of pinnacles that rise from deeper waters (Flinders, Bougainville, Flora, Holmes and Osprey Reefs).

Shallow and pelagic habitats are affected most strongly by prevailing south-easterly trade winds and this sub-region receives the highest frequency of tropical cyclones. This has led to shallow ecological communities shaped to a large degree by high disturbance regimes (Ceccarelli et al. 2009). Demersal or reef-associated fish communities are strongly influenced by the variety and type of habitats available. In deeper environments, 441 demersal fish species, including 70 endemics, have been recorded (Last et al. 2005). The ecological communities of the Townsville and Queensland Troughs are likely to be driven by sediment grain size, down-slope movements of sediment and detritus, and nutrients are most likely supplied from shallower benthic and pelagic habitats. Recent research in the Townsville Trough has revealed large knolls formed by a catastrophic landslide on the continental slope. The knolls, named Gloria Knolls, are 200-300 m high and support cold-water coral communities (Beaman and Webster 2008; Beaman et al. 2009). These two troughs, which may harbour further geomorphic features such as knolls, offer habitat otherwise absent in the entire East Marine Region, and further exploration is likely to reveal unique species and communities (Brewer et al. 2007).

Striped marlin

This sub-region also hosts the bifurcation point of the South Equatorial Current, where it splits into the Hiri Current to the north, and the EAC to the south. Seasonally, this point shifts north or south, and currents vary in strength (Rochford 1958; Wyrtki 1960; Church 1987; Benzie and Williams 1992). The major currents interact strongly with the topographically complex bathymetry of the sub-region, affecting productivity, connectivity and dispersal in the pelagic realm (Ridgway and Dunn 2003). Pelagic habitats are characterised by warm, low-productivity waters, although there are pockets of higher productivity associated with shallow reefs and pinnacles, and chlorophyll concentrations rise in winter with the peak in prevailing south-easterly winds (Lyne and Hayes 2005). The waters of the Queensland Trough host a spawning aggregation of a species of deep-sea lanternfish (*Diaphus danae*) (Paxton and Flynn in prep). This lanternfish aggregation may support an annual spawning aggregation of yellowfin and bigeye tuna (McPherson 1988). Other pelagic predators such as seabirds and whale sharks have been anecdotally reported to be involved with the tuna aggregation event (Torelli 2010). Significant aggregations of billfish, particularly black marlin, occur in this sub-region. Migrations of pelagic species through the sub-region are slightly better understood than in the sub-regions further north.

The east-to-west movement of major currents has influenced the dispersal and genetic connectivity of organisms across the Coral Sea. The reefs of this sub-region have been suggested as possible dispersal stepping-stones between the western Pacific region and the Great Barrier Reef, particularly for species that require shallow habitat (Benzie and Williams 1992; van Herwerden et al. 2009). Additionally, this sub-region hosts the origin of the EAC, the main avenue of connectivity between tropical and southern subtropical regions, transporting both larvae and adults. The deeper waters of the Queensland and Townsville Troughs appear to pose dispersal barriers only to species with limited dispersal capacity (Planes et al. 2001; van Oppen et al. 2008). Reef sharks have been found to move across the deep waters of the Trough between Osprey Reef and the Great Barrier Reef (Heupel et al. 2010), suggesting that species with mobile larval or adult phases are less likely to become genetically differentiated. Successive surveys have noted that the reefs in this sub- region have distinct fish assemblages compared with the GBR, and that some common reef fish families are largely or completely absent from Coral Sea reefs (Ceccarelli et al. 2008; Ceccarelli et al. 2009).

Shark and divers

Marion Plateau sub-region

The Marion Plateau sub-region off the central Queensland coast and southern GBR includes the Marion Plateau with its two large reefs (Marion and Saumarez Reefs), and the eastern slope of the Plateau as it descends into the Cato Trough. This plateau, which is 100-600 m deep, is essentially a deeper extension of the Australian continental shelf (Keene et al. 2008) and is separated from the Queensland Plateau to the north by the Townsville Trough. The slope of the plateau is intersected by a number of canyons, and an un-named seamount exists near the sub-region's eastern boundary, but none of these have been studied. The underlying geomorphology, sediment grain size and the direction and strength of bottom currents are likely to be the primary influence on the distribution of ecological communities in this sub-region (Brewer et al. 2007).

Demersal communities in this sub-region are poorly known, and no comprehensive ecological data exist for the two reefs or the seamount. Significant biogeographic differences have been found between sponge communities of this sub-region and those of the adjacent southern Great Barrier Reef (Hooper and Ekins 2004). Outer shelf habitats support 441 demersal fish species, 243 of which occur in waters deeper than 200 m and 70 of which are endemic (Last et al. 2005). Benthic communities are likely to range from coral reef assemblages to deep-reef communities and sparser cold-water coral or sponge beds on deeper hard substrata, with filter-feeders and burrowing and mobile invertebrates dominating areas of soft sediment.

While not as heavily impacted as the Queensland Plateau sub-region, the Marion Plateau is also subject to prevailing south-easterly winds and regular tropical cyclones. Strong wind-driven waves and currents determine the distribution patterns of ecological communities, especially in shallow waters. Tidal movement is also a strong influence on geomorphic and ecological structure in this sub-region (Ehrenberg et al. 2006), and in deeper waters a slow eddy generated by the EAC has been discovered (Midddleton et al. 1994). Pelagic habitats are characterised by warm, low-productivity waters, although there are pockets of higher productivity associated with shallow reefs and pinnacles, which in turn attract zooplankton and secondary consumers such as jellyfish, salps, small fish and cephalopods. Turbulent water flow in the lee of Cato Island (see below) has been found to aggregate zooplankton (Rissik et al. 1997), which in turn attracts lanternfish (Rissik and Suthers 2000); these small mid-trophic level fish form a key component of pelagic food webs (Griffiths et al. 2010). Iconic pelagic species migrate through the sub- region. Connectivity between this and other regions is likely to be dominated by the EAC's southerly flow, although the clockwise gyre in deeper waters may cause some retention of larvae and adults (Midddleton et al. 1994). The strength of any connectivity between the Marion and Queensland Plateaux is unknown.

Northern Seamounts Field sub-region

The Northern Seamounts Field sub-region lies to the east of the Queensland Plateau and Marion Plateau sub-regions and includes the Kenn Plateau and the northern portion of the Tasmantid Seamount Chain, which includes its oldest seamounts (McDougall and Duncan 1988). Shallow reefs where pinnacles approach the surface in this sub- region include Mellish Reef, Frederick Reef, Kenn Reef, Wreck Reef and Bird and Cato Islands Reef. The most notable seamounts are Cato Seamount, Wreck Seamount and Kenn Seamount (Exon et al. 2006).

Benthic and demersal communities are likely to be highly dependent on the underlying geomorphology, with distinct shifts between plateau, slope, canyon, seamount and reef environments. The supply of pelagic carbonates appears to be an important driver of the deep sea floor on the Kenn Plateau (Exon et al. 2006). Seamounts and reefs in this sub-region have not been adequately described, and seamount communities have only been described for southern seamounts of the Tasmantid Seamount Chain (Williams et al. 2006). Seamounts tend to host vulnerable ecological communities made up of sponges, cold-water corals and other sessile invertebrates, which provide food and habitat for a rich demersal fauna that is, in turn, preyed upon by deep-diving pelagic species.

Knowledge gathered from other seamounts, even within the same biogeographic region, must be generalised with caution, as seamount assemblages are often unique to individual seamounts (Richer de Forges et al. 2000). No data exist for the demersal fish community of this sub-region, but a biogeographic affinity exists with New Caledonia (Heap et al. 2005).

The strongest influences on the pelagic realm in this sub-region include the westward-flowing South Equatorial Current, the southerly EAC coming off the Marion Plateau, tidal flow from the GBR and a gyre in the area of Cato Island and Kenn Reef. There is likely to be significant interaction between these oceanographic features and the underlying topography of the seamounts and the Kenn Plateau (Brewer et al. 2007). Billfish and other large pelagic predators are known to aggregate around the seamounts (Morato et al. 2010), as the turbulence around reefs, islands and seamounts often promote higher productivity (Rissik and Suthers 2000). The highly migratory species typically attracted to such high-productivity patches provide significant connectivity pathways as they migrate through the sub- region to adjacent regions (Brewer et al. 2007). Levels of connectivity between the reefs of this sub-region and those of adjacent sub-regions of the Great Barrier Reef are unknown.

Physical–Ecological Linkages

The Coral Sea's ecology is largely shaped by physical forces such as climate and weather patterns, the direction and strength of currents, the shape of the underlying seabed, and the interaction between water movement and seafloor topography. These forces affect the distribution of species, the availability of nutrients and prey, the levels of disturbance experienced by ecological communities and their ability to recover from natural and human pressures and impacts.

Climate and weather patterns are especially important in shaping ecological communities in shallow waters, such as coral reefs, shoals and seamounts that reach into near-surface waters and terrestrial communities on islets and cays. Reefs of the Coral Sea are typically exposed to high disturbance regimes, leading to communities with robust and low-lying morphologies that offer little shelter to surrounding mobile organisms (Done 1982; Ceccarelli et al. 2008). On land, cay vegetation consists to a large extent of pioneering species capable of withstanding high disturbance regimes (Batianoff et al. 2008b).

The harsh environment is compounded by the propensity of the Coral Sea to experience a high frequency of tropical cyclones (Brewer et al. 2007) and periods of elevated ocean temperatures (Oxley et al. 2004b). This creates ecological communities in which the cycle of disturbance and recovery occurs rapidly, with little chance of reaching highly diverse or established climax communities. The ecology in the deep ocean is somewhat buffered from weather and climate fluctuations, but seasonal and long-term changes to ocean currents can have repercussions on the deeper water masses that drive deep-sea ecology (Hobday et al. 2006a).

Terrestrial and shallow-water ecological communities in the Coral Sea experience harsh environmental conditions. Wind, waves and isolation have shaped a tough, pioneering assemblage, with most species dependent on long-range dispersal and self-seeding.

Ocean circulation can affect ecological communities at all depths, by transporting food and assisting migration of pelagic species and dispersal of larval organisms. In the Coral Sea, the large-scale westerly movement of the South Equatorial Current means that ecosystem recovery after disturbance cannot be assisted with larval sources from the Great Barrier Reef. Small-scale hydrodynamics are not well-understood in the Coral Sea, but it is expected that there is some connectivity to western Pacific habitats, while many shallow reefs and patchy deep-sea environments are reliant on either long-range dispersal (Noreen et al. 2009) or self-seeding (Ayre and Hughes 2004; Smith et al. 2008b). It is likely that Coral Sea populations act as stepping-stones for dispersal westwards from the Pacific (van Herwerden et al. 2009), or as sources for populations further south, connected through the EAC (Zann 2000). For example, populations of coral trout found on the Great Barrier Reef have been shown to be genetically connected to populations of the same species in New Caledonia (van Herwerden et al. 2009). Grey reef sharks, which generally display a high degree of site fidelity, have recently been found to undertake long-distance movements, suggesting a degree of mixing between Coral Sea and Great Barrier Reef populations (Heupel et al. 2010). However, there is a distinction between genetic evidence of connectivity, which can result from very low rates of interchange of individuals, and connectivity that maintains and replenishes populations, which requires a much greater degree of movement of individuals. The latter has yet to be demonstrated in the Coral Sea.

Corals

The distance between similar habitats, habitat size and geomorphology, and sediment characteristics have all been shown to be important determinants of the abundance and distribution of organisms (Brewer et al. 2007; Beaman 2010b). Habitats in the Coral Sea are relatively isolated from each other. This is typical in the case of deep-sea environments everywhere, where patches of suitable habitat are generally separated by large distances over featureless expanses of bare substrate (Glover and Smith 2003). In this region it also holds true for shallower habitats such as coral reefs, which are much more isolated from each other than the closely connected network of the adjacent Great Barrier Reef. Habitat size and diversity is well-known to affect species diversity (Heatwole 1971; Harvey et al. 2009), and using geophysical data to predict ecological diversity is increasingly used on broad spatial scales (Beaman and Harris 2007). For instance, plant species richness is greater in the Coringa-Herald/Willis Island region, where cays are larger and have significant soil development (Batianoff et al. 2008b), than on the smaller Lihou Reef cays (Harvey et al. 2009).

In other areas, geomorphic features in deeper habitats were the primary drivers for the composition and density of ecological communities on deep reefs and on abyssal slopes and plains (Alongi 1987; Sarano and Pichon 1988).

Physical interactions between ocean currents and topography also create distinct patches of habitat or variations in ocean productivity. For instance, the disturbance in current flow in the lee of reefs and islands significantly affects primary productivity and primary consumers such as zooplankton (Rissik et al. 1997), further affecting the feeding ecology of lanternfish, and therefore the availability of prey to larger predators (Rissik and Suthers 2000). Large gyres have been documented around the Queensland Plateau and the Marion Plateau, which are likely to affect the connectivity of these areas with adjacent regions or sub-regions, potentially creating barriers to dispersal and pockets of endemicity (Brewer et al. 2007).

Biological Characteristics

Overview

Biological communities of the Coral Sea include terrestrial communities of sandy cays and islets, shallow-water coral reefs, seamounts and pinnacles, benthic communities at depths that range from hundreds to thousands of metres on hard and soft substrates, and pelagic communities from the ocean's surface to depths of over 4,000 m. Only a small portion of some of these ecosystems has been studied.

There are 49 small cays and islets in the Coral Sea, and most remain largely unexplored.

Terrestrial communities

There are 49 small cays and islets in the Coral Sea, making up a tiny portion of the entire area. The extent of vegetation and terrestrial community development is unknown for most. Nevertheless, on a small number of cays these are some of the best-studied environments of the Coral Sea, thanks to long-term monitoring programs focusing on vegetation, insects and seabirds (Baker et al. 2008; Greenslade 2008; Batianoff et al. 2010). In particular, the cays of Coringa-Herald are the site of perhaps the most comprehensive surveys of the terrestrial flora of isolated oceanic sand cays in Australian waters (Batianoff et al. 2010).

The Herald Cays host at least 30 species of plants and include 15% of Australia's *Pisonia grandis* forests.

Of those cays of Coringa-Herald, Lihou Reef, the Willis Island group and the Diamond Islets that have been surveyed, only a subset are known to be vegetated. Even unvegetated cays harbour life; seabirds roost and nest there, and turtles lay their eggs above the high tide mark (Harvey et al. 2009). The seabirds provide the main source of energy on these cays, through their guano, eggs and carrion, supporting simple food webs of terrestrial and intertidal invertebrates (Heatwole 1971). Vegetated cays support a greater abundance of life, and over time facilitate the development of soil, which in turn provides habitat for more complex plant communities (Batianoff et al. 2008b).

At least 30 species of plants occur on the Coringa-Herald cays, making up 17 distinct vegetation communities. Approximately 70% of plant species are of wider Melanesian provenance, and are essentially a subset of species found in mainland habitats of similar type and latitude (Batianoff et al. 2008b). Species richness of plants varies little across the cays: 12 species were recorded on South West Herald Cay and Coringa Islet, 13 species on Chilcott Islet, 14 on North East Herald Cay and 17 on South East Magdelaine Cay (Batianoff et al. 2008a). It is likely that these species were dispersed along prevailing currents, such as the east-to-west South Equatorial Current, surface currents driven by the south-easterly trade winds and seasonal monsoon winds, and migratory seabirds (Batianoff et al. 2008b). Human visitation has been a vector for plant dispersal especially on Willis Island, where there is a permanent, staffed weather station, but thanks to strict quarantine regulations, this has not had any significant effect on the spreading of weeds (Batianoff et al. 2009).

The native vegetation of Coral Sea cays has evolved without fire regimes, grazing by animals or common insect predation. As a result, some keystone species such as *Pisonia grandis* have not developed resistance to mainland pests such as scale insects (Batianoff et al. 2008b), and have been subject to dramatic impacts from these pests (Batianoff et al. 2009). Introduced pests are most likely to be introduced to the Coral Sea's terrestrial environments by humans. The Coringa-Herald cays have been subject to pest invasions in the past, causing lasting damage on some of the cays (Greenslade 2008). This has included rats (*Rattus rattus*) preying upon seabird eggs and chicks, especially on Coringa Islet, and scale insects devastating Pisonia forests on a number of the Coringa-Herald cays (Smith and Papacek 2001). A number of expeditions have been carried out specifically to exterminate pests (Weston et al. 1991; Smith and Papacek 2002). The infestation of scale insects also led to a shift in community structure in the invertebrate fauna (Greenslade and Farrow 2007).

The terrestrial flora and fauna of the Coral Sea cays are typical of highly exposed, small and remote Indo-Pacific and Melanesian islands. The number of plant species present at any given time on the Coringa-Herald cays is dependent on immigration, survival and extinction rates. Plants provide crucial habitat for insects and nesting seabirds, which in turn enrich the soil.

Grey reef sharks

Terrestrial invertebrates have been a matter of interest, both in relation to studies of long-range dispersal (Farrow 1984) and as a result of the insect pests on *Pisonia* trees (Greenslade 2008). The Guinea ant (*Tetramorium bicarinatum*) was found to be a key driver of these communities, acting as an indicator of active, above-ground invertebrates on these islands (Greenslade and Farrow 2008). There were differences in the invertebrate communities between groups of cays, driven by dispersal capacity, soil composition and moisture content, and the composition of vegetation communities (Greenslade and Farrow 2008). Similarly to Coringa-Herald, considerable variability was found in the invertebrate communities of the four surveyed vegetated cays of Lihou Reef (Harvey et al. 2009). The cover of particular plants was the best predictor of the composition and abundance of invertebrates. Most invertebrates were generalist feeders, forming a complete and self-sustaining food web (Harvey et al. 2009). Unlike Coringa-Herald, no pest species were recorded on Lihou Reef. The vegetation status and terrestrial invertebrate communities on other Coral Sea cays remain unexplored.

The terrestrial flora and fauna communities found on the Coral Sea cays are typical of highly exposed, small and remote Indo-Pacific and Melanesian islands (Batianoff et al. 2008b). The number of plant species present at any given time on the Coringa-Herald cays is dependent on immigration, survival and extinction rates, all of which are likely to have a high turnover (Greenslade 2008). Keystone species are potentially more important in this harsh environment in their role of promoting or protecting biodiversity. On coral cays, the keystone species of plants are those that are abundant and resilient enough to provide consistent habitat for other species of plants and animals; on the Coringa-Herald cays eight species have been identified as those most important for providing a plant cover that reduces temperature, wind and moisture stress for other species (Batianoff et al. 2008b). The presence and abundance of these species further affects the functional and species diversity of terrestrial invertebrates and vertebrates (Harvey et al. 2009). Conversely, the threat of pest outbreaks, thought to be in part related to climate variability, can threaten ecosystem balance and biodiversity (Greenslade 2008).

Coral reefs

Together with terrestrial communities, the Coral Sea's coral reefs are perhaps the best-studied of its habitats, despite the fact that only four of 18 reef systems – Coringa-Herald, Lihou Reef, Osprey Reef and Flinders Reef – have been subject to extensive ecological surveys. One of the most striking observations in the more recent surveys has been the high variability in cover and diversity of live coral between reefs, with very low cover at Coringa-Herald, considerably higher cover at Lihou Reef (Oxley et al. 2003; Ceccarelli et al. 2008) and coral cover comparable to the Great Barrier Reef at Osprey Reef (Andrews et al. 2008). The last survey of Flinders Reef took place in the 1980s, making it difficult to ascertain its present condition (Done 1982; Williams 1982). The remoteness of the Coral Sea reefs and cays means that in-depth studies are difficult, and therefore the tracking of temporal dynamics is in its infancy.

Shallow benthic communities of Coral Sea reefs are defined by the level of exposure or shelter from prevailing wave action. Highly exposed reef fronts are dominated by crustose coralline algae and low turf algae on limestone pavement (Done 1982), which can result in a relatively featureless habitat structure. This has affected the fish communities, so that the highest density and diversity tends to be found in more sheltered and structurally complex habitats. Surveys conducted at Coringa-Herald in 2006 and 2007, which largewly lacks sheltered habitat, found that overall live coral cover was only 7%, and species richness was low for benthic organisms and fish (Evans et al. 2007; Ceccarelli et al. 2008). Historical surveys and accounts suggest that while cover was always low, it was closer to 20–30% during the 1980s (Done 1982; Byron et al. 2001). In contrast, Lihou Reef had markedly higher live coral cover (~15%) and fish density than Coringa-Herald, probably coinciding with higher levels of shelter and overall habitat diversity. Even higher coral cover of between 30 and 60% was recorded by Reef Check on Osprey Reef in 2006 and 2007 (Andrews et al. 2008). It is unknown to what extent this is applicable to other reefs in the Coral Sea. Ongoing monitoring of benthic communities, with a focus on coral bleaching, is conducted at Osprey Reef by Reef Check (Andrews et al. 2008) and at Osprey Reef by CoralWatch (http://www.coralwatch.org/web/guest/home1).

Seamounts, pinnacles and deep reefs

Deep environments of the Coral Sea remain virtually unexplored. Efforts are underway to address this gap in knowledge, especially at Osprey Reef. Successive studies using submersibles and remotely operated vehicles have provided detailed descriptions of species and habitats (Sarano and Pichon 1988). Benthic communities are found to be patchy, and their composition is heavily influenced by the underlying geological structure (Beaman 2010b). Very little information exists on the seamounts of the Coral Sea. Investigations of seamounts to the south and west uncovered seamount fauna with very restricted distributions, with seamounts within the same chain exhibiting very different species assemblages (Richer de Forges et al. 2000; Williams et al. 2006).

The recently completed Deep Down Under Expedition (www.deepdownunder.de) was a collaboration between German Universities, Project Deep Ocean Australia and the Queensland Museum. The data collected during the expedition at Osprey Reef and Shark Reef is currently being analysed, but has already revealed species new to science from both deep and shallow habitats (e.g. Woerheide et al. 2000; Luter et al. 2003), "living fossils" from the deep slopes, such as rock sponges (Lithistids), glass sponges (important contributors to reef-building during the Mesozoic), brachiopods, sea lilies, and *Nautilus* (Woerheide and Reitner 1996; Reitner et al. 1999a, 1999b; Dunstan et al. 2010). The life history of deep-sea organisms often renders them particularly vulnerable to environmental impacts and exploitation (Glover and Smith 2003; Williams et al. 2010).

Shallow Coral Sea reefs are defined by the level of exposure or shelter from prevailing wave action. Highly exposed reef fronts are dominated by crustose coralline algae and low turf algae on limestone pavement, which can result in a relatively featureless habitat structure. Sheltered reef areas have higher cover of coral and greater habitat complexity. This has affected the fish communities, so that the highest density and diversity tends to be found in more sheltered and structurally complex habitats.

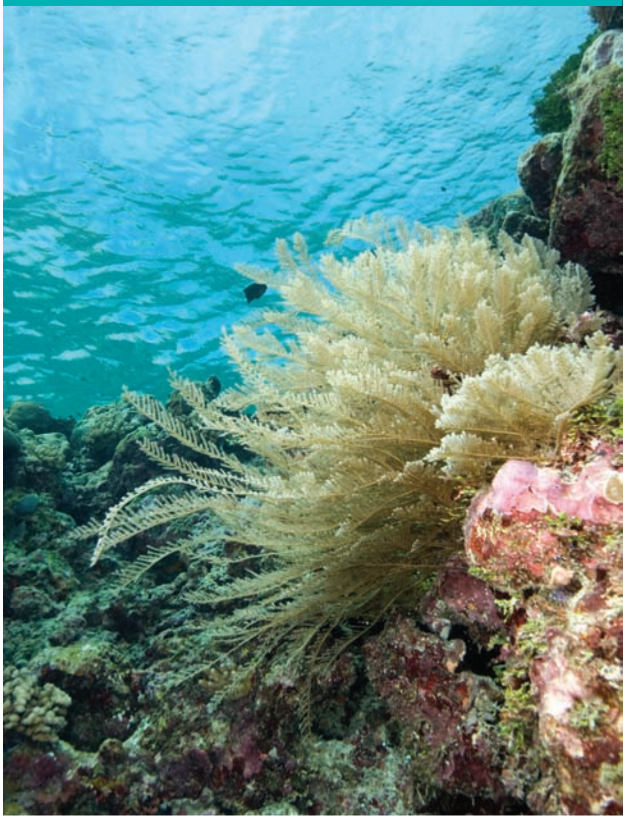
The deep sea

The only knowledge of biological communities in the Coral Sea's deep-sea environments comes from three projects, one studying knolls in the deep waters of the Queensland Trough (Beaman and Webster 2008), and two investigating abyssal benthic communities along a transect from the edge of the continental shelf to the deep-sea floor (Alongi 1987; Correge 1993). Investigations of knolls in the Queensland Trough in approximately 1,170 m of water found a unique cold-water benthic community consisting of live octocorals, dead scleractinian corals, bamboo corals, barnacles, gastropods, pteropods and hard nodules (Beaman et al. 2009). The knolls were named Gloria Knolls, and were most probably created by an ancient catastrophic landslide on the continental slope (Beaman and Webster 2008). Radiocarbon dating on the fossilised corals indicated ages ranging back to about 45,000 years ago, suggesting that the Holocene was an era of favourable conditions for prolific growth of benthic communities (Beaman et al. 2009). Soft sediment communities in the abyssal depths are shaped by a combination of depth gradients, temperature changes, food availability and disturbance regimes (Alongi 1987; Alongi and Pichon 1988; Alongi 1992). At a large scale, the species composition of deep-sea benthic organisms is also shaped by the major water masses that dominate the deep ocean layers (Correge 1993).

The pelagic realm

Pelagic ecological processes interact strongly with oceanographic features at a range of scales: from migrations and larval dispersal events that depend on major ocean currents; to the hydrodynamics that affect Coral Sea habitats and their links to the Great Barrier Reef and the wider Pacific; to small-scale studies of how water movement interacts with geological features such as reefs (Ridgway and Dunn 2003; Lyne and Hayes 2005). For instance, the disturbance in current flow in the lee of reefs and islands significantly affects primary productivity and primary consumers such as zooplankton (Rissik et al. 1997), further affecting the feeding ecology of lanternfish, and therefore the availability of prey to larger predators (Rissik and Suthers 2000). In turn, complex interactions between oceanographic features and ecological processes such as predation affects the population structure of organisms at the base of the food chain, such as krill (Taylor et al. 2010). The composition of species in different trophic groups appears to change between the southern Coral Sea and the northern Tasman Sea (Revill et al. 2009), and the identity of prey species is driven by the shift from oligotrophic Coral Sea and East Australian Current waters to the more nutrient rich offshore and southern waters of the Tasman Sea (Young et al. 2006).

Soft coral



Pelagic fish communities are difficult to study, and have been mostly subject to fisheries research. Comprehensive community-level studies on pelagic fish and trophic webs have been conducted in southern Coral Sea waters, using stable isotope analysis to determine the food web hierarchy between major predators and their prey (Revill et al. 2009). This study distinguished between three major trophic groupings (Figure 9):

1. A "top predator" group, consisting of large billfish (broadbill swordfish, *Xiphias gladius* and striped marlin, *Tetrapturus audax*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*) and southern bluefin (*Thunnus maccoyii*) tuna and shortfin mako shark (*Isurus oxyrinchus*);

2. A second group of mid-trophic level predatory fishes including albacore tuna (*Thunnus alalunga*), lancet fish (*Alepisaurus ferox*), mahi mahi (*Coryphaena hippurus*) and squid; and

3. A prey grouping of small fishes including lanternfish, small scombrids, nomeids and macroamphosids (Revill et al. 2009).

They also found a distinct shift in the identity of species making up each group between the nutrient-poor Coral Sea and nutrient-rich Tasman Sea waters, suggesting that these results may not be representative of the northern or eastern portions of the Coral Sea, where such studies are yet to be conducted.

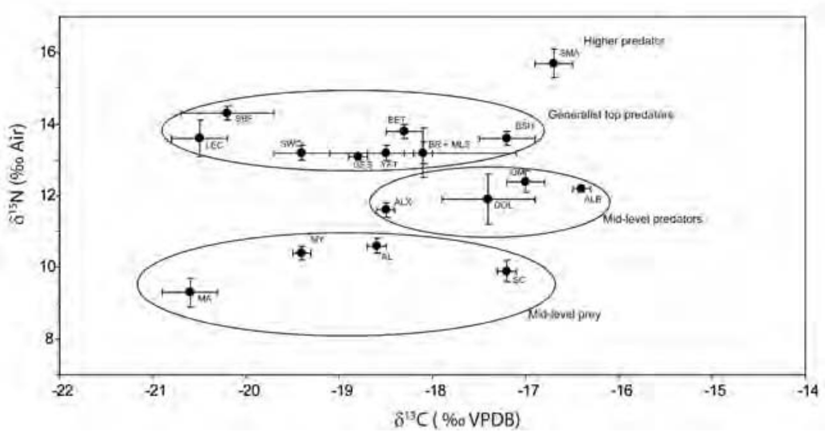


Figure 9. Results of analysis on stable isotopes in fish caught during longlining operations in the southern Coral Sea and Tasman Sea, showing major trophic groupings. SMA: shortfin mako shark, SBF: southern bluefin tuna, LEC: escolar, SWO: broadbill swordfish, GES: snake mackerel, YFT: yellowfin tuna, BET: bigeye tuna, BR: Bramidae, MLS: striped marlin, BSH: blue shark, ALX: lancetfish, DOL: dolphinfish, OM: ommastrephid cephalopods, ALB: albacore tuna, MA: trumpetfish, MY: myctophid fish (lanternfish), AL: juvenile lancetfish, SC: scombrid fish. From http://www.cmar.csiro.au/biochemicaltracers/documents/11Jock-Young.pdf

Iconic Species

Marine mammals

At least 28 species of dolphins and whales frequent the Coral Sea (Appendix 1). There are indications that the Coral Sea is an important migration corridor for some cetaceans, and that there are pockets of habitat for other species, but very little research exists on marine mammals in the Coral Sea. Some research on humpback whale migrations is undertaken by Opération Cétacés in New Caledonia, but movement between New Caledonian wintering grounds and the east Australian migration corridor are very rare (Garrigue et al. 2000; Garrigue et al. 2010). A long-term study has followed the dynamics of a population of dwarf minke whales (*Balaenoptera acutorostrata*) on the northern Great Barrier Reef which most probably extends into the Coral Sea Conservation Zone (Arnold et al. 2005).

Studies on the mitigation of depredation of longline catches by toothed whales indicate that false killer whales (*Pseudorca crassidens*) and short-finned pilot whales (*Globicephala macrorhynchus*) have historically been responsible for most longline losses in the Coral Sea (McPherson et al. 2003). The relative levels of depredation by the two species varied over time, suggesting that there may be long-term fluctuation in their populations within the Coral Sea. Other species observed in the Coral Sea in relation to longline depredation events include killer whales (*Orcinus orca*), sperm whales (*Physeter macrocephalus*), pygmy killer whales (*Feresa attenuata*) and melon-headed whales (*Peponocephala electra*). Fishing crews allegedly reported pods of up to 400 melon-headed whales and pods of between 10 and 400 false killer whales in the Coral Sea (McPherson et al. 2003), while two visual and acoustic surveys totalling six weeks recorded approximately 700 individual whales (of which 13 were beaked whales) in the southern Coral Sea (Cato et al. 2010). The visual component of this survey yielded records of spinner dolphins (*Stenella longirostris*), Fraser's dolphins (*Lagenodelphis hosei*), bottlenose dolphins (*Tursiops truncatus*), melon-headed whales (*Peponocephala electra*), pilot whales (Globicephala sp.), false killer whales (*Pseudorca crassidens*), sperm whales (*Physter macrocephalus*), humpback whales (*Megaptera novaeangliae*) and minke whales (*Balaenoptera acutorostrata*) (Dr S. Gibbs, pers. comm. 2011).
Despite limited information, it appears that toothed whales congregate around the black marlin spawning aggregation in the northwestern Coral Sea between October and December (McPherson et al. 2003). The rare Omura's whale (*Balaenoptera omurai*), closely related to Bryde's whale (*Balaenoptera edeni*) has been recorded in the Coral Sea (near the Solomon Islands, outside the Coral Sea Conservation Zone), but the importance of this area to the species is unknown (Miller 2009).

Humpback whales and dwarf minke whales frequent Coral Sea waters, and a number of toothed whale species are known to occur there, sometimes in pods of hundreds of individuals.

The distribution of beaked whales, a group of toothed whales noted for their elongated snouts, has been studied in a 18,900 km^2 area of the Coral Sea east of Fraser Island (Cato et al. 2010). Data collected by this project is still in the process of being analysed, but thousands of toothed whale clicks were recorded, of which a small proportion were identified as being typical of beaked whales. These were recorded primarily around the steep slopes of Cato Island and Wreck Reef. The frequency of the clicks was found to be consistent with those produced by Cuvier's and Blainville's beaked whales (Cato et al. 2010).

The Coral Sea is known to be a habitat for humpback and dwarf minke whales; summer sightings of humpback whales in the Coral Sea suggest that some individuals may not migrate south each year, or that they may be late migrants (Bannister et al. 1996). The population of humpback whales migrating along Australia's eastern waters (Group V) are genetically distinct from the population off Western Australia (Group IV). It is thought that the Group V whales split into two sub-groups as they migrate north from Antarctica, with one group remaining close to the coast and the other moving well into the Coral Sea and towards New Caledonia to breed. In the late 1950s and early 1960s, whaling reduced the ~10,000-strong Group V population to an estimated 500 individuals, and recovery since the 1963 humpback whaling ban has been slow (Vang 2002).

The Coral Sea cays function as critical habitat for green turtles, providing important nesting grounds for turtles arriving from foraging grounds as far away as the Torres Strait and Papua New Guinea. Hawksbill and loggerhead turtles forage around the shallow Coral Sea reef habitats and migrate through its waters. The Coral Sea also functions as an important migratory route for many turtle species.

Humpback whale

Turtles

Six of the world's seven species of marine turtle are known to occur in the Coral Sea Conservation Zone: the green turtle (*Chelonia mydas*), the hawksbill turtle (*Eretmochelys imbricata*), the loggerhead turtle (*Caretta caretta*), the leatherback turtle (*Dermochelys coriacea*), the flatback turtle (*Natator depressus*) and the Olive Ridley turtle (*Lepidochelys olivacea*). The reefs and cays of the Coral Sea provide habitat for a number of marine turtles, especially the green turtle (*Chelonia mydas*), supporting nesting, foraging and migratory populations. The annual monitoring of nesting green turtles on the Coringa-Herald cays between the early 1990s and 2005 found a regional fidelity in nesting females, where they would return to the same general area, but not necessarily to the same cay or beach (Harvey et al. 2005). It was found that 75% of tagged green turtles returned within a 4–6 year period, but after the 2002/2003 nesting season, the surveys were discontinued due to logistic constraints (Harvey et al. 2005). A preliminary survey at Lihou Reef identified very high densities of nesting turtle tracks, and what could be a 'turtle graveyard' on an unvegetated cay (Harvey et al. 2009). A broad-scale study of the population genetics of the green turtle investigated populations from Australian and Southeast Asian waters (Moritz et al. 2002). This study found that turtles from the Coral Sea cays formed a distinctive genetic group, which forms part of the Papua New Guinea/Torres Strait harvest. The need for international management strategies has been highlighted (Harvey et al. 2005), and there is a need for population-level studies of other species of turtles in the Coral Sea, as well as surveys to identify other critical nesting and foraging habitats.

Distinct migration routes can be difficult to determine, possibly because each breeding population of green turtles was recently found to travel to multiple breeding grounds (Dethmers et al. 2010). Green turtles may migrate through the Coral Sea between inshore Queensland foraging grounds and nesting beaches in New Caledonia and Vanuatu. While other species of marine turtles have not been found to nest in the Coral Sea, they may migrate through these waters. Loggerhead turtles (*Caretta caretta*) travel from Eastern Indonesia, Papua New Guinea, the Solomon Islands, New Caledonia and the Northern Territory to nest on the Queensland coastline. Leatherback (*Dermochelys coriacea*) and Olive Ridley (*Lepidochelys olivacea*) turtles appear in longline bycatch records, and travel through the Coral Sea to forage in Australian waters. Additionally, a small number of hawksbill turtles forage around Coral Sea reefs (Tzioumis and Keable 2007). Female hawksbill turtles (*Eretmochelys imbricata*) undertake migrations from eastern Australian waters through the Coral Sea to Vanuatu, the Solomons and Papua New Guinea, and waters around the Coringa-Herald cays offer foraging habitat for them (Figure 10) (Miller et al. 1998). Major ocean currents are likely to play an important role in the migration of hatchlings (Figure 11). Recent research has found genetic connectivity between loggerhead turtle rookeries in the southwest Pacific and post-hatchlings caught in longlines in the eastern Pacific. There is strong evidence for the southward migration of hatchlings along the EAC (Boyle et al. 2009). There is therefore strong evidence that the Coral Sea provides migration and dispersal corridors for a number of turtle species.

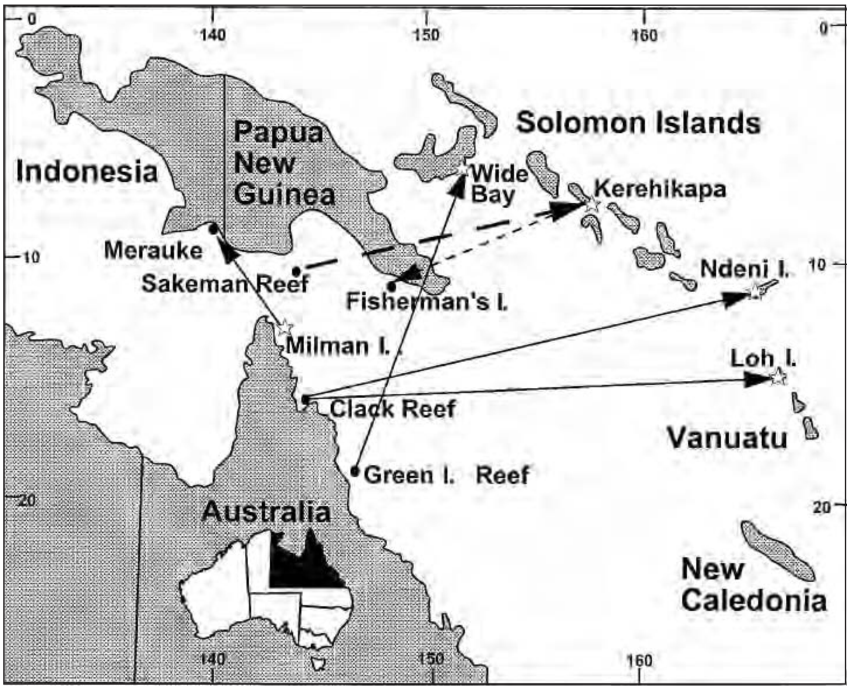


Figure 10. Migrations by adult female hawksbill turtles, *Eretmochelys imbricata*, in the Coral Sea region. Filled circle: foraging area; star: nesting beach. From Miller et al. (1998).

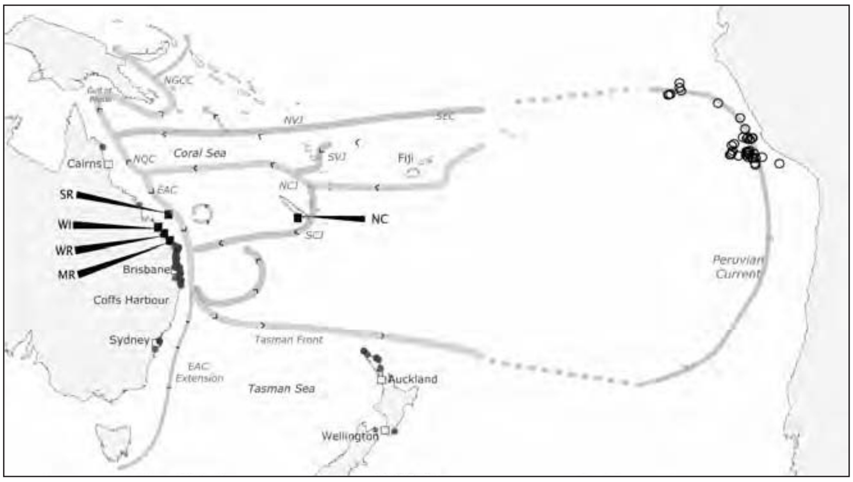


Figure 11. The distribution of loggerhead post-hatchling turtle records for the southern Pacific region relative to primary surface currents and the location of rookeries sampled for genetic characterisation. Filled squares: sampled rookeries; filled circles: stranded post-hatchlings; and open circles: post-hatchlings captured in longline fisheries. The rookeries sampled included WR, Wreck Rock; SR, Swain Reefs; WI, Wreck Island; MR, Mon Repos; and NC, New Caledonia. The annotations refer to the southern equatorial current (SEC) that flows into the Coral Sea where it divides into a number of jets: the North Vanuatu Jet (NVJ); the South Vanuatu Current (SVJ); the North Caledonian Jet (NCJ); and the South Caledonian Jet (SCJ). These jets are the source of the current systems off eastern Australia, the East Australian Current (EAC), the North Queensland Current (NQC) and the New Guinea Coastal Current (NGCC). From Boyle et al. (2009).

Sharks and rays

Sharks and rays (collectively known as elasmobranchs) occur in pelagic, reef and deep-sea habitats of the Coral Sea. Perhaps the most iconic of these is the whale shark (*Rhincodon typus*), the world's largest living fish species. Estimates of species composition, distribution and abundance can only be obtained from fisheries data (mainly longline and trawl catches), coral reef surveys and dedicated deep-water collection trawls or video-based surveys.

Oceanic and reef sharks have been documented in large numbers in some parts of the Coral Sea. The southern edge of the Coral Sea is considered a global predator biodiversity hotspot.

Pelagic Sharks

At least ten species of oceanic sharks have distributions that extend into the Coral Sea. Based on commercial fishing catch and bycatch records, the most abundant are blue sharks (*Prionace glauca*), shortfin mako sharks (*Isurus oxyrhynchus*), bronze whalers (*Carcharhinus brachyurus*), oceanic whitetip sharks (*C. longimanus*), hammerhead sharks (*Sphyrna mokarran and S. lewini*), tiger sharks (*Galeacerdo cuvier*) and silky sharks (*C. falciformis*). Also present in longline records are dusky sharks (*C. plumbeus*), porbeagle sharks (*Lamna nasus*), thresher sharks (*Alopias vulpinus*), longfin mako sharks (*I. paucus*), great white sharks (*Carcharodon carcharias*) and crocodile sharks (*Pseudocarcharias kamoharai*). Some of these species (e.g. tiger sharks) travel between open ocean and coastal habitats, while others (e.g. blue sharks) are truly oceanic. Filter-feeding whale sharks (*Rhincodon typus*) have also been recorded in the Coral Sea, mainly in association with feeding or spawning aggregations (AIMS 2011). Sightings of whale sharks associated with lanternfish and tuna aggregations peak in October and November (Colman 1997). This aggregation is one of only three known in Australian waters. Tagging studies off the east coast of Australia include pelagic sharks, especially mako sharks (6,000 tagged between 1973 and 2008), whaler sharks (5,169), hammerhead sharks (4,943) and blue sharks (3,950). Tagged blue sharks were found to have travelled through the Coral Sea between New South Wales and Papua New Guinea or New Caledonia; blue sharks prefer cool waters and tend to stay in deeper waters near the thermocline in the tropics, and are therefore most likely to be recaptured by longliners (NSW DPI 2009). Very little research exists on oceanic sharks in tropical eastern Australian waters, but the southern edge of the Coral Sea is considered a global predator biodiversity hotspot (Worm et al. 2003).

Recently, trophic web studies have contributed important new information on the role of sharks in pelagic ecosystems, together with other top predators. The shortfin mako shark *Isurus oxyrhinchus* is one of the most important apex predators in the southern Coral Sea (Revill et al. 2009), and has less dietary overlap than some of the other predators (Young et al. 2010), making its role more unique. Byproduct and bycatch information extracted from fisheries status reports suggests that the five most frequently caught shark species in the East Marine Region, including the Coral Sea, are (in order of declining abundance): blue sharks (*Prionace glauca*), shortfin mako sharks (*Isurus oxyrhynchus*), bronze whaler sharks (*Carcharhinus brachyurus*), oceanic whitetip sharks (*Carcharhinus longimanus*) and tiger sharks (*Galeocerdo cuvier*). These species are identified as being of high importance across the Great Barrier Reef and in the pelagic habitats beyond (Ceccarelli and Ayling 2010).

Manta ray

Reef sharks

Reef sharks associated with the Coral Sea include grey reef sharks (*Carcharhinus amblyrhynchos*), blacktip and whitetip reef sharks (*Carcharhinus melanopterus* and *Triaenodon obesus*), tawny nurse sharks (*Nebrius ferrugineus*). Reefs also periodically host the more mobile silvertip sharks (*Carcharhinus albimarginatus*), tiger sharks (*Galeocerdo cuvier*) and great hammerhead sharks (*Sphyrna mokarran*) (Smith et al. 2008a). The coral reefs of the Queensland Plateau host at least three species of shallow-water rays, including blue-spotted stingrays, eagle rays and bull rays (Ceccarelli et al. 2009).

Despite their largely sedentary nature and fidelity to one reef, reef sharks can undertake long-range movements, with at least one grey reef shark tracked as it travelled between Osprey Reef and the Great Barrier Reef (Heupel et al. 2010). Densities of reef sharks are often used as an indicator of the general health of reef populations, and although the usefulness of this is debated, there is a significant increase in reef sharks with protection from fishing (Ayling and Choat 2008). Habitat structure and prey availability is most probably equally important, as highlighted by the large difference in shark densities between the small isolated reefs of Coringa-Herald (Ceccarelli et al. 2008), the larger and more networked complex of Lihou Reef (Ceccarelli et al. 2009), and the large atoll-like Osprey Reef (Ayling and Choat 2008). Coringa-Herald had very low densities of sharks despite strict protection from fishing, whereas Lihou Reef and Osprey Reef boasted densities similar to 'no-go' Pink Zones of the Great Barrier Reef (Ceccarelli et al. 2009).

Deep-water sharks

Deep-water sharks are known to dwell on the Queensland Plateau (Compagno and Stevens 1993). Last and Stevens (2009) recognise 52 species of deep-water sharks, rays and chimaeras from the Coral Sea, 18 of which are known only from there (Table 4). Less information is available on rays. Pelagic stingrays and manta rays are known to occur in the open ocean, as they appear in longline bycatch records (AFMA 2008). A number of deepwater skates, rays and stingarees have been recorded from the Coral Sea, some of which are only known from there (Table 4) (Seret and Last 2003).

Family	Species	Common Name	Location
Hexanchidae (Cowsharks)	*Heptranchias perlo*	Sharpnose sevengill shark	Queensland continental margin and slope
	Hexanchus griseus	Bluntnose sixgill shark	Seamounts off Queensland
	Hexanchus nakamurai	Bigeye sixgill shark	Queensland continental margin and slope
Echinorhinidae (Bramble sharks)	*Echinorhinus cookei*	Prickly shark	Queensland continental margin and slope

Family	Species	Common Name	Location
Squalidae (Dogfishes)	*Squalus albifrons*	Eastern highfin spurdog	Queensland Plateau off Cairns
	Squalus grahami	Eastern longnose spurdog	Queensland continental slope
	Squalus megalops	Piked spurdog	Queensland continental margin and slope
	Squalus montalbani	Philippine spurdog	Flinders Reef slope
	*Squalus notocaudatus**	Bartail spurdog	Queensland slope between Cairns and Rockhampton
Centrophoridae (Gulper sharks)	*Centrophorus moluccensis*	Endeavour dogfish	Queensland continental margin and slope
	Centrophorus niaukang	Taiwan gulper shark	Queensland continental slope
Etmopteridae (Lanternsharks)	*Etmopterus brachyurus*	Short-tail lanternshark	Queensland slope off Cairns
	Etmopterus dianthus	Pink lanternshark	Queensland slope off Cairns
	*Etmopterus dislineatus**	Lined lanternshark	Queensland slope between Cairns and Rockhampton
	Etmopterus lucifer	Blackbelly lanternshark	Queensland continental margin and slope
Dalatiidae (Kitefin sharks)	*Dalatias licha*	Black shark	Southern Queensland continental margin and slope
	Squaliolus aliale	Smalleye pygmy shark	Queensland slope off Cairns
Pristiophoridae (Sawsharks)	*Pristiophorus delicatus**	Tropical sawshark	Queensland slope between Cairns and Rockhampton
Squatinidae (Angelsharks)	*Squatina albipunctata*	Eastern angelshark	Queensland continental slope
Scyliorhinidae (Catsharks)	*Apristurus australis*	Pinocchio catshark	Queensland continental slope
	Apristurus longicephalus	Smoothbelly catshark	Queensland continental slope off Townsville
	Apristurus platyrhynchus	Bigfin catshark	Queensland continental slope
	*Asymbolus pallidus**	Pale spotted catshark	Queensland slope between Cairns and Swain Reefs
	Cephaloscyllium signourum	Flagtail swellshark	Lihou Reef slope
	Cephaloscyllium variegatum	Saddled swellshark	Queensland continental slope
	*Cephaloscyllium zebrum**	Narrowbar swellshark	Flinders Reef slope
	*Figaro striatus**	Northern sawtail shark	Queensland slope between Cairns and Townsville
	Galeus gracilis	Slender sawtail shark	Queensland slope off Cape York
	*Parmaturus bigus**	Short-tail catshark	Marion Plateau/ Saumarez Reef slope
Pseudotriakidae (False catsharks)	*Pseudotriakis microdon*	False catshark	Queensland continental slope off Mackay

Family	Species	Common Name	Location
Triakidae (Houndsharks)	*Hemitriakis abdita**	Darksnout houndshark	Queensland continental slope off Cairns
	Iago garricki	Longnose houndshark	Queensland slope between Cairns and Townsville
	Mustelus ravidus	Grey gummy shark	Queensland continental slope off Townsville
	Mustelus walkeri	Eastern spotted gummy shark	Queensland continental slope
Narcinidae (Numbfishes)	*Narcine nelson**	Eastern numbfish	Queensland slope between Dunk Island and Rockhampton
Arhynchobatidae (Softnose skates)	*Insentiraja laxipella**	Eastern looseskin skate	Queensland continental slope off Cairns
	*Notoraja ochroderma**	Pale skate	Queensland continental slope off Cairns
	*Pavoraja mosaica**	Mosaic skate	Queensland slope between Ingham and Yeppoon
	*Pavoraja pseudonitida**	False peacock skate	Queensland slope between Cairns and Rockhampton
Rajidae (Skates)	*Dipturus apricus**	Pale tropical skate	Queensland slope between Hinchinbrook Island and Gladstone
	Dipturus melanispilus	Blacktip skate	Marion Plateau
	*Dipturus polyommata**	Argus skate	Queensland slope between Townsville and Rockhampton
	*Dipturus queenslandicus**	Queensland deepwater skate	Saumarez Reef slope
	Dipturus wengi	Weng's skate	Queensland continental slope
Anacanthobatidae (Leg skates)	*Sinobatis filicauda**	Eastern leg skate	Queensland slope between Cairns and Swain Reefs
Plesiobatidae (Giant stingarees)	*Plesiobatis daviesi*	Giant stingaree	Queensland continental slope
Hexatrygonidae (Sixgill stingrays)	*Hexatrygon bickelli*	Sixgill stingray	Flinders Reef slope
Urolophidae (Stingarees)	*Urolophus piperatus**	Coral Sea stingaree	Queensland slope. Marion and Saumarez Reef slopes
Chimaeridae (Shortnose chimaeras)	*Chimaera macrospina*	Longspine chimaera	Queensland Plateau
	Chimaera obscura	Shortspine chimaera	Queensland continental slope
	Hydrolagus lemures	Blackfin ghostshark	Queensland continental slope
	Hydrolagus marmoratus	Marbled ghostshark	Queensland continental slope

Table 4. Species of deep-water elasmobranchs (52) with distributions ranging into the Coral Sea. *Identifies the 18 species known only from the Coral Sea. From Last and Stevens (2009).

Tuna and billfish

Among the best-known iconic species of the Coral Sea are its large pelagic predators, the tunas (e.g. yellowfin, bigeye and albacore tuna) and billfish (e.g. black, blue and striped marlin, broadbill swordfish and Pacific sailfish). Much fisheries research has been invested in the most valuable tuna species, especially yellowfin and bigeye tuna, and the most abundant billfish species. Stock status has been variable, and striped marlin, bigeye tuna and yellowfin tuna have been variously classified as 'overfished' or 'subject to overfishing' in recent years (Perks and Vieira 2010; Wilson et al. 2010), sparking some concern over the sustainability of continued fishing. The distribution of different species varies according to their ecology; sailfish and black marlin occur in higher densities closer to landmasses, while blue and striped marlin tend to prefer the open ocean. Broadbill swordfish congregate near seamounts to feed (Pepperell 2010). Five of the Coral Sea's tuna and billfish species are among the scombrid fish recently listed as threatened or near threatened on the IUCN Red List (IUCN 2011). These include the bigeye tuna (*Thunnus obesus*, Vulnerable), yellowfin tuna (*T. albacares*, Near Threatened), albacore tuna (*T. alalunga*, Near Threatened), blue marlin (*Makaira nigricans*, Vulnerable), and striped marlin (*Kajikia audax*, Near Threatened).

Waters over the Queensland and Townsville Troughs appear important for attracting aggregations of large pelagic species, either to feed or spawn.

The northwestern Coral Sea appears to be important to the reproductive biology of a number of tuna and billfish species (Leis et al. 1987; McPherson 1991a, 1991b; Young et al. 2003). Habitat preferences vary between different reproductive stages of striped marlin, which move closer to landmasses during the summer spawning period (Hanamoto 1978; Pepperell 2010). There is a common theory that bigeye tuna undertake a cyclic migration into and out of the western Coral Sea region each year (Evans et al. 2008), which contributes to a strong mid-year peak in catch rates (Hampton and Gunn 1998). They are reported to aggregate in surface waters to spawn and to feed on aggregations of lanternfish in spring (Evans et al. 2008). However, there is little information about the preferred prey of targeted species and prey behaviour, distribution and abundance (Evans et al. 2008).

The northwestern Coral Sea hosts the only confirmed spawning aggregation of black marlin in the world.

Blue marlin, black marlin and sailfish larvae have been recorded in high densities outside the northern Great Barrier Reef, indicating that this is an important spawning ground (Leis et al. 1987). Black marlin are known to aggregate on the outer Great Barrier Reef and in the Coral Sea for spawning each year (Williams et al. 1999). This aggregation, extending from the Ribbon Reefs inside the Great Barrier Reef Marine Park to the Coral Sea over the southern end of the Queensland Trough and the Townsville Trough, is the only confirmed black marlin spawning aggregation in the world (Mr P. Speare, AIMS, pers. comm.). This spawning aggregation supports what is probably the world's premier black marlin sport fishery (Speare 2003), despite the lack of information on the sustainability of this practice (Kalish et al. 2000). The spawning aggregation of billfish occurs from October to December each year, and juveniles and adults then migrate both southwards and inshore (Figure 12).

On a smaller scale, the areas most important for reproduction and larval development are still being investigated. For instance, it was thought that tuna larvae were found primarily in the vicinity of coral reefs. While this was found to be true for some species, others increased in abundance in offshore waters (Fowler et al. 2008). Larval distributions are thought to be driven by a combination of spawning patterns, vertical distribution, wind-driven onshore advection and downwelling on the seaward side of the outer reefs of the Great Barrier Reef (Fowler et al. 2008).

Tagging studies have examined the horizontal and vertical (diving) movements of a number of species. The primary studies have been a project run by CSIRO and the Secretariat of the Pacific Community (SPC), and a long-term tagging program run by the NSW Department of Primary Industries (NSW DPI). The joint CSIRO/SPC project resulted in 180 archival tags being deployed on bigeye tuna between 1999 and 2004 (Kirby et al. 2004; Allain et al. 2005). Seventeen had been recaptured by 2005, and data were retrieved from 14 archival tags (Clear et al. 2005; Evans et al. 2005). Recent studies on bigeye tuna found that depth preferences varied diurnally, with variations in oxygen concentrations and with the lunar cycle, with periods of greater light (daytime and full moon) coinciding with more time spent in deeper, cooler waters (Evans et al. 2008).

Yellowfin tuna

Tunas and billfish tagged in the Game Fish Monitoring Program and other tagging research projects show a wide variety of distances moved before recapture, but average distances range between 200 and 800 nautical miles (Table 5). Remarkable distances are covered by individuals; the Program has recorded distances of over 3,000 nautical miles for a black marlin, over 1,800 nautical miles for a yellowfin tuna, some 2,700 nautical miles for a southern bluefin tuna and 1,700 miles for an albacore tuna (NSW DPI 2009). Most of these fish passed through the Coral Sea during these phenomenal migrations. These wide-ranging habits mean that genetically, most of these species are part of a single Pacific-wide stock (Lambeck 2004), but genetic research has found that the western Pacific bigeye tuna stocks are genetically distinct from eastern Pacific stocks (Gunn et al. 1993; Hampton 2002; Hampton et al. 2003; Grewe and Hampton 2005). In the pelagic realm, tunas and billfish have been the focus for major studies on climate, oceanography, fisheries and pelagic trophic webs (see 'The pelagic realm' section).

Species	Info	Reference
Yellowfin tuna (*Thunnus albacares*)	34 tunas tagged in the Coral Sea and recaptured, most along the New South Wales (NSW) coast within 200 nautical miles (nm) of release; longest straight-line distance between release and recapture was 569 nm after 9 months. 273 tunas tagged by game fishers, most recaptured within the Australian Fishing Zone less than 600 nm from release. Most tunas tagged by the Australian Commonwealth Scientific and Research Organisation (CSIRO) in the Coral Sea were caught close to the release area.	Hampton and Gunn (1998)
	Median lifetime displacement of 336–376 nm, mostly northeast into EEZs of other Pacific Island nations.	Sibert and Hampton (2003)
	Average distance travelled for all individuals recaptured from 2006 to 2008 was 247 nm.	NSW DPI (2009)

Species	Info	Reference
Bigeye tuna (*Thunnus obesus*)	Most tuna tagged by CSIRO in the Coral Sea were caught close to the release area.	Hampton and Gunn (1998)
	90% of tuna captured within 150 nm of tagging location.	Clear et al. (2005)
Albacore tuna (*Thunnus alalunga*)	Two individuals tagged and recaptured: one moved 302 nm, the other 1,727 nm.	NSW DPI (2009)
Dolphinfish (*Coryphaena hippurus*)	Moved distances of up to 440 km.	Kingsford and Defries (1999)
	Average distance travelled for all individuals recaptured from 2006 to 2008 was 112.6 nm.	NSW DPI (2009)
Black marlin (*Makaira indica*)	Average short-term movement of five tagged marlin was 277.4 nm.	Gunn et al. (2003)
	Average distance travelled for all individuals recaptured from 2006 to 2008 was 727.5 nm.	NSW DPI (2009)
	Average distance of 280 nm.	Squire Jr. (1974)
	The majority of striped marlin released off Australia have a mean displacement of less than 200 nm (after six to nine months).	Bromhead et al. (2004)
	Average distance travelled for all individuals recaptured from 2006 to 2008 was 214.2 nm.	NSW DPI (2009)
Shortfin mako shark (*Isurus oxyrinchus*)	Move between ocean basins, enough to cause a lack of genetic differentiation.	Schrey and Heist (2003)
	Average distance travelled for all individuals recaptured from 2006 to 2008 was 571 nm.	NSW DPI (2009)
	Tagged off eastern Australia, stayed within the region.	Stevens et al. (2010)
Blue shark (*Prionace glauca*)	Average distance travelled for all individuals recaptured from 2006 to 2008 was 697 nm.	NSW DPI (2009)
	Tagged off eastern Australia, stayed within the region.	Stevens et al. (2010)
Wahoo (*Acanthocybium solandri*)	Can move more than 1,000 km.	Theisen et al. (2008)
Skipjack tuna (*Katsuwonus pelamis*)	Median lifetime displacement ranges from 420 to 470 nm.	Sibert and Hampton (2003)
Sailfish (*Istiophorus platypterus*)	Average distance travelled for all individuals recaptured from 2006 to 2008 was 38.6 nm.	NSW DPI (2009)
Thresher shark (*Alopias vulpinus*)	Tagged off eastern Australia, stayed within the region.	Stevens et al. (2010)

Table 5. Average distances moved by key pelagic species tagged in or adjacent to the Coral Sea. From Ceccarelli (2011).

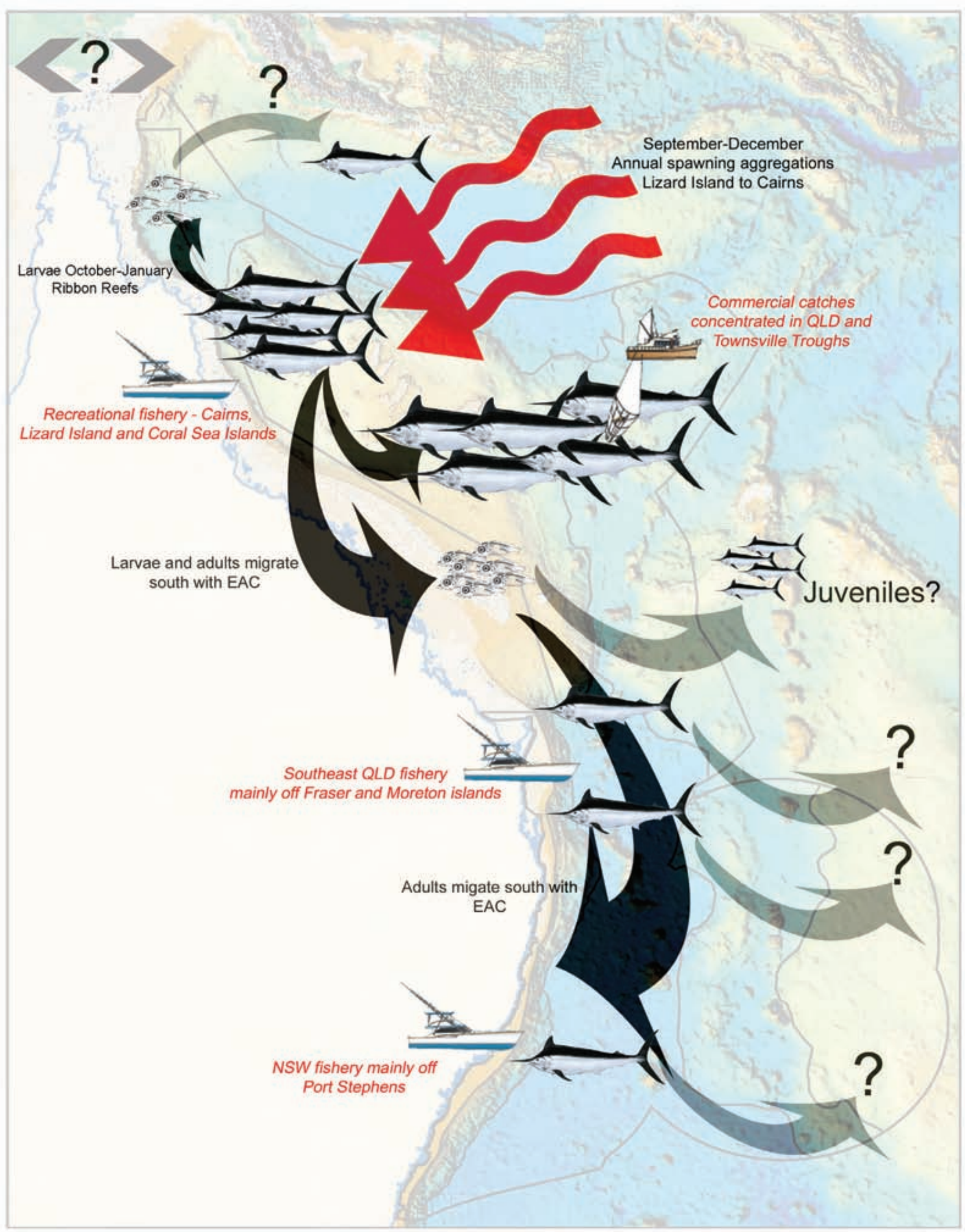


Figure 12. Spawning, growth, migration and fishery interactions of black marlin on the east Australian coast. From Brewer et al. (2007).

Seabirds

The Coral Sea cays host significant populations of nesting and roosting seabirds, with 36 species recorded from the cays of Lihou Reef and Coringa-Herald (Commonwealth of Australia 2001). Many of these species are of conservation significance and are listed under bilateral agreements such as the China–Australia, Japan–Australia and the Republic of Korea–Australia Migratory Bird Agreements (CAMBA, JAMBA and ROKAMBA, respectively). Coringa-Herald seabird populations have been monitored regularly since 1993 on North-East Herald Cay, with occasional visits to other islets (Baker et al. 2008). These cays alone host a significant proportion of Australia's breeding population of several species, including the red-footed booby (*Sula sula*), lesser frigatebird (*Fregata ariel*), great frigatebird (*Fregata minor*) and red-tailed tropicbird (*Phaethon rubricauda*). Seabird populations have remained mostly stable between 1993 and 2008, especially populations of nesting red-footed booby, masked booby and red-tailed tropicbird (Baker et al. 2008). The only exceptions to this pattern have been dramatic declines in populations of frigatebirds and black noddies since 1998. The causes for the declines have been attributed to a complex set of changes in food sources, suitable nesting habitat, SST and other climatic conditions since the 1997/1998 El Niño event (Congdon et al. 2007; Wilcox et al. 2007). The Coral Sea also provides feeding grounds for seabirds that nest on Great Barrier Reef islands. Satellite tracking of birds nesting in the southern Great Barrier Reef showed an extensive journey that included foraging near a series of southern Coral Sea reefs and seamounts (Figure 13) (Congdon et al. 2007).

> Coringa-Herald seabird populations have been monitored regularly since 1993 on North-East Herald Cay. These cays alone host a significant proportion of Australia's breeding population of several species, including the red-footed booby (*Sula sula*), least frigatebird (*Fregata ariel*), great frigatebird (*Fregata minor*) and red-tailed tropicbird (*Phaethon rubricauda*). The Coral Sea also provides critical feeding grounds for seabirds that nest on Great Barrier Reef islands.

At Lihou Reef, abundant nesting seabirds were observed in 2008 (Harvey et al. 2009). The four vegetated cays hosted nesting and roosting communities of 15 species of seabirds. Observations made on East Diamond Islet, some tens of kilometres to the west of Lihou Reef, recorded fairy terns (*Sterna nereis*), previously unrecorded in Australian waters (Mustoe 2006; Carter and Mustoe 2007).

Harvey et al. (2009) provide a detailed flow-diagram model of how seabirds provide the key link between terrestrial and marine habitats of Lihou Reef (Figure 15). Seabirds are top predators in the marine environment, preying on fish near the surface. They nest and roost on cay vegetation, causing disturbance but also contributing to soil development and fertilisation through their guano and carcasses. They also attract mites and ticks, providing food and habitat for invertebrate species (Figure 15). These links are even more important for unvegetated cays, where ephemeral fauna and microbial communities are sustained by seabird and carrion or by intertidal species (Heatwole 1971).

Nautilus

Osprey Reef is the site of intensive studies on Nautilus pompilius, a member of the cephalopod class thought to be between 1 and 5 million years old and capable of extremely deep dives (~400m). The Coral Sea population is genetically distinct from the Great Barrier Reef, suggesting that despite their ability to undertake deep dives, their horizontal movements may be more restricted (Sinclair et al. 2007).

Nautilus

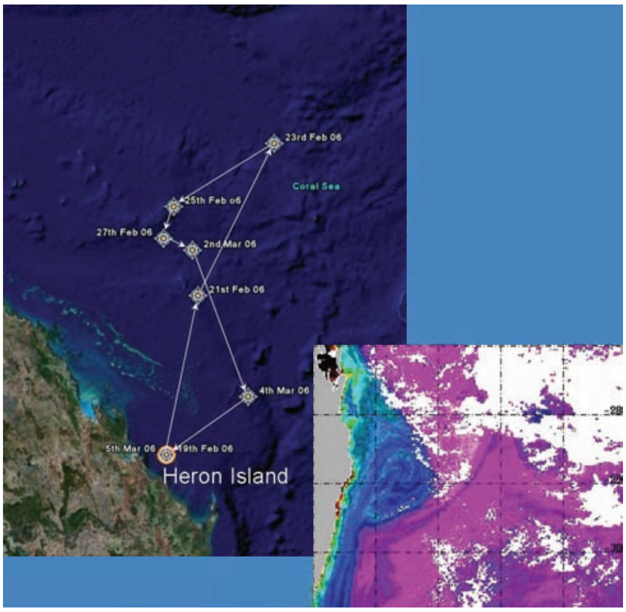


Figure 13. Maps of satellite transmitter tracking of wedge-tailed shearwaters. Top map displays the foraging track for a single adult from February to March 2006. Map on lower right shows wedge-tailed shearwater foraging positions (black dots) along the edge of an oceanographic frontal system off the northern NSW coast. Taken from Congdon et al. (2007).

Key Species Groups

Pelagic fish

Pelagic fish include some of the Coral Sea's most iconic species, such as billfish and tunas (see Iconic Species section above), but this group also encompasses the species from lower trophic levels that are thought to effectively control pelagic ecosystems. In a recent study simulating the effects of removing top pelagic predators through longline fishing and changing productivity in the context of expected climate change, it was found that eastern Australian pelagic ecology is not controlled by either predators or primary production, but by micronekton[1] fish and squid. Because they are highly abundant and productive, changes in their abundance is much more likely to have repercussions throughout the system (Griffiths et al. 2010). Pelagic fish are likely to be influenced by patches of high productivity around reefs, islands and seamounts, and also tend to be attracted to variations in water movement found above bathymetric features such as undersea canyons and pinnacles (Rissik and Suthers 2000; Morato et al. 2010).

Many pelagic fish migrate vertically, following the daily vertical movements of small planktonic prey species (Text Box 2). Among these fish are the lanternfish, the most abundant and productive pelagic fish and key prey for most pelagic predators. Spawning and feeding aggregations of these fish can attract very high abundances of pelagic predators; such an aggregation, fuelled by spawning lanternfish, was recently found in the Coral Sea (AIMS 2011). The depth at which pelagic fish spend time has been the subject of intense interest in fisheries studies that investigate the necessary hook depths to optimise catches of tunas and billfish (Evans et al. 2008). While some large predators spend most of their time at shallow depths – for instance, black marlin tend to remain in the top 100 m of water (Kalish et al. 2000) – diving and foraging depths of pelagic fish vary. It is thought that foraging at different depths and at different times allows predators to exploit similar resources (Young et al. 2010).

Big eye trevally

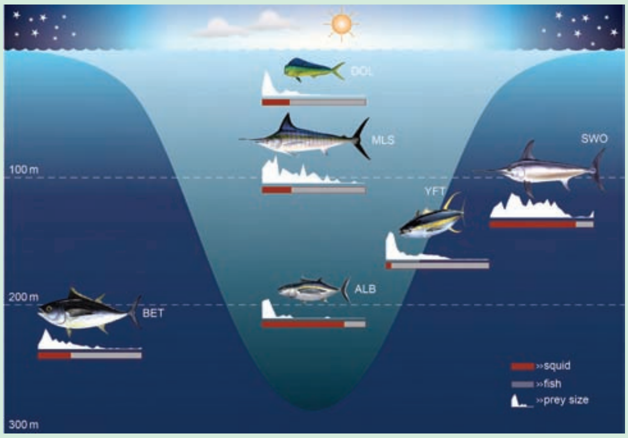
1. Micronekton is composed of actively swimming organisms ranging in size between plankton (<2 cm), which drifts passively, and nekton (>10 cm), which are able to swim freely and are therefore less affected by currents.

Text Box 2. Key information on diel vertical migration in pelagic organisms, with a focus on niche partitioning by pelagic predators as determined by Young et al. (2010).

Diel vertical migration describes a common phenomenon in pelagic ecosystems, where each day organisms move up to the shallower epipelagic zone at night and return to the deeper mesopelagic zone of the oceans during daylight. Most planktonic organisms, and some pelagic fish and cephalopods, undertake some form of diel vertical migration. Drivers of vertical migration for planktonic organisms include predator avoidance, UV avoidance, metabolic optimisation and the exploitation of certain deep or shallow currents for dispersal.

Vertical movement by planktonic animals is followed by small fish and squid that prey on them, and these in turn are followed by larger predators. Most large pelagic predators show considerable overlap in their diets, but small shifts in feeding behaviour, including different feeding depths, allow them to coexist in the same region (Young et al. 2010).

Schematic diagram from Young et al. (2010), showing how pelagic predators partition their feeding habitat during daylight and nighttime hours based on their presence in longline catches at different depths. BET: bigeye tuna, DOL: dolphinfish, MLS: striped marlin, ALB: albacore tuna, YFT: yellowfin tuna, SWO: broadbill swordfish.



Large pelagic fish are some of the Coral Sea's most iconic species, but the open ocean also hosts species from lower trophic levels that are thought to effectively control pelagic ecosystems. Eastern Australian pelagic ecology is not controlled by either predators or primary production, but by small, highly abundant and productive fish and squid. Changes in their abundance have repercussions throughout the system. Pelagic fish are likely to be influenced by patches of high productivity around reefs, islands and seamounts, and also tend to be attracted to variations in water movement found above bathymetric features such as undersea canyons and pinnacles.

Coral reef fish

Coral Sea reef fish communities were first described in the 1960s (Whitley 1964), and the species list has been updated with each successive ecological reef survey (Ceccarelli et al. 2009). However, given the recent focus on only two reef systems, Coringa-Herald and Lihou Reef, it can be expected that more species still remain to be added before there is a complete 'Coral Sea reef fish' list. New species are still being discovered, especially cryptic, deep-dwelling or nocturnal species (Randall and Nagareda 2002; Watson and Walker 2004; Randall and Walsh 2010). It has long been apparent, however, that despite broad similarities with the Great Barrier Reef, there exists a distinct 'Coral Sea reef fish community' (described in detail for Flinders Reef, Williams 1982), with a set of species that are unique to the Coral Sea reefs, and other species or families that are common on the Great Barrier Reef, but absent from the Coral Sea (Oxley et al. 2003).

Some Coral Sea reef fish and sharks use the enclosed lagoons of some of the atolls as nurseries (Leis 1994). For instance, Leis (1994) found high concentrations of some reef fish larvae in plankton tows in the lagoons of Osprey and Holmes Reefs, but very few oceanic fish larvae. Those reef fish that displayed closed populations, with a lagoonal, rather than an oceanic, larval phase, were also highly abundant on those reefs. This suggests that those fish species would not rely on dispersal from external sources to replenish local populations. Whether this has led to distinct species compositions and genetic differentiation is unknown. A genetic study on hybrid wrasses from Holmes Reef, for instance, did not draw conclusions about the effects of isolation on patterns and drivers of hybridisation (Yaakub et al. 2006). Conversely, species with low dispersal capabilities have shown genetic differentiation between the Coral Sea and the Great Barrier Reef (Planes et al. 2001).

Fish communities of the Coral Sea include some species that don't occur on the Great Barrier Reef, and vice versa. A definitive 'Coral Sea reef fish' species list is still under development, with new species discovered periodically.

Surveyed Coral Sea habitats have revealed both species-poor and depauperate fish faunas (e.g. Coringa-Herald), and areas of richer communities, with higher densities of predatory fish (e.g. Lihou Reef) (Oxley et al. 2003; Ceccarelli et al. 2009). Osprey Reef in particular appears to have very high densities of reef sharks (particularly grey reef sharks (*Carcharhinus amblyrhynchos*), whitetip reef sharks (*Triaenodon obesus*) and large, iconic reef fish such as the Humphead or Maori wrasse (*Cheilinus undulatus*) (Dunstan 2008). The high grazing rates measured on this reef (Hutchings et al. 2005) suggest that populations of grazing fish are also healthy, although no estimates exist of species or functional group composition. In fact, despite the relatively high rate of visitation on this reef due to its accessibility compared with other Coral Sea reefs, robust density estimates of sharks, rays, iconic fish and grazers on this reef are not available.

Some Coral Sea reefs host exceptionally high densities of predators and large, rare fish species such as the Humphead or Maori wrasse.

Sygnathids

Fish in the Sygnathid family include species of pipefishes and seahorses, and many are protected under national and international legislation. Very little is known about the specific Coral Sea locations in which they may be found. Three species are included in the IUCN Red List, and the entire family is listed under the Australian Government *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. Their rarity and cryptic habits make them difficult to study, and their presence is only occasionally included in successive fish species lists from the Coral Sea (Whitley 1964; Oxley et al. 2004b).

Freshwater eels

All species of freshwater eels from New Zealand and eastern Australia spawn in the northern Coral Sea, at depths of between 200 and 300 m (DPI Victoria 2010). Some species undertake migrations of up to 3,000 km to reach this spawning location. Larval eels then develop as they are transported south, primarily by the EAC, and then migrate towards estuaries along the Australian or New Zealand coastline. Dispersal to New Zealand is likely to take place along the Tasman Front, which directs warm eddies from the EAC east from the Australian mainland towards Lord Howe Island and New Zealand (McDowall et al. 1998).

Sea snakes

None of the Coral Sea reefs surveyed so far have been noted for particular sea snake abundance or diversity. There has been one dedicated study describing the behaviour and movements of sea snakes at Saumarez Reef (Heatwole et al. 1978). A review of key species occurring in the East Marine Region stated that 16 species of viviparous sea snakes (family Elapidae) and up to three species of sea krait are likely to occur there; most of these are likely to have distributions that encompass the Coral Sea. An additional three species of the family Elapidae found on the Chesterfield Reefs of the French Coral Sea waters are also likely to occur on Kenn Reef (Tzioumis and Keable 2007).

All species of freshwater eels from New Zealand and eastern Australia spawn in the northern Coral Sea in waters between 200 and 300 m deep. Larval eels then develop as they are transported south by the EAC, and then migrate towards estuaries along the Australian or New Zealand coastline. This involves a migration of up to 3,000 km for these eels.

Pelagic squid

Very little is known about pelagic squid in the Coral Sea. The only study to specifically sample a small area of the Coral Sea found very low densities of squid (Moltschaniwskyj and Doherty 1995). Most studies on cephalopods have been conducted at the southern edge of the Coral Sea, in areas that do not overlap with the Conservation Zone. Towards its southern edge, the Coral Sea is subject to oceanographic conditions that increase productivity, so research results found here may not apply to the central or northern parts, which are generally very low in productivity (Brewer et al. 2007). Most of the information on squid in the Coral Sea comes from studies of the stomach contents of pelagic predators such as swordfish, billfish and tunas; 38 taxa from 19 families have been recorded from the eastern marine region of Australia (Lansdell and Young 2007). Squid are thought to vary seasonally in abundance, with higher densities in summer with rising sea surface temperature, and together with small pelagic fish, make up the bulk of the biomass and productivity in this marine region (Griffiths et al. 2010). Squid are widely recognised as playing a central role in pelagic trophic webs, linking secondary producers (mostly pelagic invertebrates and small fish) to higher predators (Lansdell and Young 2007).

Crustaceans

A Coral Sea species list for crustaceans exists only for the Herald Cays, where the only comprehensive study on intertidal and subtidal invertebrates was undertaken. The Royal Geographical Society of Queensland study reported 125 species of decapod crustaceans, including nine undescribed species and 16 previously unrecorded in Australian waters (Davie and Short 2001). Nine decapod crustacean species found at the Herald Cays appear to be undescribed and may be endemic to these cays (Lee Long 2009), but most of the species found there were reported to have a wide Indo-Pacific distribution. Individual groups of crustaceans have been subject to taxonomic reviews. New species from the Coral Sea are regularly described (Holdich and Harrison 1981; Otto 1999, 2000; Ahyong et al. 2007; Bruce 2009; Storey and Poore 2009) and range extensions that include the Coral Sea have been discovered (Jones 1988). However, comprehensive inventories or comparative studies of invertebrate diversity, distribution and abundance remain to be completed.

Echinoderms

Coral reef surveys of Coringa-Herald and Lihou Reef have routinely included echinoderms that are commercially targeted (e.g. holothurians or sea cucumbers) or predators of live coral (crown-of-thorns starfish). At least 14 species of holothurians occur on the Coral Sea reefs (Oxley et al. 2004b), but no such estimates exist for other echinoderms. The Coral Sea Fishery (CSF) targets holothurians, and fishers reported that approximately three-quarters of their catch comes from the larger reefs, such as Osprey or Flinders Reef (Hunter et al. 2002). Concerns over the decline of commercially high-valued species (e.g. black teatfish *Holothuria nobilis/whitmaei*, white teatfish *H. fuscogilva*, prickly redfish *Thelenota ananas*) were raised during surveys of protected areas,

Hermit crab

which currently appear to have healthy populations of these species but are reliant on reefs around them to provide larvae (Oxley et al. 2003; Oxley et al. 2004b). Recent surveys of the Coringa-Herald reefs found that holothurian communities were dominated by three common species that reproduce by fission: lollyfish (*H. atra*), chocolatefish (*H. leucospilota*) and greenfish (*Stichopus chloronotus*) (Ceccarelli et al. 2008). This was not true for Lihou Reef, where the dominant species included *H. whitmaei* and *T. ananas*, neither of which is known to reproduce by fission (Ceccarelli et al. 2009). Populations of these high-value species are known to recover extremely slowly – if at all – once overexploited (Ceccarelli et al. 2007), and the Coral Sea reefs closed to fishing may provide crucial sources of larvae for population recovery on nearby Coral Sea reefs. However, any further region-wide decline of species reliant on pelagic larvae is likely to see the entire community shift towards asexually-reproducing species. No comprehensive inventory of echinoderm species exists for the Coral Sea.

Molluscs

As with the other invertebrates, molluscs are poorly known and have only been comprehensively catalogued at the Herald Cays, where 745 species of molluscs were collected by successive trips (Loch 2001; Preker 2001). Many species were documented simply as shells washed ashore on the Herald Cay beach, and no terrestrial molluscs were found. Most species found here were thought to be common throughout the Indo-Pacific, though a few species were collected in abundance here that are rare elsewhere. A range extension from Pacific reefs and atolls – primarily Tonga and northern Fiji – was recently suggested for the rare deep-water clam *Tridacna tevoroa* on Lihou Reef (Ceccarelli et al. 2009), indicating a biogeographic link between the Coral Sea and the wider Pacific. Gastropods that are commercially valuable to the ornamental shell trade were found in high densities on the reefs of Coringa-Herald and Lihou Reef (Ceccarelli et al. 2008; Ceccarelli et al. 2009).

Tridacnid clams, sometimes referred to as giant clams, are often included in ecological surveys because they are of commercial importance across much of the Pacific, and have become overexploited in some locations. Of the six existing species of Tridacnidae, four have been recorded on reefs of Coringa-Herald and Lihou Reef, and these occur in low densities with a preference for shallow habitats (Oxley et al. 2004b; Ceccarelli et al. 2008; Ceccarelli et al. 2009).

Plankton

Coral Sea waters are generally low in nutrients, resulting in low phytoplankton and zooplankton densities. The zooplankton community in the Coral Sea is made up of a distinct set of species when compared with Tasman Sea plankton (Sheard 1965). Areas where ocean currents and topographic features interact, such as in the lee of islands and reefs, may create patches of increased productivity, and plankton density is generally higher in these habitat patches (Rissik et al. 1997). The vertical migration of planktonic organisms (see Text Box 2) means that surface sampling for plankton may not accurately reflect overall species composition or density. In the Coral Sea, there is a nutricline, or a subsurface water layer where nutrients suddenly increase, at between 50 and 140 m; this is a likely aggregation point for pelagic plankton (Brewer et al. 2007).

Higher productivity has been measured in the northern Coral Sea in summer (Jitts 1965), but phytoplankton production generally increases with increasing latitude, and is many times greater in the Tasman Sea than the Coral Sea (Furnas and Mitchell 1988). The Tasman Front is a sharp gradient in plankton density and in productivity in general (Baird et al. 2008). In the southern Coral Sea, research has found that density and species composition varies across oceanographic and topographic features. Large diatoms dominated the warm and nutrient-poor EAC, presumably due to a cold-core filament beneath the surface current. The study included waters around the Britannia Seamount (Tasman Sea), where zooplankton and micronekton were concentrated in subsurface waters, and an oceanic front, which attracted the highest concentration of micronekton (Young et al. 2011).

The planktonic community also includes the early larval stages of fish and sessile or benthic invertebrates. Concentrations of larval fish can give an indication of important spawning areas, as was found when high densities of billfish larvae were captured outside the Great Barrier Reef north of Cairns (Leis et al. 1987). This coincides with the black marlin spawning aggregation that extends from the Ribbon Reefs inside the Great Barrier Reef Marine Park to the Coral Sea over the southern end of the Queensland Trough and the Townsville Trough. The lagoons of Coral Sea atolls have also revealed information about the likely life cycles of different groups of fish. Plankton tows inside lagoons yielded a high proportion of reef fish, and indicated that these lagoons may act as nurseries and retain larval fish in closed life cycles (Leis 1994). It appears that even among pelagic fish, the larvae of some species prefer near-reef habitats, while others are more abundant offshore (Fowler et al. 2008). Ocean currents are critical to larval dispersal of marine organisms, and currents in the Coral Sea have been shown to provide dispersal pathways to the planktonic larval stages of a number of species of crustaceans, billfish and eels (Dennis et al. 2001; Brewer et al. 2007; DPI Victoria 2010).

Sponges

A species list of sponges exists only for Lihou Reef, where sponges were abundant but not diverse (37 species were recorded), and many species were rare (Ceccarelli et al. 2009). A number of sponge taxa were included in a survey of Flinders Reef, and compared with sponge communities on the Great Barrier Reef (Wilkinson 1987; Wilkinson and Cheshire 1989). It was found that sponge communities were less abundant and diverse than on midshelf reefs of the Great Barrier Reef, and that the high degree of water clarity around Flinders Reef promoted a sponge assemblage dominated by light-dependent species (Wilkinson and Cheshire 1989). On some of the more exposed reef fronts, turf algae and sponges are the dominant benthos (Ceccarelli et al. 2009). Sponges and sponge gardens are also a feature of deep-sea, deep reef and seamount environments (Hooper et al. 1999; Williams et al. 2006). Sponges can also attract interest because of their chemical properties, which have been used in medicinal research (e.g. Lu et al. 2010; Ueoka et al. 2010). At least one project has extracted the secondary metabolites from a Lihou Reef sponge, but no details on the final use of this research are available (Bowden et al. 2004).

Sponges and sponge gardens are a common feature of deep-sea, deep reef and seamount environments. Coralline, colonial sponges discovered in caves at Osprey Reef appear to be 'living fossils' that once formed the primary building blocks of reefs.

Coralline, colonial sponges discovered in caves at Osprey Reef appear to be 'living fossils' that once formed the primary building blocks of reefs (Woerheide et al. 2000). Due to their rarity and cryptic habitat, species of coralline sponges in different regions have become genetically distinct. Their rigid skeleton still plays an important role in cementing the framework of reef caves and overhangs (Woerheide and Reitner 1996).

Biogeographic relationships and broad patterns of biodiversity have been described for this region of Australian waters using sponges (Hooper et al. 1999; Hooper and Ekins 2004). Species richness of sponges was found to be related mostly to the size and types of available habitats, and to collection efforts (Hooper and Ekins 2004). The Coral Sea was not identified as having particularly high sponge diversity, but there were reasonably high levels of endemism, with Wreck Reef showing 46% endemism (Hooper et al. 1999). Genetic research has hypothesised that major Coral Sea currents, such as the South Equatorial Current, act as effective barriers to dispersal, promoting genetic differentiation (Benzie et al. 1994). The Coral Sea sponge fauna forms a distinct group of its own, with some links to the Great Barrier Reef and western Pacific (Hooper and Ekins 2004; Ceccarelli et al. 2009). A sponge biodiversity study suggested that not only could the Coral Sea be biogeographically distinct from the Great Barrier Reef, but the northern and southern Coral Sea faunas could also differ from each other (Hooper et al. 1999).

Corals

Corals in the Coral Sea show affinities with the Central and Western Pacific. Very recent surveys are still adding species to the Coral Sea coral list, now numbering up to 174 species of hard corals at Lihou Reef and Coringa-Herald combined. This recent research has also extended the ranges of some species previously unrecorded in Australian waters (e.g. *Pocillopora linguata* and *Siderastrea savignyana*) (Ceccarelli et al. 2008). No endemic coral species have been recorded, but some brooding corals (species for which larvae are ready to settle within a few days of release, without a dispersive pelagic stage) show genetic differentiation from Great Barrier Reef counterparts (van Oppen et al. 2008).

Soft coral communities have been described in detail for Flinders Reef, where their cover was found to be very low due to the constant exposure to strong wave action (Dinesen 1983). However, soft corals are an important feature of deeper coral communities on Coral Sea reefs, and gorgonians tend to be very abundant (Dinesen 1983). Recent exploration in the deeper reaches of Osprey Reef has provided a description of mesophotic (low-light) coral communities. These communities grow in bands or zones, with distinct transitions from shallow-water corals above ~30 m, a mixture of shallow-water species and deep-water specialists between 40 m and 100 m, and deep-water specialists below ~100 m. These mesophotic communities may act as refugia during disturbance events such as cyclones and bleaching events, which then provide larvae during the recovery of shallower communities (Bongaerts et al. 2011). There are thought to be at least 200 species of deep-water and azoothanthellate (lacking symbiotic algae) corals in the East Marine Region, many of which are likely to occur in the Coral Sea (Tzioumis and Keable 2007).

Recent exploration in the deeper reaches of Osprey Reef has provided a description of mesophotic (low-light) coral communities. These mesophotic communities may act as refugia during disturbance events such as cyclones and bleaching events, which then provide larvae during the recovery of shallower communities.

Robust coral cover estimates are only available for two reef systems, Coringa-Herald (Ceccarelli et al. 2008) and Lihou Reef (Ceccarelli et al. 2009). Additionally, a description of coral communities exists for Flinders Reef, conducted over three decades ago (Done 1982). Low coral cover appears to be a typical feature of reef fronts exposed to high disturbance regimes, such as the small reefs of Coringa-Herald. Surveys conducted at Coringa-Herald in 2006 and 2007, which largely lacks sheltered habitat, found that overall live coral cover was 7%, and species richness was low (Evans et al. 2007; Ceccarelli et al. 2008). Historical surveys and accounts suggest that while cover was always low, it was closer to 20% during the 1980s (Byron et al. 2001; Oxley et al. 2003). In contrast, Lihou Reef had higher live coral cover and diversity, coinciding with higher levels of shelter and overall habitat diversity (Ceccarelli et al. 2009). Osprey Reef had even higher coral cover of between 30% and 60% (Andrews et al. 2008), perhaps driven by its atoll-like reef structure. Coral species richness was also reduced on the smaller reefs, and the Coringa-Herald reefs were noted for the absence of the coral families *Pavona* and *Psammocora*, and the rarity of *Montipora, Porites, Turbinaria and Fungidae* (Oxley et al. 2003).

Severe bleaching events have been documented in the Coral Sea in the last decade. The Lihou Reef system appears to be under considerable pressure from climatic events, but it currently demonstrates a high capacity for recovery.

Marine surveys in the Coral Sea have documented the aftermath of at least two major bleaching events. Lihou Reef suffered bleaching across 65% of the hard coral cover (Oxley et al. 2004b; Ceccarelli et al. 2009). There are also records of a bleaching event from Osprey Reef (Andrews et al. 2008), where bleaching was higher in deeper water, possibly because deep-water corals were less adapted to high temperature and irradiation (Salih et al. 2006). Successive surveys of Lihou Reef found that after the bleaching event, 67% of surveyed colonies were healthy, while 18% were dead and 15% had suffered partial mortality. Coral species less affected by bleaching included *Coscinarea columna, Porites lichen, Pocillopora edyouxi, Leptastrea inequalis, Turbinaria spp., Goniopora spp.* and *Astreopora* spp (Oxley et al. 2004b). The bleaching-resistant *Porites lichen* was later found to dominate some sites, while other areas were covered in plate *Acropora* communities typical of recovering reefs (Ceccarelli et al. 2009). The Lihou Reef system appears to be under considerable pressure from climatic events (Oxley et al. 2004b), but it currently demonstrates a high capacity for recovery (Ceccarelli et al. 2009). It is unknown to what extent this is applicable to other reefs in the Coral Sea.

Coral

Algae

Low-lying turf algae form the greatest percentage of much of the Coral Sea's reef benthic cover, and many of the reef fronts are cemented together with crustose coralline algae (Neil and Jell 2001). Estimates of algal cover exist for Coringa Herald and Lihou Reef (Ceccarelli et al. 2008; Ceccarelli et al. 2009), and an inventory of the 66 algal species found on the Herald Cays has been compiled (Millar 2001). The algal community is typical of coral reef algae found on the Great Barrier Reef, but some notable exceptions included the almost complete absence of brown algae and the presence of two unusual species, one undescribed and one previously thought to be endemic to the Caribbean (Millar 2001). As primary producers, algae are important components of coral reefs, providing resources for herbivorous fish and invertebrates. Low-lying turfs that are grazed frequently tend to be the most productive, whilst fleshy seaweeds can provide habitat for juvenile fish. Large macroalgae on surveyed Coral Sea reefs tends to be very sparse and restricted to a few species growing in sheltered or lagoonal habitats (Ceccarelli et al. 2009).

A number of algal species have internal calcium carbonate structures that provide robustness in high-energy environments. The low-lying crustose coralline algae act as cement, binding together most of the Coral Sea's reef fronts (Neil and Jell 2001). Other calcified taxa, including *Amphiroa* and *Halimeda*, grow upright, and much of the sand around the coral reefs and cays is made of the calcareous remains of these species after they die. *Halimeda* is one of the most abundant benthic taxa in shallow coral reef environments (Byron et al. 2001; Ceccarelli et al. 2008), highlighting its importance in the formation and maintenance of reefs and cays.

Terrestrial invertebrates

Both vegetated and unvegetated cays of the Coral Sea host populations of terrestrial invertebrates, from ephemeral assemblages springing up around seabird carcasses (Heatwole 1971) to well-established communities with multiple trophic levels (Harvey et al. 2009). Terrestrial invertebrates are important because they can be keystone species – maintaining equilibrium in the ecosystem as predators or habitat modifiers – or form important links in larger food webs (Harvey et al. 2009). They can also be useful indicators of environmental change (Greenslade 2008), and they can pose a threat as pests or parasites (Batianoff et al. 2010). For instance, the Guinea ant *Tetramorium bicarinatum* was found to be a key driver of terrestrial communities on the Coringa-Herald cays, acting as a keystone species and indicator of active, above-ground invertebrates on these islands (Greenslade and Farrow 2008). Dispersal capacity, soil composition, moisture content and the composition of vegetation communities are critical drivers of the species composition of invertebrates on the cays (Greenslade and Farrow 2008). Terrestrial invertebrates have been a matter of interest, both in relation to studies of long-range dispersal (Farrow 1984) and as a result of the insect pests on *Pisonia* trees (Greenslade 2008).

The scale insect *Pulvinaria urbicola* decimated the Pisonia forest of the Coringa-Herald cays in the mid to late 1990s. The infestation of scale insect also led to a shift in community structure in the invertebrate fauna.

The invertebrate populations of Lihou Reef were surveyed for the first time in 2008, and were also dominated by species with long-range dispersal capabilities. There were large differences in the richness and composition of invertebrates between individual cays within the reef systems of Lihou Reef and Coringa-Herald, highlighting the random nature of communities formed through long-range dispersal (Harvey et al. 2009). There can be a clear relationship between the cover of particular plants and the abundance of invertebrates. Most invertebrates at Lihou Reef were generalist feeders, forming a complete and self-sustaining food web (Harvey et al. 2009). Simple food webs also occur on unvegetated cays, often around seabird carcasses or microalgal blooms. Invertebrate communities on unvegetated cays tend to be more transient, however, as they depend on impermanent food sources (Heatwole 1971).

A number of research reports outline the efforts undertaken to control the outbreak of the scale insect *Pulvinaria urbicola*, which decimated the *Pisonia* forest of the Coringa-Herald cays in the mid to late 1990s (Smith and Papacek 2001, 2002; Batianoff et al. 2010). Other invertebrates exacerbated the deforestation, including the scale insect's attendant ants and a later infestation of hawkmoths. The efforts at biological control were partially successful, and the introduced predator controlled the pest insect (Freebairn 2006), but only after large tracts of *Pisonia* forest had died (Greenslade and Farrow 2008). The infestation of scale insect also led to a shift in community structure in the invertebrate fauna (Greenslade and Farrow 2007).

Terrestrial flora

There is no comprehensive inventory of which cays in the Coral Sea are vegetated, and what types of vegetation exist across the whole area. Detailed information exists only for cays in the Coringa-Herald group, and to some extent Willis Island, where successive terrestrial surveys have been carried out (Farrow 1984; Greenslade and Farrow 2007; Batianoff et al. 2008b; Greenslade and Farrow 2008). A recent study has also produced an inventory of plant species and vegetation types for some of the Lihou Reef cays (Harvey et al. 2009). Most significantly, the Coringa-Herald cays support 15% of all *Pisonia grandis* forest in Australia.

Batianoff et al. (2009) reported 30 species on the Coringa-Herald cays, 70% of which are widespread across Melanesian islands of similar size and exposure to disturbance from wind and salt spray (Batianoff et al. 2008b). Species richness of plants varies little across the cays: 12 species were recorded on South West Herald Cay and Coringa Islet; 13 species on Chilcott Islet; 14 on North East Herald Cay and 17 on South East Magdelaine Cay (Batianoff et al. 2008a). Mapping units of similar floral assemblages – 17 distinct vegetation communities are described in Batianoff and Naylor (2007) and in Batianoff et al. (2008b) – and individual species have been observed throughout the Great Barrier Reef and the Pacific region (Batianoff et al. 2008b). The recent Lihou Reef vegetation survey reported only grassland and shrubland, concomitant with the lesser development of the cays themselves (Harvey et al. 2009).

The current genetic pool of Coral Sea terrestrial plants is likely to be independent of the Australian mainland flora. It is likely that these species were dispersed along prevailing currents, such as the east-to-west South Equatorial Current, surface currents driven by the south-easterly trade winds and seasonal monsoon winds, and migratory seabirds. Human visitation has been a vector for plant dispersal especially on Willis Island, where there is a permanent, staffed weather station (Batianoff et al. 2008b).

At any given time, the presence or absence of a given plant species in this harsh environment is a product of progressive establishment or failure of permanent and transient species, based on immigration, survival and extinction rates (Greenslade 2008). On coral cays, the keystone species of plants are those that are abundant and resilient enough to provide consistent habitat for other species of plants and animals; on the Coringa-Herald cays eight species have been identified as those most important for providing a plant cover that reduces temperature, wind and moisture stress for other species (Batianoff et al. 2008b). The presence and abundance of these species further affects the functional and species diversity of terrestrial invertebrates and vertebrates (Harvey et al. 2009). Conversely, the threat of pest outbreaks, thought to be in part related to climate variability, can threaten ecosystem balance and biodiversity (Greenslade 2008). The Coral Sea cay flora has evolved without fire regimes, grazing by animals or common insect predation. As a result, some keystone species such as *Pisonia grandis* have not developed resilience to mainland pests such as scale insects (Batianoff et al. 2008b), and have been subject to dramatic impacts from these pests. Climate change predictions include higher temperatures and longer droughts, possibly promoting the growth of woody over herbaceous plants and changes in vegetation structure (Batianoff et al. 2010).

The dieback of *Pisonia* trees due to scale insect pests and prolonged dry conditions has been a cause for concern, and was extensively documented (O'Neill et al. 1997; Batianoff et al. 2010). Dieback was also recorded for *Cordia subcordata* and *Argusia argentea* on all cays, but the cause of this has not yet been understood (Batianoff et al. 2008b). These three species of tree and shrub provide critical nesting habitat for many of the cays' seabirds, making the dieback a conservation issue for the overall ecology of the cays (Batianoff et al. 2009).

Deep-sea organisms

The vast expanses of abyssal plain, deep-sea slopes and canyons and the plains and troughs around the Coral Sea plateaux hint at a wealth of marine life adapted to live at depths of hundreds or thousands of metres. Isolated studies have described the sediment communities (Alongi and Pichon 1988), deep-sea benthos growing on knolls in the Queensland Trough (Beaman and Webster 2008) and life in the deeper reaches around Osprey Reef (Sarano and Pichon 1988). Given the vast extent of deep-sea habitats in the Coral Sea, these efforts have made small but valuable inroads in the large knowledge gap for these habitats.

Vast underwater landslides on the Australian continental shelf have formed large knolls – called the Gloria Knolls – in the Queensland Trough. Rich cold-water coral communities have developed there, with fauna closely related to deep-water species in New Zealand and Tasmania.

Deep-sea plains, both in the basins and on raised platforms, are known to accumulate layers of sediment, and may be interspersed with rocky substratum (Keene et al. 2008). These geological differences drive the composition of organisms able to survive there (Beaman 2010b). In the sediments, microbial fauna may dominate, and there may be changes in the dominance of certain species with changing depth and sediment size (Alongi 1992). Where hard substrate allows organisms to attach, they form habitat for a more diverse array of species that exploit the food and shelter provided by a more varied benthos. Even in the tropics, these communities in the deeper ocean tend to be more closely related to the cold-water fauna of New Zealand or Tasmania (Beaman and Webster 2008). Dredge samples taken from the Gloria Knolls, 1170 m deep, contained live gorgonians, dead scleractinian and bamboo corals, barnacle plates, gastropods and serpulid worms.

Rich benthic communities, even when patchy, can attract a variety of mobile marine species, including those that reside in the deep sea, and shallower pelagic dwellers that undertake deep dives to feed. Surveys in the deep reaches of Osprey Reef have revealed large schools of predators, including trevallies, sharks and groupers (Sarano and Pichon 1988). Deep-water sharks are known to dwell on the Queensland Plateau (Compagno and Stevens 1993). Last and Stevens (2009) recognise 52 species of deep-water sharks, rays and chimaeras from the Coral Sea, 18 of which are known only from there.

Vegetated cay

Species of Conservation Significance

Species requiring special protection because of their rarity, migratory habits, restricted habitats or other characteristics that render them vulnerable are listed under national or international agreements or legislative documents. A number of protected species exist in the Coral Sea, but most are only known from this region because their distribution patterns are expected to extend here. The exact distribution and abundance of most species listed as requiring protection are poorly known in the Coral Sea.

The International Union for the Conservation of Nature (IUCN) lists 341 species that are known to exist in the Coral Sea, including 26 species of cetacean, 219 species of corals, 21 species of fish, 46 species of sharks and rays, at least 5 species of marine turtles and 24 species of birds. Over half (51%) of these species have declining population trends, as many are slow-growing, late-reproducing species with few offspring.

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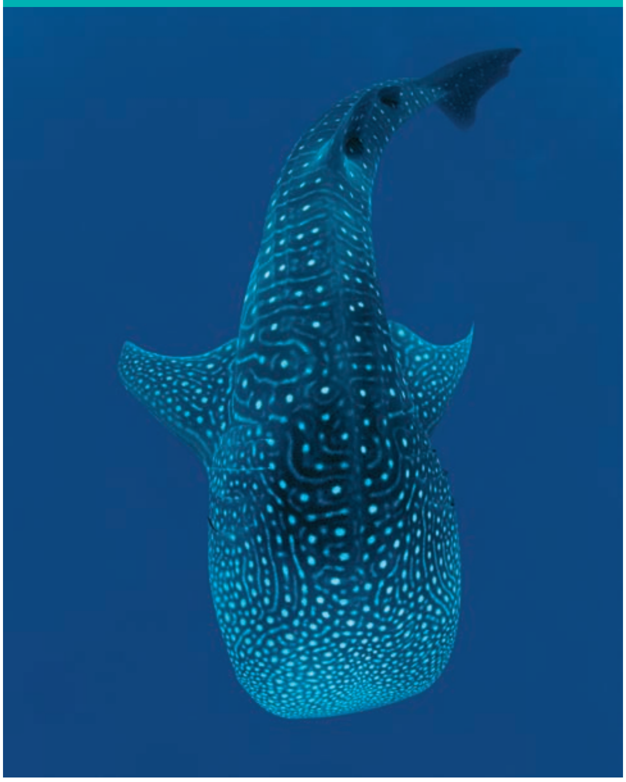
Most of these species are also listed under the *Australian Environment Protection and Biodiversity Conservation (EPBC) Act 1999*, which records 62 listed species occurring in the Coral Sea (Appendix 2). This list includes 28 species of cetaceans, 23 species of seabirds, 3 species of sharks, 6 species of turtles and all members of the pipehorse and seahorse families. Three species found in the Coral Sea have been nominated for listing under the EPBC Act: the shortfin mako (*Isurus oxyrinchus*), the dusky shark (*Carcharhinus obscurus*) and the Humphead or Maori wrasse (*Cheilinus undulatus*). These are currently undergoing further assessment by the Threatened Species Scientific Committee which is due to report to the Minister for Environment by September 30, 2011 (DSEWPaC 2011a). Sea snakes are also listed under the EPBC Act, particularly the family Hydrophiidae (Appendix 2). There is considerable overlap between the IUCN and EPBC lists, and most species are also protected under international agreements for the conservation of migratory species.

Whale shark



General information: key species of conservation significance

The following tables collate and summarise general information about the global distribution, habitat, population status and biological characteristics of selected key species listed in the IUCN Red List and in the EPBC Act. These species are known to occur in the Coral Sea, but may not have been specifically studied there. Selected species include marine mammals, fish, turtles, seabirds, and sharks.

Orca/Killer whale

Family	Scientific Name
Delphinidae	***Orcinus orca***
Distribution and migration Cosmopolitan, from polar regions to equator in all oceans. Recorded in all Australian waters except Northern Territory. Concentrations may occur in southern Australian waters. Frequently seen in the Antarctic. May make seasonal movements related to food supply.	**Habitat** Oceanic, pelagic and both shallow and deep waters. May be more common in cold, deep waters. Often seen along Australian continental slope and on shelf, frequently near seal colonies. Often seen near Macquarie Island.
Size information Birth weight/length: ~180 kg/~2.30–2.50 m Maximum weight: >4,000 kg (male), >3,100 kg (female) Maximum age: 40 years Maximum length: 9.8 m (male), 8.5 m (female)	**Reproduction** Sexual maturity: ~16 years/5.2–6.2 m (male), ~10 years/4.6–5.4 m (female) Calving interval: 3–8 years Mating season: all year Gestation: 12–17 months Calving season: spans several months, season variable Calving areas: none known in Australian waters
Diet and behaviour Highest-order apex predator in Australian waters. Diet differs seasonally and regionally. In north-eastern Pacific, resident animals eat mostly fish, while transient animals eat birds and mammals. Reports from Australian waters of attacking 'dolphins', young humpbacks, blue whales, sperm whales, dugongs and Australian sea lions. Also a well-documented case of herding bottlenose and common dolphins. Often hunts in packs, especially when attacking schools of fish and large whales. Cause most of the non-lethal scarring on humpback whales in east Australian waters. Groups of up to several hundred may occur, but usually less than 30. Off southern Australia, group size up to 52 with most sightings less than 10. Pod composition appears to remain consistent – ~20% adult males, 40–50% adult females and 30–40% immatures and juveniles. Social hierarchy exists within the pod.	**Population status** No population estimates for continental Australian waters. Total number of mature animals within Australian waters may be less than 10,000. In Antarctic south of 60°S, a preliminary population estimate of at least 70,000.
Sources Bannister et al. (1996), Naessig and Lanyon (2004), Ross (2006)	

Pygmy killer whale

Family	Scientific Name
Delphinidae	***Feresa attenuata***
Distribution and migration Found at low latitudes in the Pacific, Indian and Atlantic oceans to about 35°N and 35°S. In Australia, distribution inferred from strandings in New South Wales and Western Australia, and sightings in north-eastern Australia. No evidence of migration.	**Habitat** Pelagic or neritic (deep-sea pelagic) in tropical and subtropical waters, generally 18°C or warmer.
Size information Birth length: ~0.8 m Maximum weight: 155 kg Maximum age: >14 years Maximum length: 2.07 m (male)	**Reproduction** Sexual maturity: <2.16 m (male), <2.21 m (female) Calving season: infer summer Calving areas: none known
Diet and behaviour May prey on squid and fish. Behavioural observations suggest preying on other cetaceans (e.g. *Stenella spp.* and *Delphinus delphis*). Groups of up to 120 individuals, although generally less than 50. Has been seen with Fraser's dolphin, can herd and attack other small cetaceans.	**Population status** Unknown. Believed to be uncommon or rare throughout its range.
Sources Bannister et al. (1996), Ross (2006)	

False killer whale

Family	Scientific Name
Delphinidae	*Pseudorca crassidens*
Distribution and migration Pelagic and circumglobal between ~45°S and 45°N. North–south and inshore seasonal movements possibly associated with warm currents and seasonal availability of prey. Widely recorded by strandings and some sightings in all Australian waters, especially from May to September on the south and south-eastern coasts, suggesting seasonal movement inshore or along the continental shelf. Known for depredation of longline catch in the Coral Sea. Research from Hawaii suggests high site fidelity.	**Habitat** Tropical (~22–32°C) to temperate (~10–20°C) oceanic waters, approaching land only where the continental shelf is narrow, possibly attracted to upwelling zones of enhanced prey abundance along the continental slope.
Size information Birth length: 1.2 m - 1.8 m Maximum weight: ~1.5 t (male), ~1 t (female) Maximum length: 5.96 m (male), 5.06 m (female)	**Reproduction** Sexual maturity: 8–14 years, ~4.0–4.5 m (male), ~3.5–4.0 m (female) Average calving interval: 6.9 years Mating season: year-round Calving season: year-round Gestation: 15.1–15.6 months No calving areas in Australian waters
Diet and behaviour Primarily squid and large pelagic fish, such as cod (*Gadus*), mahimahi (*Coryphaena*), yellowtail tuna (*Pseudosciena*) and salmon (*Onchorhynchus*). Attacks billfish and tunas caught by longlines, and stressed dolphins escaping tuna purse-seine nets. Cephalopod remains in stomachs include *Todarodes, Oregoniateuthis, Phasmatopsis, Gonatopsis* and *Berryteuthis*. Highly gregarious, occurring in socially cohesive herds of ~20–50 with both sexes equally represented. Small herds can form large aggregations of ca 100 to 800+ to exploit locally abundant prey. Often seen with other cetaceans, e.g. bottlenose dolphins.	**Population status** Widely distributed but nowhere abundant. No population assessments available for southern hemisphere populations.
Sources Bannister et al. (1996), McPherson et al. (2003), Ross (2006), McSweeney et al. (2008)	

Sperm whale

Family	Scientific Name
Physeteridae	***Physeter macrocephalus***
Distribution and migration Worldwide in deep waters (>200 m). Recorded from all Australian waters. Females and young males restricted to warmer waters north of ~45°S in southern hemisphere, adult males travelling to and from colder waters. In open ocean, generalised movement southwards in summer, and corresponding movement northwards in winter, separate in each hemisphere.	**Habitat** Pelagic, offshore, in deep water. Breeding and nursing schools, and groups of young males, occur in tropical and temperate waters. Concentrations found where seabed rises steeply from great depth (coasts and oceanic islands), probably associated with upwelling-driven concentrations of deep-sea cephalopods. Only adult males found in cold waters south of ~45°S. Key locations in Australia include between Cape Leeuwin and Esperance, WA, south-west of Kangaroo Island, SA; off Tasmanian west and south coasts; off New South Wales, including Wollongong; off Stradbroke Island, Queensland.
Size information Birth weight/length: ~400 kg/4.0 m Maximum weight: 57.1 t (male), 24 t (female) Maximum age: ~60 years Maximum length: 18.3 m (male), 12.5 m (female)	**Reproduction** Sexual maturity: 18–21 years/11.0–12.0 m (male)*, 7–13 years/8.3–9.2 m (female) Calving interval: 4–6 years Mating season: Sept–Dec Gestation: 14–15 months Calving season: Nov–March Calving areas: no specific localities recognised
Diet and behaviour Major food oceanic cephalopods, frequently taken at depth; also deep-sea angler fish and mysid shrimps. Stomach contents can include remains of large squid species, e.g. *Architeuthis* >2 m. Produce clicks or sharp, broad-band pulses, can carry up to 10 km under water and comprise a series of multiple pulses, unique to sperm whales. Probably used both for echolocation and communication. Prolonged and deep divers, usually ~45 minutes, but often over 60 minutes; one record of a group diving for 138 mins. Maximum depths between 1135 m and 3195 m. Form two kinds of schools, breeding and bachelor. Former include females of all ages and immature and younger pubertal males. Large, socially mature males accompany schools for short periods only during breeding season. Average school size about 25 animals, although aggregations of such schools have been reported, sometimes up to low thousands.	**Population status** Southern hemisphere 'Division 5' (including WA) estimated, in 1980, to have declined by 91% (males >20 years) and 26% (females >13 years). Information lacking on current status, Australian population likely to be less than 10,000.
Sources Bannister et al. (1996), DSEWPaC (2011b)	

Melon-headed whale

Family	Scientific Name
Delphinidae	*Peponocephala electra*
Distribution and migration Indian, Pacific and Atlantic oceans between ~35°N and 35°S. Best known from mass strandings, including in Queensland waters. In Australian waters, recorded from Western Australia, Queensland and New South Wales waters. Known for depredation of longline catch in the Coral Sea. Not known to be migratory.	**Habitat** Pelagic and oceanic, primarily tropical and subtropical (usually >25°C) but can be found in temperate waters. Generally in upwelling areas.
Size information Birth length: ~1 m Maximum weight: >100 kg Maximum age: >20 years Maximum length: 2.75 m	**Reproduction** Sexual maturity: 13 years/2.12–2.64 m (male), 6 years/2.29–2.57 m (female) Mating season: infer August to December (Australia) Gestation: estimate 12 months Calving season: August to December (Australia) Calving areas: none known in Australian waters
Diet and behaviour Prey on squid and a variety of small fish. Occurs in large herds of 150–1,500 animals or groups of less than 40. Has been observed spy-hopping and swimming with Fraser's dolphin, spotted and spinner dolphins. Reported as herding other melon-headed whales and possibly attacking other dolphins.	**Population status** Estimated 45,000 in eastern tropical Pacific. Apparently common in the Philippines. May be more common in Australian waters than records suggest.
Sources Bannister et al. (1996), McPherson et al. (2003), Ross (2006), DSEWPaC (2011b)	

Short-finned pilot whale

Family	Scientific Name
Delphinidae	***Globicephala macrorhynchus***
Distribution and migration Circumglobal, between ~41°S and ~45°N. Evidence of genetically distinct populations in northern and eastern Pacific Ocean. Distribution in Australian region includes oceanic waters and continental seas. Seasonal inshore–offshore movements, apparently in response to abundance and spawning of prey. Known for depredation of longline catch in the Coral Sea.	**Habitat** In Australian region occurs in tropical (~22–32°C) to temperate (~10–22°C) oceanic waters, approaching coastal seas.
Size information Birth weight/length: ~55 kg/~1.4 m Maximum weight: ~2 t (male), ~1.5 t (female) Maximum age: 46 years (male), 63 years (female) Maximum length: 5.89 m (male), 4.8 m (female)	**Reproduction** Sexual maturity: 14.6 years/~4.0–5.0 m (larger males mature earlier), 9 years/2.9–3.6 m (female) Calving interval: ca 5 years (females continue breeding until ca 17–34 years (av 24), producing an average of 4–5 calves) Mating season: year-round Gestation: 14.9 months Calving season: peak in July–August Calving areas: none known for Australian waters
Diet and behaviour Feeds mainly on squid, cuttlefish and octopus and some fish (including cephalopods such as *Loligo reynaudi* and *Lycoteuthis diadema*, *Loligo opalescens*, *Todarodes pacificus, Eucleoteuthis luminosa, Ommastrephesbartrami* and the giant octopus *Octopus dofleini*). Reported to herd and possibly attack Stenella dolphins and common dolphins escaping tuna purse-seine nets in eastern tropical Pacific. Socially cohesive, in small groups of ~10–30, but commonly in herds of several hundred; often accompanied by bottlenose dolphins. Male pilot whales and dolphins tend to remain at the perimeter of the herd; subadult males protect creches of young. Capable of diving to at least 600 m.	**Population status** Widespread and apparently common. No information on numbers or trends in southern hemisphere populations.
Sources Bannister et al. (1996), McPherson et al. (2003), Ross (2006), DSEWPaC (2011b)	

Cuvier's beaked whale and Blainville's beaked whale

Family	Scientific Name
Ziphiidae	*Ziphius cavirostris, Mesoplodon densirostris*
Distribution and migration Circumglobal except polar waters. Recorded by strandings in all Australian states and Northern Territory, mostly from January to July, suggesting some seasonality of occurrence. Apparently a year-round resident in some parts of its range, e.g. off New Zealand and Japan. Strandings in eastern Australia may be linked to EAC.	**Habitat** Deep oceanic waters from tropical (ca 22–32°C) to temperate (Blainville's) or sub-polar (Cuvier's). None known in Australia, but acoustic surveys have identified both species in the southern Coral Sea.
Size information Birth length/weight: ~2.4–2.7 m (both spp.), 60 kg (Blainville's) Maximum weight: ~3.5 t (Cuvier's), ~1 t (Blainville's) Maximum age (Cuvier's): 47 years (male), 28 years (female) Maximum length (Cuvier's): 6.93 m (male), 6.60 m (female) Maximum length (Blainville's): 5.8–~6.4 m (male), 4.71 m (female)	**Reproduction** Sexual maturity: ~8–11 years/~4.5–5.5 m Mating season: infer all year (Cuvier's), infer summer (Blainville's) Calving season: all year, no seasonal pattern (Cuvier's), possibly late summer–autumn (Blainville's) Gestation: not known Calving areas: none known for Australian waters
Diet and behaviour Primarily squid in waters slightly less than 1000 m, deep-water fish for animals taken in deeper waters; also decapod and mysid shrimps. Stomach of a large Cuvier's beaked whale (male) stranded in Victoria contained beaks of ~500 individual squid, including *Mesonychoteuthis hamitoni* (60%), histioteuthids (20%), the remainder representing the families Mastigoteuthidae, Onychoteuthidae, Vampyroteuthidae. Group size varies from one to seven, often solitary (especially adult males), but larger schools to ~25 individuals have been reported. Mass strandings of five and six individuals recorded. Breaching has been observed. Often raises flukes out of water before commencing vertical descent. Apparently capable of deep dives and can remain below for at least 30 minutes. Only adult males have functional teeth, consisting of a single pair at the tip of the lower jaw which appear to be used as weapons during aggressive encounters, leading to heavy scarring of older animals. Lacking functional gripping teeth, prey may be seized and disabled using the hard edges of the mandibles and the rostral palate.	**Population status** Widely distributed, no data on population size or range.
Sources Bannister et al. (1996), Ross (2006), Cato et al. (2010), DSEWPaC (2011b)	

Dwarf minke whale

Family	Scientific Name
Balenopteridae	***Balaenoptera acutorostrata***
Distribution and migration Worldwide, oceanic. Extensive but unpredictable migrations between cold water feeding grounds and warmer water breeding grounds. Migration paths widespread; exact locations of breeding grounds unknown, some populations may not migrate. Extends north to at least ~12°S on east Australian coast; records as far as 58–65°S but not to Antarctic. Recorded from all Australian states except Northern Territory. Indication that Coral Sea/GBR population may be partially sedentary.	**Habitat** Generally oceanic, but sometimes recorded close to coasts. Regularly sighted in northern Great Barrier Reef area at 14–16°S, June–July.
Size information Birth length: ~2.8 m Maximum weight: ~10 t Maximum age: <50 years Maximum length: 9.8 m (male), 10.7 m (female)	**Reproduction** Sexual maturity: 5–8 years/7.3 m (male), 6–8 years/7.9 m (female) Calving interval: 1 year Mating season: Aug–Sept Gestation: ~10 months Calving season: June–July Calving area(s): specific areas not identified
Diet and behaviour Characterised as 'swallowers' or 'gulpers' feed on euphausiids and lanternfish. Little evidence of echolocation, although they can make a variety of sounds, including frequency-modulated 'sweeps', grunts, whistles, clanging bells. Recorded as evading ships by 'running', 'diving' and with 'low profile' behaviour. Breaches regularly in northern Great Barrier Reef area. Often occur singly or in groups of two to three. 'Ship-seeking' behaviour may occur, where individuals approach slow-moving or stationary vessels. Well-marked segregation often evident, by sex and age.	**Population status** Recent estimates based on sightings surveys of the southern hemisphere population are at 700,000 animals.
Sources Bannister et al. (1996), Ross et al. (2006), Birtles et al. (2002), DSEWPaC (2011b)	

Humpback whale

Family	Scientific Name
Balaenopteridae	*Megaptera novaeangliae*
Distribution and migration Global, coastal off Australia in winter and spring, oceanic in Antarctic waters in summer. Recorded from Australian waters except off the Northern Territory. Annual migrations between warm water breeding grounds, ca 15–20°S and summer colder water (Antarctic) feeding grounds, to 60–70°S. At least six southern hemisphere populations exist, based on Antarctic feeding distribution and location of breeding grounds either side of each continent. Off Australia, wintering animals off east coast belong to Group V population, related to those wintering off Tonga. Not all animals may migrate south each year; some summer sightings in Coral Sea and Torres Strait, Coral Sea animals may be late migrants. Reported sex ratio bias towards males in east coast migration; perhaps not all females migrate north each year.	**Habitat** Antarctic pelagic in summer; temperate–subtropical/ tropical coastal in winter. Queensland: off Stradbroke Island, Hervey Bay, islands in Great Barrier Reef, especially Whitsunday Passage area. Exact locations of breeding grounds unknown but suspected to be in central Great Barrier Reef area.
Size information Birth weight/length: 2,000 kg/4–5 m Weaning, age/length: up to 11 months/7.5–9 m Maximum weight: ~45 tonnes Maximum age: ~50 years Maximum length: 18 m	**Reproduction** Sexual maturity: 4–10 years/11.6 m (male), 12.1 m (female) Calving interval: 2–3 years, sometimes twice/3 years, sometimes annual Mating season: June–October Gestation: 11–11.5 months Calving season: June–October Calving area(s): tropical coastal waters, exact locations not identified
Diet and behaviour 'Washing machine' feeding behaviour described from southern hemisphere. Feed mainly in Antarctic waters south of ~55°S. In southern hemisphere almost exclusively on *Euphausia superba* (krill), elsewhere on small shoaling fish and occasional benthic organisms. 'Songs', mainly from breeding males, on breeding grounds and possibly elsewhere. Songs different between populations, and between years. Regular surface activity. Social groups of up to seven animals, predominantly male; agonistic/threat behaviour common. Immatures and females with yearling calves lead northward migration, followed by adult males, non-pregnant mature females; pregnant females in the rear. Southward migration similar, with cow/calf pairs travelling last. Patterned tail fluke underside and side pigmentation individually unique.	**Population status** Recent population estimates: Group V: 14–1900. Currently ~10% rate of increase.
Sources Bannister et al. (1996), DSEWPaC (2011b)	

Seahorses with ranges extending into the Coral Sea (genus Hippocampus)

Family	Scientific Name
Syngnathidae	***Hippocampus bargibanti* (Pygmy seahorse), *Hippocampus hystrix* (Spiny seahorse), *Hippocampus kuda* (Spotted seahorse), *Hippocampus trimaculatus* (Longnose seahorse), *Hippocampus spinosissimus* (Hedgehog seahorse), *Hippocampus zebra* (Zebra seahorse)**
Distribution and migration Most are found throughout the Indo-Pacific. Pygmy and zebra seahorses associated with coral reefs of the Western Pacific including Australia.	**Habitat** All are associated with reefs and shallow areas, but can be found down to depths of 70–100 m. Pygmy seahorse: on gorgonians (sea fans) of the genus *Muricella*, 16–40 m deep Thorny seahorse: Shallow sheltered reefs among clumps of algae, in seagrass beds or associated with sponges and sea squirts. Large adult pelagic and probably associated with drifting debris. Spotted seahorse: Inhabit seagrass and marine algae areas of estuaries and seaward reefs; also on steep mud slopes and in open water and attached to drifting *Sargassum.* Longnose, hedgehog and zebra seahorses: Gravel or sand bottoms around shallow coral reefs.
Size information Pygmy seahorse to 2 cm Zebra seahorse to 7 cm Thorny, Hedgehog seahorses to 17 cm Longnose seahorse to 22 cm Spotted seahorse to 30 cm	**Reproduction** The male carries the eggs in a brood pouch which is found under the tail. Spotted seahorse known to be monogamous.
Diet and behaviour Feed on small invertebrates (benthic crustaceans and zooplankton), fish eggs and larvae. Cryptic behaviour through camouflage.	**Population status** Unknown, many listed under IUCN Red Book as Vulnerable.
Sources Allen et al. (2003), Froese and Pauly (2010), DSEWPaC (2011b)	

Humphead or Maori wrasse

Family	Scientific Name
Labridae	*Cheilinus undulatus*
Distribution and migration Indo-Pacific: Red Sea to South Africa and to the Tuamoto Islands, north to the Ryukyu Islands, south to New Caledonia. Non-migratory.	**Habitat** Steep outer reef slopes, channel slopes, and lagoons, also in algae reefs or seagrasses. Rest in reef caves and under coral ledges at night. Depth range 2–60 m.
Size information Maximum length/weight: 229 cm SL/191 kg Common/average length: 60.0 cm TL Maximum age: 32 years	**Reproduction** Protogynous hermaphrodite: majority of individuals develop first as females, reaching sexual maturity at ~5 years (~35–50 cm). They then change into males at ~9 years (~70 cm); at this time their growth rates also increase significantly (from 17.9 ± 2.1 mm to 44.6 ± 14.4 mm per annum). Forms spawning aggregations varying in size and timing, depending on location, from daily during most months of the year. Individuals may travel kilometres from their home range to participate in these aggregations.
Diet and behaviour Primary prey items are mollusks, fish, sea urchins, crustaceans, and other invertebrates. One of the few predators of toxic animals such as sea hares, boxfishes and crown-of-thorns starfish. Generally solitary or in pairs, travelling across the reef by day and sheltering in reef caves and under coral ledges at night.	**Population status** Rare, listed as Endangered (IUCN) and on Appendix II of CITES. A 10-fold or greater decline over the last 10 to 15 years is indicated in heavily exploited areas (Malaysia, Indonesia and the Philippines). Densities of Humphead/Maori Wrasse rarely exceed 20 fish per hectare in their preferred habitats of outer reefs, and are usually found in densities of below 10 fish per hectare. The population density of adults in the Coral Sea is thought to be 3–5 adults per hectare, totalling between 50,000 and 100,000 adults.
Sources Allen et al. (2003), Sadovy et al. (2003), Choat et al. (2006), Froese and Pauly (2010), DSEWPaC (2011b)	

Red-footed booby

Family	Scientific Name
Sulidae	*Sula sula*
Distribution and migration Tropical distribution, including the Caribbean, the South-West Atlantic Ocean and the Pacific and Indian Oceans.	**Habitat** Marine and largely pelagic. It often rests on boats using them as vantage points. Comes to land to breed, roosts on oceanic islets with abundant vegetation.
Size information Length: 66–67 cm Wingspan: 91–101 cm Weight 0.9–1 kg	**Reproduction** Breeding is not seasonal in most of its range. Individuals form large colonies, nesting and roosting mainly in trees or on islets with abundant vegetation. Is often found nesting in close association with the great frigatebird. The male red-footed booby attracts a female through 'skypointing', where the male points its bill directly upwards. The nest is built on a shrub or among the branches of a small tree, from twigs and sticks that are collected by the male. The female lays a single egg, incubated by both sexes for around 45 days. After hatching, the young chick fledges and leaves the nest at ~3 months old.
Diet and behaviour Feeds mainly on flying fish and squid with a mean prey length of 8.8 cm. Prey are caught by plunge-diving, but flying fish are also taken in flight. Can fly for long distances with great ease. Forages mainly during the day, in association with other predators, such as tuna and dolphins, which herd and chase shoals of fish towards the surface. Highly gregarious species, forming large breeding colonies usually between late January and September.	**Population status** 1,000,000 mature individuals, suspected to be in decline.
Sources BirdLife International (2011), DSEWPaC (2011b)	

Lesser frigatebird

Family	Scientific Name
Fregatidae	*Fregata ariel*
Distribution and migration Tropical waters of the Indian and Pacific Ocean (excluding the east Pacific), and South Atlantic (Trinidad and Martim Vaz, Brazil). Immature and non-breeding individuals disperse throughout tropical seas, especially the Indian and Pacific Oceans.	**Habitat** Inhabits remote islands in tropical and sub-tropical seas, where it breeds in small bushes, mangroves and even on the ground.
Size information Length: 71–81 cm Wingspan: 175–193 cm Weight: 625–875 g (males), 760–955 g (females)	**Reproduction** Unusual and dramatic breeding behaviour. Males gather in groups, with gular pouches inflated, bills clattering, and wings and heads waving, while calling to attract females flying overhead. Mating pairs snake necks together and nibble at each others feathers, before commencing the construction of a nest. The male provides material and the female does the building. Both birds defend the nest in which a single white egg is laid, incubated for ~46 days by both male and female. The chick takes 20 to 24 weeks to fledge, and is then tended to and fed for a further 4–6 months. Mating pairs only breed in alternate years. Many chicks starve to death within months of becoming fully independent; some areas in which the lesser frigatebird nests are severely affected by the occurrence of El Niño events, during which local fish move elsewhere. During the breeding season, adult birds usually stay within 100 to 200 kilometres of the colony, but when not breeding, they range widely throughout tropical seas.
Diet and behaviour Feeds mainly on fish (especially flying fish) and squid, jellyfish and scraps discarded by boats, and will often feed over tuna and other predatory fish that drive smaller fish species to the surface. Also feeds on seabird eggs and chicks, carrion and fish scraps. Kleptoparasitic behaviour is observed. Capable of staying in flight for several days and nights, and may even sleep in flight. Uses thermals to reach heights of up to 2,500 m. Gregarious roosting in large groups.	**Population status** 200,000 estimated mature adults, suspected to be in decline.
Sources BirdLife International (2011), DSEWPaC (2011b)	

Red-tailed tropicbird

Family	Scientific Name
Phaethontidae	*Phaethon rubricauda*
Distribution and migration Tropical waters of the Indian and Pacific Oceans. Outside of the breeding season, as far north as Japan and as far south as New Zealand.	**Habitat** Oceanic, breeds on remote islands. Forages widely over tropical pelagic waters 24-30°C.
Size information Length: 78 – 81 cm Wingspan: 104 – 119 cm Weight 600 – 835 g	**Reproduction** Birds first breed at 2 to 5 years of age and return to the same colony to nest each year. Nest in loose colonies during breeding season. Aerial courtship displays, with up to 15 birds flying upwards in wide circles while emitting harsh squawks, before monogamous partners mate. Competition for nesting sites. A nest scrape is created by the male on the ground under a bush or shrub that offers shelter from the sun. A single egg is incubated alternately by the male and female for 42-46 days. Chick fledges at 67- 91 days of age.
Diet and behaviour Main prey is flying fish and squid. Prey is often pursued underwater. Waterproof plumage allows resting on ocean's surface. During non-breeding season juveniles and adults travel up to 5,000 kilometres from nesting colony.	**Population status** 32,000 mature adults, expected to be stable.
Sources BirdLife International (2011), DSEWPaC (2011b)	

Green turtle

Family	Scientific Name
Cheloniidae	*Chelonia mydas*
Distribution and migration Global distribution in tropical and subtropical waters, within the 20°C isotherms. Nest, forage and migrate across tropical northern Australia. Western Australia supports one of the largest populations remaining in the world. Can migrate more than 2,600 km between feeding and nesting grounds. Average migration distance of turtles nesting on the Great Barrier Reef is ~400 km. Individual turtles foraging in the same area may not take the same migration route.	**Habitat** Pelagic for first 5–10 years, often associated with driftlines and rafts of *Sargassum*. At 30 to 40 cm curved carapace length, settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds.
Size information Curved carapace length up to 1 m. Hatchlings weigh ~25 g and measure 5 cm (straight carapace length).	**Reproduction** In the southern Great Barrier Reef, mating begins in October and nesting occurs between October and March, peaking in January. Nesting in the northern Great Barrier Reef and in the Ashmore and Cartier Island region occurs all year, with a mid-summer peak. In the Gulf of Carpentaria, nesting occurs all year round with a mid-winter peak. In the Coral Sea it is between October and April with a peak November to February. Females may reach sexual maturity between 25 and 50 years. Mating occurs near nesting beaches. Eggs are buried in aerated sand, low in salt, high in humidity, and between 25°C and 33°C. Mortality of hatchlings may be high. Sex of the hatchlings is determined by the temperature of the nest: at or below 26°C producing all male hatchlings, and nests at or above 29°C producing all female hatchlings, intermediate temperatures produce mixed sex hatchlings. Breeding occurs every 1–9 years, and females lay an average of five clutches of around 115 eggs per season. The incubation period is 64 days. The number of females breeding each year is correlated with the Southern Oscillation Index, which determines sea surface temperatures.
Diet and behaviour Adults eat mainly seagrass and algae, but diet can include mangroves, fish-egg cases, jellyfish and sponges. Young turtles more carnivorous, eat plankton during pelagic phase. Females usually remain in shallow water within 5–10 km of the beach between nesting episodes, and can lay on multiple beaches within and between nesting seasons.	**Population status** Global population up to 2.2 million. Severe declines in Indonesia, but most populations stable or increasing. Total Australian population estimated at over 70,000 with 7 regional genetically distinct sub-populations. Listed as Endangered by IUCN.
Sources DSEWPaC (2011b)	

Great white shark

Family	Scientific Name
Lamnidae	*Carcharodon carcharias*
Distribution and migration Global distribution, mostly around temperate waters. Can be highly migratory, crossing ocean basins. Australia population largely in southern waters (preferring temperatures below 18°C), but can move into tropical waters and has been caught off Cairns.	**Habitat** Primarily coastal and offshore over continental and insular shelves, but may also occur off oceanic islands far from land. Can venture inshore to the surf line and into shallow bays.
Size information Maximum length: 792 cm TL (male), 430 cm TL (female) Common/average length: 600 cm TL (male) Maximum weight: 3,400 kg Maximum age: 36 years	**Reproduction** Ovoviviparous/oophagous, embryos feeding on yolk sac and other ova produced by the mother. Usually 2–17 young per litter, gestation up to 18 months with 3-year reproductive cycle.
Diet and behaviour Feeds on whales, bony fishes, sharks, rays, seals, dolphins and porpoises, sea birds, carrion, squid, octopi and crabs. Usually solitary or in pairs but can be found in feeding aggregations of 10 or more; does not form schools.	**Population status** Considered uncommon compared to other widespread species. Declining population trend (up to 20% in 3 generations). Listed as Vulnerable by IUCN.
Sources Last and Stevens (2009), Froese and Pauly (2010), IUCN (2010) Ceccarelli and Ayling (2010), Pepperell (2010), DSEWPaC (2011b)	

Blue shark

Family	Scientific Name
Carcharhinidae	*Prionace glauca*
Distribution and migration Considered the widest-ranging shark. Circumglobal in temperate and tropical waters. Highly migratory, may travel considerable distances (one specimen tagged in New Zealand was recaptured 1,200 km off the coast of Chile).	**Habitat** Oceanic, but may be found close inshore where the continental shelf is narrow, occasionally occurs in shallow areas.
Size information Maximum length: 400 cm TL (male) Common/average length: 335 cm TL (male) Maximum weight: 205.9 kg Maximum age: 20 years	**Reproduction** Sexual dimorphism, maturing and adult females have much thicker skin to withstand biting from males during mating. Viviparous, gestation lasts up to a year, produces 4–135 young per litter.
Diet and behaviour Feeds on fishes (herring, silver hake, white hake, red hake, cod, haddock, pollock, mackerel, butterfish, sea raven and flounders), small sharks, squids, pelagic red crabs, cetacean carrion, occasional sea birds and garbage. Frequent diving behaviour to 600 m or more.	**Population status** Considered abundant and productive, but no population estimate available. Most abundant shark in Australian longline catches. Classified as Near threatened by IUCN.
Sources Last and Stevens (2009), Froese and Pauly (2010), IUCN (2010), Pepperell (2010)	

Oceanic whitetip

Family	Scientific Name
Carcharhinidae	*Carcharhinus longimanus*
Distribution and migration Global distribution, highly migratory.	**Habitat** Oceanic, deep-water species which only occasionally approaches coastal areas.
Size information Maximum length: 396 cm TL (male) Common/average length : 270 cm TL (male) Maximum weight: 167.4 kg Maximum age: 22 years	**Reproduction** Partial segregation by size and sex in some areas. Viviparous, 1–15 young, 60–65 cm, per litter. Gestation of ~1 year.
Diet and behaviour Feeds primarily on oceanic bony fishes (including tuna and mahimahi), also threadfins, stingrays, sea turtles, sea birds, gastropods, squid, crustaceans, mammalian carrion and garbage. Frequently accompanied by Remora, *Coryphaena*, pilot fishes.	**Population status** Declining population trend. Most abundant shark in some oceanic longline fisheries. Listed as Vulnerable by IUCN.
Sources Last and Stevens (2009), Froese and Pauly (2010), IUCN (2010), Pepperell (2010).	

Whale shark

Family	Scientific Name
Rhincodontidae	*Rhincodon typus*
Distribution and migration Circumglobal in tropical and warm temperate seas. Males are highly migratory between ocean basins, but return to the same sites annually (e.g. Ningaloo Reef, WA).	**Habitat** Often seen offshore, but can be observed inshore, sometimes entering lagoons or coral atolls.
Size information Maximum length: 2,000 cm TL (male) Common/average length: 1,000 cm TL (male) Maximum weight: 34,000 kg Maximum age: 70 years	**Reproduction** Ovoviviparous, litter size can be over 300 pups.
Diet and behaviour Feed on plankton and nekton, including small fishes (sardines, anchovies, mackerel, juvenile tunas and albacore), small crustaceans and squids. Often seen in a vertical position with the head at or near the surface when feeding, or actively swimming and turning the head from side to side. Can be found singly, or in aggregations of over 100 individuals. Often associated with groups of pelagic fishes, especially tunas and trevallies.	**Population status** Yearly numbers of Whale Sharks in Ningaloo Marine Park are estimated to vary between 200 and 400 individuals, but no available global population estimate. Decreasing population trend, including at Ningaloo. Listed as Vulnerable by IUCN.
Sources Bradshaw et al. (2008), Last and Stevens (2009), Froese and Pauly (2010), IUCN (2010), Pepperell (2010), DSEWPaC (2011b)	

Location	Sp. Richness	Source
Milne Bay, PNG	442	(Fenner 2003)
New Caledonia	342	(Pichon 2006)
Coringa-Herald, Coral Sea	**140**	**(Ceccarelli et al. 2008)**
Elizabeth Reef, SE Australia	114	(Oxley et al. 2004a)
Lihou Reef, Coral Sea	**106**	**(Ceccarelli et al. 2009)**
Lihou Reef, Coral Sea	**100**	**(Oxley et al. 2004b)**

Table 6: Species richness of scleractinian coral at different Indo-Pacific and eastern Australian locations (from Ceccarelli et al. 2009). Coral Sea locations are listed in bold.

Locality	CFDI	No. reef fishes	Estim. reef fishes
Maumere Bay, Flores, Indonesia	333	1,111	1,107
Togean and Banggai Islands, Indonesia	308	819	1,023
Komodo Islands, Indonesia	280	722	928
Madang, Papua New Guinea	257	787	850
Kimbe Bay, Papua New Guinea	254	687	840
Manado, Sulawesi, Indonesia	249	624	823
El Nido-Bacuit Bay, Philippines	243	694	803
Capricorn Group, Great Barrier Reef	232	803	765
Samoa Islands	211	852	694
Chesterfield Islands, Coral Sea (French)	**210**	**699**	**691**
Layang Layang Atoll, Malaysia	202	458	664
Sangalakki Island, Kalimantan	201	461	660
Bodgaya Islands, Sabah, Malaysia	197	516	647
Pulau Weh, Sumatra, Indonesia	196	533	644
Lihou Reef, Coral Sea	**189**	**343**	**620**
Coringa-Herald Reefs, Coral Sea	**187**	**342**	**613**
Elizabeth-Middleton Reefs, Tasman Sea	184	322	603
Sipadan Island, Sabah, Malaysia	184	492	603
Lord Howe Island, Australia	139	395	450
Bintan Island, Indonesia	97	304	308
Johnston Island, Central Pacific	78	227	243
Midway Atoll	77	250	240
Rapa Island	77	209	240
Norfolk Island	72	220	223

Table 7. Coral fish diversity index (CFDI) values for restricted Indo-Pacific localities, number of coral reef fish species as determined by surveys to date, and estimated numbers using the CFDI regression formula. Table modified from Allen and Werner (2002), with added values from Ceccarelli et al (2009) and Ceccarelli and Job (in prep.). Coral Sea locations are in bold.

Ecological Patterns and Processes

The Coral Sea's ecology is strongly driven by the constraining elements of isolation and exposure to high levels of disturbance – the Queensland Plateau Region experiences the highest frequency of cyclones in eastern Australia (Brewer et al. 2007). The existing biodiversity in the Coral Sea has been shaped by its geological history, latitudinal gradients, dispersal abilities of organisms, random effects of currents, wind and other vectors of dispersal and the availability and extent of suitable habitat (Farrow 1984; Oxley et al. 2003; Batianoff et al. 2008b). In general, it is expected that isolated habitat patches are reliant to a large extent on self-seeding (Ayre and Hughes 2004), and molecular analysis may find that their isolation has led to populations of species that are genetically distinct from those in adjacent regions (Planes et al. 2001). Biogeography and molecular biology studies on plants, birds, insects and other fauna indicate that the wider Tasman–Coral Sea region (including New Zealand, New Caledonia, Papua New Guinea and the east Australian coast, is one of the primary evolutionary centres of modern life (Heads 2009), and studies combining geology, evolution and biogeography hint at the importance of the Coral Sea for numerous groups (Whitmore 1973). A sponge biodiversity study suggested that not only could the Coral Sea be biogeographically distinct from the Great Barrier Reef, but the northern and southern Coral Sea faunas could also differ from each other (Hooper et al. 1999). Further work is required to establish these patterns with more certainty, but a number of ecological patterns and processes can nevertheless be described.

Soft coral

A sponge biodiversity study suggested that not only could the Coral Sea be biogeographically distinct from the Great Barrier Reef, but the northern and southern Coral Sea faunas could also differ from each other.

Patterns of Biodiversity, Rarity and Endemicity

Existing patterns of marine and terrestrial biodiversity have been established, to some degree, for the two Commonwealth Reserves in the Coral Sea (Batianoff et al. 2008b; Ceccarelli et al. 2008; Ceccarelli et al. 2009; Harvey et al. 2009). Initial surveys suggest that the geology and geomorphology of the reefs has a strong influence on the distribution, abundance, composition and diversity of marine and terrestrial organisms (Beaman and Harris 2007; Ceccarelli et al. 2009). Surveys have revealed a unique but reduced coral, fish and invertebrate fauna compared to the adjacent Great Barrier Reef. These differences are largely driven by the lower diversity of habitats and resources; even within the Coral Sea, smaller reefs (such as Coringa-Herald) support a subset of the species found on larger reef systems (such as Lihou Reef). In deeper waters, currents and the geophysical structure of the substrate interact to determine benthic assemblages (Beaman and Harris 2007). Similarly, oceanic features such as currents, fronts and gyres influence the distribution of pelagic biodiversity (Midddleton et al. 1994; Rissik et al. 1997; Young et al. in press).

The geology and geomorphology of Coral Sea habitats has a strong influence on the distribution, abundance, composition and diversity of marine and terrestrial organisms.

Australian coral reefs are geographically close to the global centre of coral reef biodiversity, known as the Coral Triangle, and Australia is ranked as one of a few countries with over 1,000 species of reef fish. The Coral Sea reefs that have been surveyed display intermediate levels of species richness for both corals and reef fish; this is likely to increase if more reefs are surveyed (Table 6, Table 7). The Great Barrier Reef, which adjoins the Coral Sea, is classed as one of the world's 'megadiversity' centres (Allen 2008; Bellwood and Meyer 2009), while the southern Coral Sea has been ranked as a diversity hotspot for predators (Worm et al. 2003).

Rare species are routinely found during surveys of cryptic or deep habitats, and many of the protected species and pelagic predators are globally rare. Pelagic species tend to be more widespread, although at least one recently discovered species of hatchetfish is thought to have a distribution restricted to the Coral Sea (Harold 1989). Rarity in the Coral Sea is probably influenced to a large degree by the fact that available habitats tend to be small and widely dispersed. Deep-water and seamount specialists tend to be universally rare because of their high degree of specialisation and the restricted range of habitats available to them. Unfortunately, for many species and species groups it is too early to tell if they appear rare because of the low sampling effort, or if they are locally rare but otherwise common, or if they are universally rare. Recent survey efforts have extended the previous ranges of a Pacific Island clam, a crab and two coral species (at Lihou Reef and Coringa-Herald); while these species can probably be considered rare in Australia, the corals could be quite common closer to the centre of their distribution (Ceccarelli et al. 2008). However, it is likely that greater protection from human impacts would be afforded to them in the Coral Sea than on South East Asian reefs close to large population centres. The clam *Tridacna tevoroa* is considered rare throughout its range through historic overfishing (Ceccarelli et al. 2009), making its discovery in a no-take Reserve in the Coral Sea a valuable addition for this species.

The Coral Sea combines its proximity to the centre of coral reef biodiversity and unique species assemblages with its distance from high-density population centres. This makes it an ideal and relatively undisturbed scientific reference site.

Endemic species are those that occur only in a small area, such as within the boundaries of a single nation or water body. Australia ranks among the top countries for endemism in coral reef fish, birds and plants (Hughes et al. 2002; Allen 2008; Heads 2009). However, the Coral Sea itself has revealed only limited records of endemism. This may be due to a combination of low sampling effort in the Coral Sea overall, and low regional sampling effort for certain taxa (Davie and Short 2001). Eighteen species of deep-water sharks and rays have been recorded only in the Coral Sea region (Last and Stevens 2009), but greater sampling effort may be required before they can be declared endemics. Species-level research in the Coral Sea will require considerable effort, but emerging results from recent sampling expeditions indicate that the area is unique, hosting a significant number of endemic species (Dr. P. Last, CSIRO, pers comm.).

Migration, Dispersal and Connectivity

The Coral Sea provides habitat to numerous migratory species, either as part of their habitual migration pathways, or habitat where they pause to breed, nest, spawn or feed. The most well-known migratory species to use the Coral Sea are tunas (especially yellowfin, bigeye and albacore), billfish (especially black, blue and striped marlin, Pacific sailfish and broadbill swordfish), some of the seabirds (especially the red-footed booby (*Sula sula*), lesser frigatebird (*Fregata ariel*), great frigatebird (*Fregata minor*) and red-tailed tropicbird (*Phaethon rubricauda*)) and green turtles (*Chelonia mydas*) that nest on the Coral Sea cays. Other species that occur more rarely appear to pass through the Coral Sea as individuals, rather than aggregations, and there are no records of key feeding or breeding areas for these species. This more transient group includes large pelagic cetaceans and sharks, seabirds and turtles (other than green turtles).

The primary migration pathways through the Coral Sea are likely to be associated with major ocean currents, as even large, actively swimming pelagic species tend to use current to their advantage.

The primary migration pathways through the Coral Sea are likely to be associated with major ocean currents, as even large, actively swimming pelagic species tend to use current to their advantage (Boyle et al. 2009). Species may enter the Coral Sea with the South Equatorial Current, and some may continue north towards the Arafura Sea, while others may turn south at the bifurcation point.

Southward migrations of black marlin, loggerhead turtles, freshwater eels and humpback whales are likely to take place along the EAC (Bannister et al. 1996; Brewer et al. 2007; DPI Victoria 2010). Transport out of the Coral Sea may occur eastward along the Tasman Front. For many species, well-defined migration routes through the Coral Sea have not been mapped. For instance, humpback whales travelling north appear to separate into several directions as they reach tropical waters off eastern Australia (Vang 2002). Green turtles that nest on Coral Sea cays migrate to multiple foraging grounds off Queensland, the Torres Strait, Papua New Guinea and the western Pacific island groups (Harvey et al. 2005). Seabirds that nest on Coral Sea cays also tend not to show a unidirectional dispersal pattern, but follow prey aggregations associated with dynamic oceanographic phenomena (Wilcox et al. 2007).

Current research is insufficient to determine whether the Coral Sea hosts resident populations of cetaceans or large pelagic predators. There are indications that humpback whales (*Megaptera nonaeangliae*) may stay in the Coral Sea for multiple seasons, rather than migrating every year (Bannister et al. 1996). Some of the southern seamounts may host semi-resident populations of broadbill swordfish (*Xiphias gladius*) (Young et al. 2003), and there are indications that some highly mobile pelagic species may restrict their movements to within the greater Coral Sea area (including waters of neighbouring jurisdictions) (Sibert and Hampton 2003). Ongoing tagging studies are likely to reveal which populations and species are truly transient, and may identify semi-resident groups or sub-populations of some species.

Biological Characteristics

While large migratory species provide connectivity between the habitats they travel through primarily as adults, many marine organisms are widely dispersed during their larval stages even though they may be site-attached as adults. The dispersive larval stage of most coral reef organisms allows a higher degree of connectivity between marine populations than terrestrial ones. Genetic analyses and knowledge of ocean currents can help determine the most likely dispersal pathways, and can identify reefs that may act as sources or sinks of pelagic larvae. It has previously been suggested that the Coral Sea reefs may act as genetic stepping stones between the Pacific and the Great Barrier Reef in a westward direction (Endean 1957; Benzie 1998). For example, populations of coral trout found on the Great Barrier Reef have been shown to be genetically connected to populations of the same species in New Caledonia (van Herwerden et al. 2009), and grey reef sharks have recently been found to undertake long-distance movements between Osprey Reef and the outer reefs of the Great Barrier Reef (Heupel et al. 2010). Studies on the genetic diversity of the clam *Tridacna maxima* and the foraminiferan *Marginopora vertebralis* between the Coral Sea and the Great Barrier Reef found that there was little genetic differentiation between the Coral Sea and Great Barrier Reef reefs, with the exception of reefs at the northern and southern edge of the Coral Sea sampling area (Benzie 1991; Benzie and Williams 1992). This suggests high connectivity for dispersive larvae of some species within this region, while other organisms (e.g. sponges) show greater genetic differentiation (Benzie et al. 1994). The results of the studies also indicate that the timing of a species' reproductive activity in relation to seasonal changes in the Coral Sea's major current systems is important for determining the extent and direction of dispersal. Additionally, the South Equatorial Current may form a dispersal barrier between northern and southern Coral Sea reefs that promotes genetic differentiation (Benzie 1991; Benzie et al. 1994). Linkages between habitats can be crucial for the capacity to recover from disturbance in times of widespread and cumulative environmental stress (Jones et al. 2007; Jones et al. 2009).

Reefs with disturbance-induced low coral cover may have increased chances of recovery if they are within dispersal distance of other reefs (Harrison et al. 1984; Baird 1998). Reef geomorphology, distance from other reefs and benthic composition also affect rates of productivity and calcification at a whole-reef scale (Pichon 1997). Individual Coral Sea reef systems may be connected by smaller-scale currents and eddies, and local hydrodynamics may prove more important in the recovery of these reefs from disturbance than larger-scale patterns (Arthur et al. 2006). The EAC is directed around the Marion Plateau (Brewer et al. 2007), potentially creating a separation between its reefs and those of the Queensland Plateau, but no comprehensive records exist of the flora and fauna of the Marion Plateau reefs (Marion Reef and Saumarez Reef), with the exception of records of sponge collections (Hooper and Ekins 2004). A gyre system in the ocean currents over the Queensland Plateau is a potential reason for the marine endemicity found here (Brewer et al. 2007; Treml et al. 2008). The connectivity between reefs in the Coral Sea is currently unknown, and may change according to El Niño and La Niña years (Treml et al. 2008). Recent research suggests that isolation on its own is not a good predictor of the rate of recovery from disturbance (Halford and Caley 2009).

Barracuda

Trophic Relationships

The understanding of trophic pathways and food web structure can help to identify which species, trophic or functional groups play the key roles in maintaining ecosystem balance. In the southern Coral Sea, trophic relationships have been explored in some detail in the pelagic realm (Figure 9), and to some extent on coral reef cays (Figure 14, Figure 15). The great knowledge gaps in the deeper habitats of the Coral Sea mean that trophic relationships in abyssal regions, in the troughs and on the plateaux, on the seamounts and in the deeper areas of the coral reefs are virtually impossible to construct (Brewer et al. 2007).

Trophic relationships in the Coral Sea range from simple food chains on unvegetated cays (Heatwole 1971) and within deep-sea sediments (Alongi and Pichon 1988), largely based on carrion and detritus, to much more complex pelagic and coral reef food webs (e.g. Dambacher et al. 2010). The control of energy flow is usually a complex combination of the 'bottom-up' availability of nutrients (in the form of detritus, nitrogen, plant matter etc.) and the 'top-down' pressure from predators (sharks, seabirds, etc.). In some systems, the key group maintaining balance is neither at the bottom or the top of the food web, but in the middle, such as the micronekton fish and squid found to control pelagic environments in the southern Coral Sea (Griffiths et al. 2010).

In complex environments such as coral reefs, it becomes more useful to consider species grouped to represent the key roles they play, or 'functional groups'. This can differentiate between different levels of habitat engineers, primary producers, planktivores, different groups of grazers and several tiers of predators. The number of species making up each functional group will indicate how much redundancy exists in that group – i.e. how likely it is for the role still to be filled if one or more species disappear. For instance, grazers in the Coral Sea are represented by many species that target detritus or algae from low-growing algal turfs, and that scrape turf from the substrate along with an underlying layer of calcium carbonate (Ceccarelli et al. 2009). Terrestrial cay food webs are simpler, and each group is typically made up of only a few species (Figure 14). This indicates that entire functional roles are more easily lost with the local extinction of individual species.

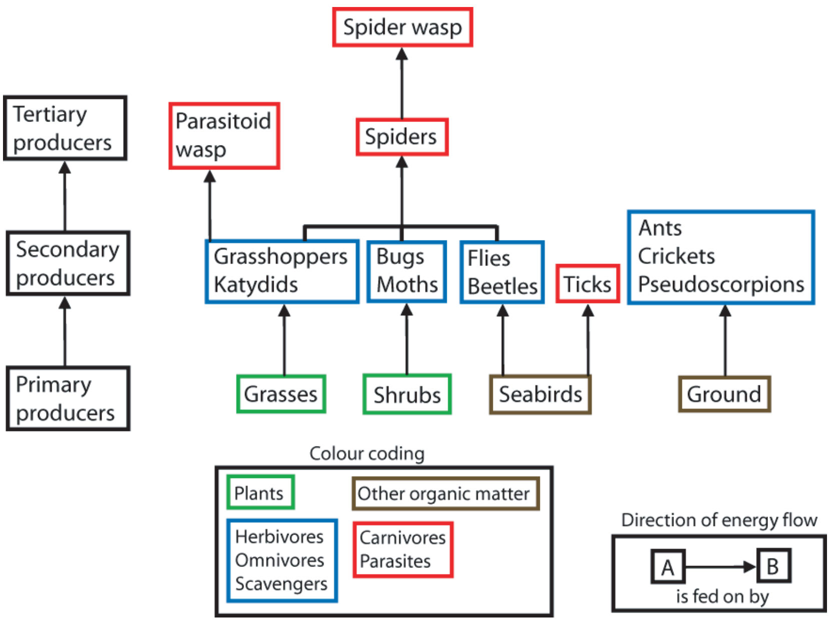


Figure 14. Trophic relationships on cays of Lihou Reef. From Harvey et al. (2009).

Spawning Aggregations

Spawning aggregations occur when many individuals of a species aggregate in the same location to spawn. These aggregations occur at specific locations and in particular seasons, influenced by tidal and moon phases, and can maximise reproductive success (Russell 2009). The best-known spawning aggregation in the Coral Sea, which extends from the Great Barrier Reef Marine Park into the Coral Sea Conservation Zone, is the mass spawning of black marlin outside the Great Barrier Reef north of Cairns between September and December (Speare 2003). A recent research expedition documented a large lanternfish spawning aggregation, which attracted numerous pelagic predators, which is thought to move around over the Queensland Trough (AIMS 2011). A number of reef fish are also known to form large (100+ individuals) spawning aggregations, such as *Plectropomus spp.* ad *Epinephelus spp.* (Russell 2001), but regular aggregation sites have yet to be documented for the Coral Sea.

A recent research expedition documented a large lanternfish spawning aggregation, which attracted numerous pelagic predators, which is thought to move around over the Queensland Trough.

Spawning aggregations are routinely targeted by fishers, because they offer the opportunity to capture many large individuals in a relatively short period (Pears et al. 2006). The fishing of spawning aggregations is now widely known to be destructive to fish stocks, and has been implicated in the decline or disappearance of aggregation spawning species elsewhere in the world (Russell 2001). Fish are at their most vulnerable during spawning aggregations, and by forming these aggregations they can make a significant contribution to the next generation. There is therefore a global call to protect these aggregations from fishing, as aggregations are considered more valuable unexploited, as a source of fish for local fisheries or as tourist attractions (Sadovy and Domeier 2005).

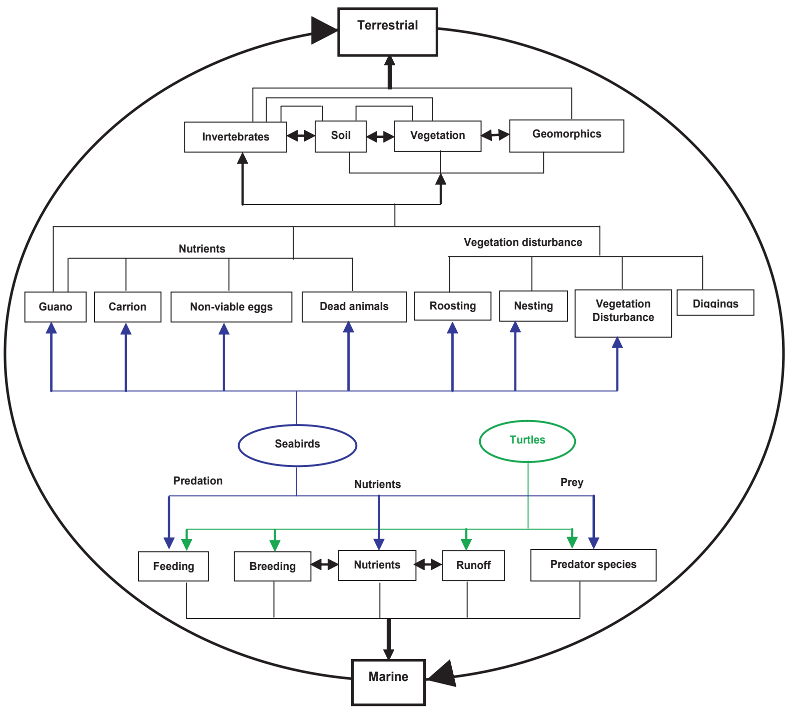


Figure 15. A simplified diagram demonstrating a selection of direct and indirect linkages between the terrestrial and marine environments of Lihou Reef, mediated by seabirds and marine turtles. Blue arrows: potential linkages between seabirds and the marine and terrestrial environments; green arrows: potential linkages between marine turtles and the marine and terrestrial environments; black, double-ended arrows: two-way linkages (from Harvey et al. 2009). The transfer of energy between marine and terrestrial communities through seabirds was also confirmed by Heatwole (1971).

Knowledge Gaps

A broad description of the physical and biological attributes of the Coral Sea is possible from tying together general knowledge about the region with the results of individual studies conducted in the Coral Sea, but many knowledge gaps remain. The following points summarise the missing information, touched upon throughout the sections above.

- Sources of data exist, buried in databases and museums, which have not been reported upon or published. These repositories may contain information that could help to fill some of the knowledge gaps listed below.
- Large-scale oceanographic features are known and well-documented, but there is a lack of knowledge of finer-scale hydrodynamics linking habitats within the Coral Sea. There is no knowledge of larval sources and sinks, migration and dispersal pathways, levels of connectivity within the Coral Sea (e.g. the connectivity between the major plateaux), and the degree of connectivity with adjacent systems.
- The potential impacts of climate change on the Coral Sea have yet to be understood. While SST is measured remotely, other important elements, such as sea level rise, have not been directly measured.
- The extent to which the isolation of the Coral Sea's habitats has led to genetic differentiation is unknown.

Rainbow

- Basic ecological knowledge is lacking for most Coral Sea habitats. Little is known about the ecological communities, interactions and processes in the open ocean, deep-sea demersal habitats, seamounts, reefs and cays. For instance, only four of the 18 reef systems have been studied at more than superficial levels, and biological collections have been made at few points in the vast expanse of deeper water.
- Research has yet to link ecological surveys with physical and chemical environmental data.
- Only few areas of feeding or breeding significance for migratory species, such as spawning aggregations, are known in the Coral Sea.
- The population status of a number of the Coral Sea's threatened species is unknown.
- Fishery-independent data on the population status and distribution of large pelagic predators (tunas, billfish, sharks) and their prey is lacking.
- The importance of the Coral Sea to many wide-ranging or migratory species (e.g. migratory cetaceans, tunas, billfish and turtles) is not well understood. Residence times of these types of species in the Coral Sea are also not well-known.
- The logistical difficulty of accessing Coral Sea environments means that there is not understanding of the temporal dynamics of ecological communities, except in the case of isolated terrestrial communities on one or two cays.

Summary and Conclusions

Despite significant gaps in knowledge, the Coral Sea is known to provide habitat for many species protected by national and international legislation. Spawning aggregations of billfish – especially black marlin – and nesting green turtles and seabirds have been identified in a few key locations, and further research may reveal additional areas of reproductive significance for these species. The Coral Sea also provides migratory corridors for cetaceans, sharks, fish, turtles and seabirds, many of which are of conservation concern, and there are likely to be further important areas for feeding, breeding, migrating and resting that have yet to be clearly identified, and which may act as critical habitat for many species. The generally low-nutrient water of the Coral Sea nevertheless provides patches of high productivity, usually associated with topographic seabed features, which serve to aggregate highly mobile pelagic species. Successive research efforts have highlighted the significance of the Coral Sea in patterns of dispersal, whereby the reefs provide a series of dispersal stepping-stones from the western Pacific towards the Great Barrier Reef, while their isolation drives genetic differentiation in self-seeding species. This has led to the evolution of unique communities that show links to the western Pacific, individual sectors of the Great Barrier Reef, and even the Arafura and Timor Seas.

Significant knowledge gaps must be identified and addressed before it is possible to form a clearer understanding of the Coral Sea's overall biodiversity, patterns of connectivity, and the drivers of ecosystem health and resilience. Over large scales, the bathymetry, geology and oceanography of the Coral Sea are relatively well-known, with maps of prominent geomorphic features and major ocean currents. An understanding of the geological forces that shaped the evolution of the Coral Sea's basin and plateaux has been developed over the course of comprehensive bathymetry and drilling projects, through projects such as Southwest Pacific Ocean Circulation and Climate Experiment (SPICE), the Ocean Drilling Program (ODP) and large-scale bathymetric mapping (Ganachaud and Grimes 2006; ODP 2007; Beaman 2010a). However, the integration of geological and geomorphologic research with the Coral Sea's oceanography and ecology is still in its infancy. Ecological knowledge is restricted to a few of the Coral Sea's reefs, deep-sea communities and terrestrial environments.

In summary, the existing knowledge about the Coral Sea serves to establish the following points:

1. The Coral Sea Conservation Zone represents an ecologically realistic area for the conservation of wide-ranging pelagic species (Ceccarelli 2011) and deep-water biota, a high proportion of which are endemic and particularly vulnerable to anthropogenic impacts (Kyne and Simpfendorfer 2010).

2. In terms of scientific rigor, policy development and implementation, Australia is probably one of very few areas of the region's tropical pelagic environment that contains a biota not markedly impacted by fishing and where an area of this scale can be established and maintained (Mora et al. 2009).

3. Although the Coral Sea contains a number of critical shallow reef and terrestrial habitats, these represent less than 1% of the total area. Their small size, isolation and high exposure regimes make them more vulnerable to catastrophic impacts of natural disturbances than the contiguous reef systems of continental and high island margins. This increases the area's ecological fragility and the risk of local extinctions (Mellin et al. 2010).

4. The capacity to manage and forecast the consequences of natural disturbance impacts on the Coral Sea biota is substantially compromised by the lack of understanding of the area's temporal dynamics, which can only be obtained through regular monitoring. The reefs of the Coral Sea will need a different management framework from the contiguous reefs of continental margins. All reef systems undergo cycles of disturbance and recovery over ecological time scales. We have no concrete information of the dimensions of these cycles in exposed oceanic reefs, but preliminary information suggests that recovery will take longer, and the risk of secondary disturbances will be higher, than on near shore contiguous reefs.

5. The only attempt to examine the cost effectiveness of management of tropical protected marine areas (Ban et al. 2009) suggested that the economies of scale dictate greater cost-effectiveness for single large areas than numerous small areas. The same analysis should be applied explicitly to future research and monitoring activities.

6. Finally, we require better fishery independent data on pelagic predators. A management regime for a protected pelagic zone of these dimensions would do well to consider alternative ways of developing abundance indices.

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Dwarf minke whale

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Glossary

abyssal plain

The flat, relatively featureless bottom of the deep ocean, at depths greater than 2000 m. The average depth of the abyssal floor is about 4000 m.

advection

The transfer of heat or matter by the flow of a fluid, especially horizontally in the atmosphere or the sea

bathymetry

The measurement of ocean depths to determine the sea floor topography

benthic

Associated with the bottom under a body of water

bifurcation

Division into two branches or parts

brachiopods

A phylum of marine animals that have hard "valves" (shells) on the upper and lower surfaces, hinged at the rear end

calcareous

Containing calcium carbonate

carbonate ooze

A fine-grained marine sediment containing undissolved calcareous skeletal remains

CFDI

Coral Fish Diversity Index, calculated using actual estimates from visual surveys to estimate the total expected number of species in a region or location

chimaeras

Deep-sea cartilaginous fish of the family Chimaeridae, with a smooth-skinned tapering body and a whiplike tail

crustose coralline algae

Red algae of the division Rhodophyta that contain calcium carbonate and cement and bind the reef together, especially in high wave energy areas

CSF

Coral Sea Fishery

CSIRO

Commonwealth Scientific and Industrial Research Organisation

demersal

(Typically of fish) living close to the floor of the sea or a lake

depauperate

A habitat or ecosystem lacking in numbers or variety of species

detritivores

Animals that feed on detritus

diatoms

Single-celled algae with cell walls of silica

dictyoceratid

An order of sponges of the class Demospongiae; includes the bath sponges

downwelling

The downward movement of fluid, e.g. in the sea

EAC

East Australian Current

echinoderms

A phylum of marine animals including sea stars, sea urchins, sea cucumbers, feather stars and brittle stars

EEZ

Exclusive Economic Zone, a marine boundary that surrounds each nation to 200 nautical miles from shore

elasmobranchs

Cartilaginous fish of a group that comprises the sharks, rays, and skates

endemism

Indigenousness, occurring nowhere else

ENSO

El Niño-Southern Oscillation, an index used to describe climate patterns across the Pacific Ocean

EPBC (1999) Act

Environmental Protection and Biodiversity Conservation (1999) Act

Fe-Mn

Iron-Manganese, chemical compounds often found in nodules in the deep sea

fission (reproduction)

A form of asexual reproduction by which an organism splits into parts, and each part re-grows into a genetically identical organism

flagellates

Protozoans that have one or more flagella used for swimming

foraminiferans

Single-celled planktonic animals (order Foraminiferida, phylum Rhizopoda) with a perforated chalky shell through which slender protrusions of protoplasm extend.

gastropods

A class of mollusks typically having a one-piece coiled shell and flattened muscular foot with a head bearing stalked eyes

GBRMP

Great Barrier Reef Marine Park, the outer edge of which makes up the western boundary of the Coral Sea Conservation Zone

geomorphic

Of or resembling the earth or its shape or surface configuration

gorgonians

Corals having a horny or calcareous branching skeleton. Not included in the group of reef-building corals

guyots

Seamounts with flat tops

gyre

A spiral or vortex

hardgrounds

Surfaces of sedimentarily cemented carbonate layers that have been exposed on the seafloor

Holocene

The present epoch, which is the second epoch in the Quaternary period, after the Pleistocene. The Holocene began about 10,000 years ago, after the retreat of the ice of the last glaciation, and is sometimes regarded as another interglacial period

NSW DPI

New South Wales Department of Primary Industries

Inceptic Coral Calcarosols

Sediment type typical of oceanic coral cays

IPO

Interdecadal Pacific Oscillation

IUCN

International Union for the Conservation of Nature

lithified

Transformed into stone

low turf algae

An assemblage of low-lying and juvenile algal forms that form a layer (~1 mm thick) over the seabed

marine snow

A continuous shower of mostly organic detritus falling from the upper layers of the water column to the deep sea

mesophotic

low light

Mesozoic

The era between the Paleozoic and Cenozoic eras, comprising the Triassic, Jurassic, and Cretaceous periods

Mn-nodules

Manganese nodules, small irregular concretions found on deep ocean floors having high concentrations of certain metals, especially manganese

nematodes

Any of several worms of the phylum *Nematoda*, having unsegmented, cylindrical bodies, often narrowing at each end

nutricline

A sharp gradient in nutrient concentration over a short depth range in the ocean

Glossary

ODP

Ocean Drilling Project

oligotrophic

Low in nutrient concentrations

pelagic

Relating to the open sea

pteropods

Small mollusks (class Gastropoda) with winglike extensions for swimming

refugia

Area in which organisms can survive through a period of unfavorable conditions, especially glaciation

salps

Free-swimming marine invertebrates (class Thaliacea) related to the sea squirts with transparent, barrel-shaped bodies

scleractinian

Stony, reef-building corals of the order Scleractinia

scree

Mass of small loose stones that form or cover a slope on a mountain

seamount

A submarine mountain

sessile

Fixed in one place, immobile

SOI

Southern Oscillation Index

SPC

Secretariat of the Pacific Community

SPICE

Southwest Pacific Ocean Circulation and Climate Experiment

SST

Sea surface temperature

substrate

The surface or material on or from which an organism lives, grows, or obtains its nourishment

syngnathids

A family of fish which includes the seahorses, the pipefishes, and the weedy and leafy sea dragons

Tasmantid Seamount Chain

A chain of seamounts that extends in a north-south direction parallel to the east Australian continental margin

taxonomy

The branch of science concerned with classification, especially of organisms; systematics.

terrigenous

Made of material eroded from the land

trophic

Relating to feeding and nutrition

viviparous

Giving birth to live young

wrasses

Marine fish (family Labridae) with thick lips and strong teeth, typically brightly colored with marked differences between the male and female

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Appendix I – IUCN-Listed Species of the Coral Sea

IUCN Red List - http://www.iucnredlist.org/about/summary-statistics

See also IUCN (2011).

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Cetacean	*Orcinus orca*	Killer whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Globicephala macrorhynchus*	Short-finned pilot whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Feresa attenuata*	Pygmy killer whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Pseudorca crassidens*	False killer whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Kogia breviceps*	Pygmy sperm whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Kogia sima*	Dwarf sperm whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Balaenoptera bonaerensis*	Antarctic minke whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Balaenoptera edeni*	Bryde's whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Mesoplodon densirostris*	Blainville's beaked whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Mesoplodon ginkgodens*	Ginkgo-toothed beaked whale	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Stenella longirostris*	Spinner dolphin	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Tursiops aduncus*	Indo-Pacific bottlenose dolphin	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Cetacean	*Mesoplodon bowdoini*	Andrew's beaked whale	May occur (likely to exclude these)	Status: Data Deficient ver 3.1	unknown
Cetacean	*Mesoplodon mirus*	True's beaked whale	May occur (likely to exclude these)	Status: Data Deficient ver 3.1	unknown
Cetacean	*Mesoplodon grayi*	Gray's beaked whale	May occur (likely to exclude these)	Status: Data Deficient ver 3.1	unknown
Cetacean	*Lissodelphis peronii*	Southern right whale dolphin	May occur (likely to exclude these)	Status: Data Deficient ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Cetacean	*Globicephala melas*	Long-finned pilot whale	Presumed to occur in Coral Sea (records adjacent)	Status: Data Deficient ver 3.1	unknown
Cetacean	*Caperea marginata*	Pygmy right whale	Presumed to occur in Coral Sea (records adjacent)	Status: Data Deficient ver 3.1	unknown
Cetacean	*Balaenoptera musculus*	Blue whale	Known to exist in Coral Sea	Status: Endangered A1abd ver 3.1	increasing
Cetacean	*Balaenoptera borealis*	Sei whale	Known to exist in Coral Sea	Status: Endangered A1ad ver 3.1	unknown
Cetacean	*Balaenoptera physalus*	Fin whale	Known to exist in Coral Sea	Status: Endangered A1d ver 3.1	unknown
Cetacean	*Cephalorhynchus hectori*	Hector's dolphin	Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4d ver 3.1	decreasing
Cetacean	*Peponocephala electra*	Melon-headed whale	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Megaptera novaeangliae*	Humpback whale	Known to exist in Coral Sea	Status: Least Concern ver 3.1	increasing
Cetacean	*Balaenoptera acutorostrata*	Dwarf minke whale	Known to exist in Coral Sea	Status: Least Concern ver 3.1	stable
Cetacean	*Ziphius cavirostris*	Cuvier's beaked whale	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Steno bredanensis*	Rough-toothed dolphin	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Grampus griseus*	Risso's dolphin	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Lagenodelphis hosei*	Fraser's dolphin	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Stenella attenuata*	Pantropical spotted dolphin	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Stenella coeruleoalba*	Striped dolphin	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Tursiops truncatus*	Bottlenose dolphin	Known to exist in Coral Sea	Status: Least Concern ver 3.1	unknown
Cetacean	*Hyperoodon planifrons*	Arnoux's beaked whale	May occur (likely to exclude these)	Status: Least Concern ver 3.1	unknown
Cetacean	*Delphinus delphis*	Common dolphin	Presumed to occur in Coral Sea (records adjacent)	Status: Least Concern ver 3.1	unknown
Cetacean	*Orcaella heinsohni*	Australian snubfin dolphin	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Cetacean	*Sousa chinensis*	Indo-pacific hump-backed dolphin	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Cetacean	*Physeter macrocephalus*	Sperm whale	Known to exist in Coral Sea	Status: Vulnerable A1d ver 3.1	unknown
Coral – blue	*Heliopora coerulea*	Blue coral	Known to exist in Coral Sea	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – brain	*Lobophyllia serratus*		Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4c ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – brain	*Caulastrea tumida*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia helianthoides*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Leptastrea bewickensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Leptastrea bottae*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Leptastrea inaequalis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Leptoria phrygia*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Montastrea annuligera*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia laxa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia lizardensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia maritima*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia matthaii*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia maxima*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia rotundata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia stelligera*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia veroni*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia vietnamensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites abdita*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites chinensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites complanata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites flexuosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites halicora*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites russelli*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Goniastrea favulus*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Goniastrea palauensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Lobophyllia pachysepta*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – brain	*Micromussa amakusensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – brain	*Oulophyllia bennettae*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – brain	*Oulophyllia crispa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Platygyra lamellina*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Platygyra ryukyuensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Platygyra verweyi*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Trachyphyllia geoffroyi*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Montastrea colemani*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Montastrea magnistellata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Montastrea valenciennesi*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Goniastrea columella*		May occur (likely to exclude these)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favia marshae*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites acuticollis*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites bestae*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites micropentagona*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites paraflexuosa*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral - brain	*Favites stylifera*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Favites vasta*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Goniastrea minuta*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Micromussa minuta*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – brain	*Platygyra acuta*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Platygyra carnosus*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – brain	*Barabattoia laddi*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Favia rosaria*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – brain	*Lobophyllia dentatus*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – brain	*Platygyra yaeyamaensis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Symphyllia hassi*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – brain	*Australogyra zelli*	Ruffle/ridge coral	Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Cyphastrea agassizi*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Cyphastrea ocellina*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Leptoria irregularis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Montastrea salebrosa*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Moseleya latistellata*	Giant star coral	Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Goniastrea deformis*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Echinopora ashmorensis*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Leptastrea aequalis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Montastrea multipunctata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Favites spinosa*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Goniastrea ramosa*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – brain	*Caulastrea curvata*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	decreasing
Coral – brain	*Caulastrea echinulata*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	decreasing
Coral – brain	*Lobophyllia diminuta*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	unknown
Coral – brain	*Lobophyllia flabelliformis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	unknown
Coral – bubble	*Euphyllia divisa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – bubble	*Euphyllia glabrescens*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – bubble	*Euphyllia yaeyamaensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – bubble	*Plerogyra sinuosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – bubble	*Plerogyra simplex*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – bubble	*Euphyllia paraglabrescens*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – bubble	*Plerogyra discus*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – bubble	*Catalaphyllia jardinei*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – bubble	*Euphyllia ancora*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – bubble	*Euphyllia cristata*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	stable
Coral – bubble	*Euphyllia paraancora*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – bubble	*Physogyra lichtensteini*	Bubble coral	Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – bubble	*Euphyllia paradivisa*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cd ver 3.1	unknown
Coral – chalice	*Pectinia maxima*		Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4cd ver 3.1	unknown
Coral – chalice	*Echinomorpha nishihirai*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – chalice	*Pectinia elongata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – chalice	*Pectinia paeonia*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – chalice	*Pectinia ayleni*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – chalice	*Pectinia pygmaeus*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – chalice	*Pectinia teres*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – chalice	*Pectinia alcicornis*	Lettuce coral	Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – chalice	*Mycedium steeni*	Giant star coral	May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	unknown
Coral – chalice	*Echinophyllia costata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – chalice	*Pectinia lactuca*	Lettuce coral	Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – corrugated	*Pavona minuta*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – corrugated	*Pachyseris gemmae*	Elephant skin coral	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – corrugated	*Pavona bipartita*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – corrugated	*Pavona decussata*	Cactus coral	Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – corrugated	*Pavona venosa*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – corrugated	*Pavona danai*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	unknown
Coral – corrugated	*Pavona diffluens*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	unknown
Coral – corrugated	*Pachyseris rugosa*	Elephant skin coral	Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – corrugated	*Pavona cactus*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – corrugated	*Leptoseris incrustans*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	unknown
Coral – corrugated	*Leptoseris yabei*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	unknown
Coral – corrugated	*Pachyseris involuta*	Elephant skin coral	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	unknown
Coral – cup	*Duncanopsammia axifuga*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – cup	*Heteropsammia eupsammides*	Smooth bum coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – fire	*Millepora boschmai*		May occur (likely to exclude these)	Status: Critically Endangered A2ac ver 3.1	unknown
Coral – fire	*Millepora tuberosa*		May occur (likely to exclude these)	Status: Endangered A4c ver 3.1	decreasing
Coral – fire	*Millepora murrayi*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – fire	*Millepora latifolia*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – fire	*Millepora foveolata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – galaxy	*Galaxea fascicularis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – galaxy	*Galaxea longisepta*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – galaxy	*Hydnophora exesa*	Ruffle/ridge coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – galaxy	*Hydnophora microconos*	Ruffle/ridge coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – galaxy	*Leptoseris striata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – galaxy	*Galaxea paucisepta*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – galaxy	*Leptoseris amitoriensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – galaxy	*Galaxea acrhelia*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – galaxy	*Galaxea cryptoramosa*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – galaxy	*Galaxea astreata*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – golf ball	*Alveopora excelsa*		Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4c ver 3.1	unknown
Coral – golf ball	*Alveopora minuta*		Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4cd ver 3.1	unknown
Coral – golf ball	*Porites ornata*		May occur (likely to exclude these)	Status: Endangered A4cde ver 3.1	unknown
Coral – golf ball	*Porites eridani*		Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4cde ver 3.1	unknown
Coral – golf ball	*Alveopora catalai*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Alveopora spongiosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Goniopora columna*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Goniopora lobata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Goniopora minor*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Goniopora stokesi*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites annae*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites cylindrica*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites deformis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites densa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites lobata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites murrayensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites stephensoni*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Alveopora viridis*		May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Goniopora tenella*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Porites negrosensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – golf ball	*Alveopora fenestrata*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Alveopora gigas*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Alveopora marionensis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Goniopora cellulosa*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – golf ball	*Alveopora daedalea*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Goniopora albiconus*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Goniopora burgosi*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Goniopora planulata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Goniopora polyformis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – golf ball	*Alveopora allingi*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – golf ball	*Alveopora verrilliana*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – golf ball	*Porites nigrescens*		Known to exist in Coral Sea	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites aranetai*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites attenuata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites cocosensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites cumulatus*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites horizontalata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites napopora*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites rugosa*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites sillimaniana*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – golf ball	*Porites tuberculosa*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	unknown
Coral – lace	*Pocillopora eydouxi*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – lace	*Seriatopora caliendrum*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – lace	*Stylophora pistillata*	Smooth cauliflower coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – lace	*Seriatopora stellata*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	stable
Coral – lace	*Seriatopora aculeata*	Birdsnest coral	Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – lace	*Pocillopora ankeli*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – lace	*Seriatopora dendritica*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – lace	*Pocillopora danae*	Cauliflower coral	Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	unknown
Coral – lace	*Pocillopora elegans*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	unknown
Coral – mushroom	*Cantharellus noumeae*	Mushroom coral	Presumed to occur in Coral Sea (records adjacent)	Status: Endangered B2ab(iii) ver 3.1	unknown
Coral – mushroom	*Ctenactis albitentaculata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – mushroom	*Fungia fungites*	Common mushroom coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – mushroom	*Podabacia motuporensis*	Bracket coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – mushroom	*Polyphyllia novaehiberniae*	Slipper coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – mushroom	*Lithophyllon undulatum*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – mushroom	*Fungia curvata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – mushroom	*Halomitra clavator*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – mushroom	*Heliofungia actiniformis*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – organ pipe	*Tubipora musica*	Organ pipe coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Acanthastrea hillae*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Acanthastrea lordhowensis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Acanthastrea rotundoflora*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Blastomussa wellsi*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Cynarina lacrymalis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Diploastrea heliopora*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – spiny brain	*Echinopora horrida*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – spiny brain	*Echinopora mammiformis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – spiny brain	*Echinopora pacificus*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – spiny brain	*Scolymia vitiensis*	Button coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Australomussa rowleyensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Echinopora taylorae*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Acanthastrea subechinata*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – spiny brain	*Acanthastrea hemprichii*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – spiny brain	*Acanthastrea regularis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – spiny brain	*Acanthastrea faviaformis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – spiny brain	*Acanthastrea ishigakiensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – spiny brain	*Acanthastrea bowerbanki*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	unknown
Coral – spiny brain	*Acanthastrea brevis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	unknown
Coral – staghorn	*Montipora setosa*		May occur (likely to exclude these)	Status: Endangered A4c ver 3.1	decreasing
Coral – staghorn	*Anacropora spinosa*		Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4ce ver 3.1	decreasing
Coral – staghorn	*Isopora togianensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora austera*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora carduus*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora digitifera*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora divaricata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora florida*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora formosa*	Staghorn coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora glauca*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora granulosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – staghorn	*Acropora humilis*	Finger coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora hyacinthus*	Brush coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora loripes*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora lutkeni*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora millepora*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora monticulosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora nana*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora nasuta*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora secale*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora selago*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Acropora tenuis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Isopora palifera*	Catch bowl coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Astreopora expansa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Astreopora macrostoma*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora capitata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora confusa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora efflorescens*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora effusa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora foliosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora foveolata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora incrassata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora nodosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora peltiformis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora undata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora venosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Psammocora contigua*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – staghorn	*Psammocora digitata*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – staghorn	*Psammocora obtusangula*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – staghorn	*Pseudosiderastrea tayami*	Starlet coral	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – staghorn	*Acropora pichoni*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora hirsuta*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora niugini*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora palawanensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Montipora porites*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Coral – staghorn	*Psammocora vaughani*		Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Coral – staghorn	*Anacropora matthai*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora corbettensis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora crassituberculata*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora samarensis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora turtlensis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Acropora russelli*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora lobulata*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora gaimardi*		May occur (likely to exclude these)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora florida*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora hodgsoni*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora mactanensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora malampaya*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora meandrina*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – staghorn	*Montipora orientalis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora verruculosus*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Montipora vietnamensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	decreasing
Coral – staghorn	*Acropora abrolhosensis*		Known to exist in Coral Sea	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – staghorn	*Acropora echinata*		Known to exist in Coral Sea	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – staghorn	*Acropora horrida*		Known to exist in Coral Sea	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – staghorn	*Acropora kimbeensis*		Known to exist in Coral Sea	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – staghorn	*Acropora elegans*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – staghorn	*Montipora altasepta*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cde ver 3.1	decreasing
Coral – staghorn	*Acropora aculeus*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora acuminata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora anthocercis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora aspera*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora caroliniana*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora dendrum*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora donei*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora globiceps*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora kirstyae*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora listeri*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora lokani*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora lovelli*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora microclados*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora multiacuta*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora palmerae*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora paniculata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – staghorn	*Acropora polystoma*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora solitaryensis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora speciosa*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora spicifera*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora striata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora vaughani*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora verweyi*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora willisae*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Anacropora puertogalerae*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Anacropora reticulata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Isopora brueggemanni*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Isopora crateriformis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Isopora cuneata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Astreopora cucullata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Astreopora incrustans*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Astreopora moretonensis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora angulata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora australiensis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora caliculata*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora capricornis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora cebuensis*		Known to exist in Coral Sea	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora kosurini*		May occur (likely to exclude these)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora loisetteae*		May occur (likely to exclude these)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora hemprichii*		May occur (likely to exclude these)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora awi*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora batunai*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – staghorn	*Acropora derawanensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora desalwii*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora hoeksemai*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora indonesia*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora jacquelineae*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora papillare*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora calcarea*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora pharaonis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora plumosa*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora retusa*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora simplex*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora cocosensis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora delicatula*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora friabilis*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora tenella*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora turaki*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Acropora walindii*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing
Coral – staghorn	*Montipora cactus*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Coral – stony	*Coscinaraea crassa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – stony	*Palauastrea ramosa*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – stony	*Paraclavarina triangularis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – stony	*Stylocoeniella cocosensis*	Thorn coral	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4c ver 3.1	unknown
Coral – stony	*Psammocora stellata*		Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4ce ver 3.1	unknown
Coral – turban	*Turbinaria radicalis*		Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Coral – turban	*Turbinaria bifrons*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – turban	*Turbinaria heronensis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – turban	*Turbinaria patula*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – turban	*Turbinaria reniformis*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – turban	*Turbinaria stellulata*		Known to exist in Coral Sea	Status: Vulnerable A4c ver 3.1	unknown
Coral – turban	*Turbinaria mesenterina*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Coral – turban	*Turbinaria peltata*		Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	unknown
Fish – Perciformes	*Cheilinus undulatus*	Humphead wrasse	Known to exist in Coral Sea	Status: Endangered A2bd+3bd ver 3.1	decreasing
Fish – Perciformes	*Choerodon schoenleinii*	Blackspot tuskfish	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Fish – Perciformes	*Epinephelus coioides*	Orange-spotted grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Epinephelus fuscoguttatus*	Brown-marbled grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Fish – Perciformes	*Epinephelus malabaricus*	Malabar grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Epinephelus polyphekadion*	Camouflage grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Epinephelus socialis*	Surge grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Plectropomus leopardus*	Leopard coral grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Plectropomus oligacanthus*	Highfin coral grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Plectropomus pessuliferus*	Roving coral grouper	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Epinephelus bleekeri*	Duskytail grouper	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	decreasing
Fish – Perciformes	*Bolbometopon muricatum*	Green humphead parrotfish	Known to exist in Coral Sea	Status: Vulnerable A2d ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Fish – Perciformes	*Epinephelus lanceolatus*	Queensland grouper	Known to exist in Coral Sea	Status: Vulnerable A2d ver 3.1	decreasing
Fish – Perciformes	*Plectropomus laevis*	Blacksaddled coral grouper	Known to exist in Coral Sea	Status: Vulnerable A2d+4d ver 3.1	decreasing
Fish – Perciformes	*Cromileptes altivelis*	Barramundi cod	Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	decreasing
Fish – Perciformes	*Plectropomus areolatus*	Squaretail leopard grouper	Known to exist in Coral Sea	Status: Vulnerable A4d ver 3.1	decreasing
Fish – Perciformes	*Thunnus obesus*	Bigeye tuna	Known to exist in Coral Sea	Vulnerable A1bd ver 2.3	Update in progress
Fish– Perciformes	*Thunnus albacares*	Yellowfin tuna	Known to exist in Coral Sea	Near Threatened (update in progress)	Update in progress
Fish– Perciformes	*Thunnus alalunga*	Albacore tuna	Known to exist in Coral Sea	Near Threatened (update in progress)	Update in progress
Fish – Perciformes	*Makaira nigricans*	Blue marlin	Known to exist in Coral Sea	Vulnerable (update in progress)	Update in progress
Fish – Perciformes	*Tetrapturus audax*	Striped marlin	Known to exist in Coral Sea	Near Threatened (update in progress)	Update in progress
Fish – Syngnathids	*Hippocampus kuda*	Spotted seahorse	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cd ver 3.1	decreasing
Fish – Syngnathids	*Hippocampus spinosissimus*	Hedgehog seahorse	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A4cd ver 3.1	decreasing
Fish – Syngnathids	*Hippocampus trimaculatus*	Low-crowned seahorse	Known to exist in Coral Sea	Status: Vulnerable A4cd ver 3.1	decreasing
Seabirds	*Pseudobulweria becki*	Beck's petrel	Known to exist in Coral Sea	Status: Critically Endangered C2a(ii) ver 3.1	decreasing
Seabirds	*Puffinus huttoni*	Hutton's shearwater	Known to exist in Coral Sea	Status: Endangered B2ab(ii,iii) ver 3.1	decreasing
Seabirds	*Diomedea sanfordi*	Northern royal albatross	May occur (likely to exclude these)	Status: Endangered A4bc; B2ab(iii,v) ver 3.1	
Seabirds	*Thalassarche melanophrys*	Black-browed albatross	May occur (likely to exclude these)	Status: Endangered A4bd ver 3.1	
Seabirds	*Thalassarche carteri*	Indian yellow-nosed albatross	May occur (likely to exclude these)	Status: Endangered A4bd ver 3.1	
Seabirds	*Fregata ariel*	Lesser frigatebird	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Fregata minor*	Great frigatebird	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Larus novaehollandiae*	Silver gull	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Phaethon rubricauda*	Red-tailed tropicbird	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Sula dactylatra*	Masked booby	Known to exist in Coral Sea	Status: Least Concern ver 3.1	

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Seabirds	*Sula sula*	Red-footed booby	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Sula leucogaster*	Brown booby	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Pluvialis fulva*	Pacific golden plover	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Numenius phaeopus*	Whimbrel	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Tringa incana*	Wandering tattler	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Arenaria interpres*	Ruddy turnstone	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Anous stolidus*	Common noddy	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Anous minutus*	Black noddy	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Sterna fuscata*	Sooty tern	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Sterna dougallii*	Roseate tern	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Sterna sumatrana*	Black-naped tern	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Sterna bergii*	Crested tern	Known to exist in Coral Sea	Status: Least Concern ver 3.1	
Seabirds	*Macronectes giganteus*	Southern giant-petrel	May occur (likely to exclude these)	Status: Least Concern ver 3.1	
Seabirds	*Macronectes halli*	Northern giant-petrel	May occur (likely to exclude these)	Status: Least Concern ver 3.1	
Seabirds	*Sterna albifrons*	Little tern	Presumed to occur in Coral Sea (records adjacent)	Status: Least Concern ver 3.1	
Seabirds	*Pseudobulweria rostrata*	Tahiti petrel	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Seabirds	*Thalassarche steadi*	White-capped albatross	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened A2de+3de+4de ver 3.1	
Seabirds	*Thalassarche cauta*	Shy albatross	Known to exist in Coral Sea	Status: Near Threatened D2 ver 3.1	
Seabirds	*Thalassarche bulleri*	Buller's albatross	May occur (likely to exclude these)	Status: Near Threatened D2 ver 3.1	
Seabirds	*Pterodroma leucoptera*	Gould's petrel	Known to exist in Coral Sea	Status: Vulnerable B2ab(v); D2 ver 3.1	decreasing
Seabirds	*Diomedea exulans*	Wandering (snowy) albatross	May occur (likely to exclude these)	Status: Vulnerable A4bd ver 3.1	
Seabirds	*Thalassarche chrysostoma*	Grey-headed albatross	May occur (likely to exclude these)	Status: Vulnerable A4bd ver 3.1	
Seabirds	*Sterna nereis*	Fairy tern	Known to exist in Coral Sea	Status: Vulnerable C1 ver 3.1	
Seabirds	*Pterodroma solandri*	Providence petrel	Known to exist in Coral Sea	Status: Vulnerable D2 ver 3.1	increasing
Seabirds	*Diomedea antipodens*	Antipodean albatross	May occur (likely to exclude these)	Status: Vulnerable D2 ver 3.1	

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Seabirds	*Diomedea epomophora*	Southern royal albatross	May occur (likely to exclude these)	Status: Vulnerable D2 ver 3.1	
Seabirds	*Thalassarche salvini*	Salvin's albatross	May occur (likely to exclude these)	Status: Vulnerable D2 ver 3.1	
Seabirds	*Thalassarche eremita*	Chatham albatross	May occur (likely to exclude these)	Status: Vulnerable D2 ver 3.1	
Seabirds	*Pterodroma cervicalis*	White-necked petrel	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable D2 ver 3.1	increasing
Seabirds	*Pterodroma cookii*	Cook's Petrel	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable D2 ver 3.1	increasing
Seabirds	*Thalassarche impavida*	Campbell albatross	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable D2 ver 3.1	
Sharks and Rays	*Centrophorus harrissoni*	Harrisson's dogfish	Presumed to occur in Coral Sea (records adjacent)	Status: Critically Endangered A2acd;C2a(i) ver 3.1	decreasing
Sharks and Rays	*Pristis clavata*	Queensland sawfish	Presumed to occur in Coral Sea (records adjacent)	Status: Critically Endangered A2acd;C2a(i) ver 3.1	decreasing
Sharks and Rays	*Pristis zijsron*	Green sawfish	Presumed to occur in Coral Sea (records adjacent)	Status: Critically Endangered A2acd;C2a(i) ver 3.1	decreasing
Sharks and Rays	*Carcharhinus hemiodon*	Pondicherry shark	Presumed to occur in Coral Sea (records adjacent)	Status: Critically Endangered A2acd;C2a(i) ver 3.1	unknown
Sharks and Rays	*Anoxypristis cuspidata*	Knifetooth sawfish	Presumed to occur in Coral Sea (records adjacent)	Status: Critically Endangered A2bcd+3cd+4bcd ver 3.1	decreasing
Sharks and Rays	*Carcharhinus amboinensis*	Pigeye shark	Known to exist in Coral Sea	Status: Data Deficient ver 3.1	unknown
Sharks and Rays	*Notorynchus cepedianus*	Broadnose shark	Presumed to occur in Coral Sea (records adjacent)	Status: Data Deficient ver 3.1	unknown
Sharks and Rays	*Aetomylaeus vespertilio*	Reticulate eagle ray	Presumed to occur in Coral Sea (records adjacent)	Status: Endangered A2bd+3d+4d ver 3.1	decreasing
Sharks and Rays	*Sphyrna mokarran*	Squat-headed hammerhead shark	Known to exist in Coral Sea	Status: Endangered A2bd+4bd ver 3.1	decreasing
Sharks and Rays	*Sphyrna lewini*	Scalloped hammerhead	Known to exist in Coral Sea	Status: Endangered A2bd+4bd ver 3.1	unknown
Sharks and Rays	*Myliobatis hamlyni*	Purple eagle ray	May occur (likely to exclude these)	Status: Endangered B1ab(v); C2a(i) ver 3.1	decreasing
Sharks and Rays	*Carcharhinus borneensis*	Borneo shark	May occur (likely to exclude these)	Status: Endangered C2a(ii) ver 3.1	unknown
Sharks and Rays	*Mustelus antarcticus*	Gummy shark	Presumed to occur in Coral Sea (records adjacent)	Status: Least Concern ver 3.1	stable
Sharks and Rays	*Aetobatus narinari*	Spotted eagle ray	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing

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Sharks and Rays	*Carcharhinus dussumieri*	Widemouth blackspot shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Sharks and Rays	*Carcharhinus falciformis*	Silky shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Sharks and Rays	*Carcharhinus melanopterus*	Blacktip reef shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Sharks and Rays	*Chiloscyllium punctatum*	Brownbanded bamboo shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	decreasing
Sharks and Rays	*Carcharhinus albimarginatus*	Silvertip shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus amblyrhynchoides*	Graceful shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus amblyrhynchos*	Gray reef shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus brevipinna*	Spinner shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus leucas*	Bull shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus limbatus*	Blacktip shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Dalatias licha*	Kitefin shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Eusphyra blochii*	Slender hammerhead	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Galeocerdo cuvier*	Tiger shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Heptranchias perlo*	Sharpnose sevengill shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Hexanchus griseus*	Bluntnose sixgill shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Manta birostris*	Manta ray	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Mobula japanica*	Spinetail devilray	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Orectolobus maculatus*	Spotted wobbegong	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Orectolobus ornatus*	Dwarf ornate wobbegong	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Prionace glauca*	Blue shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Pseudocarcharias kamoharai*	Crocodile shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Squalus grahami*	Eastern longnose spurdog	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Triaenodon obesus*	Whitetip reef shark	Known to exist in Coral Sea	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Centrophorus niaukang*	Taiwan gulper shark	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	decreasing

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Sharks and Rays	*Atelomycterus marmoratus*	Coral catshark	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Chiloscyllium hasselti*	Indonesian bambooshark	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Chiloscyllium plagiosum*	Whitespotted bamboo shark	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Dasyatis zugei*	Pale-edged stingray	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Echinorhinus cookei*	Spinous shark	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Mobula thurstoni*	Smoothtail devilray	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Proscymnodon plunketi*	Plunket's dogfish	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Squalus rancureli*	Cyrano spurdog	May occur (likely to exclude these)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Eucrossorhinus dasypogon*	Tasselled wobbegong	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Sharks and Rays	*Orectolobus halei*	Banded wobbegong	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	decreasing
Sharks and Rays	*Apristurus albisoma*	Whitish catshark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus brachyurus*	New Zealand whaler	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus galapagensis*	Galapagos shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus macloti*	Hardnose shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus sealei*	Blackspot shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharhinus sorrah*	Spottail shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Cephaloscyllium catum*	Northern draughtboard shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Chiloscyllium griseum*	Grey bamboo shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Chiloscyllium indicum*	Ridgebacked bamboo shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Chlamydoselachus anguineus*	Scaffold shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown

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Sharks and Rays	*Dasyatis annotata*	Brown stingray	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Dasyatis leylandi*	Brown-reticulate stingray	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Hemiscyllium freycineti*	Indonesian speckled carpet shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Himantura granulata*	Whitetail whipray	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Hydrolagus ogilbyi*	Ogilby's ghostshark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Hypogaleus hyugaensis*	Pencil shark	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Mobula eregoodootenkee*	Pygmy devilray	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Taeniura lymma*	Ribbontailed stingray	Presumed to occur in Coral Sea (records adjacent)	Status: Near Threatened ver 3.1	unknown
Sharks and Rays	*Carcharias taurus*	Sand tiger shark	Known to exist in Coral Sea	Status: Vulnerable A2ab+3d ver 3.1	unknown
Sharks and Rays	*Negaprion acutidens*	Sharptooth lemon shark	Known to exist in Coral Sea	Status: Vulnerable A2abcd+3bcd+4abcd ver 3.1	decreasing
Sharks and Rays	*Nebrius ferrugineus*	Tawny nurse shark	Known to exist in Coral Sea	Status: Vulnerable A2abcd+3cd+4abcd ver 3.1	decreasing
Sharks and Rays	*Stegostoma fasciatum*	Leopard shark	Known to exist in Coral Sea	Status: Vulnerable A2abcd+3cd+4abcd ver 3.1	decreasing
Sharks and Rays	*Isurus oxyrinchus*	Shortfin mako shark	Known to exist in Coral Sea	Status: Vulnerable A2abd+3bd+4abd ver 3.1	decreasing
Sharks and Rays	*Rhinobatos thouin*	Clubnose guitarfish	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2abd+3bd+4abd ver 3.1	unknown
Sharks and Rays	*Centrophorus granulosus*	Gulper shark	Known to exist in Coral Sea	Status: Vulnerable A2abd+3d+4d ver 3.1	decreasing
Sharks and Rays	*Carcharhinus longimanus*	Oceanic whitetip shark	Known to exist in Coral Sea	Status: Vulnerable A2ad+3d+4ad ver 3.1	decreasing
Sharks and Rays	*Galeorhinus galeus*	School shark	Known to exist in Coral Sea	Status: Vulnerable A2ad+3d+4ad ver 3.1	decreasing
Sharks and Rays	*Centrophorus squamosus*	Leafscale gulper shark	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2ad+3d+4ad ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Sharks and Rays	*Dasyatis fluviorum*	Estuary stingray	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2ad+3d+4ad ver 3.1	decreasing
Sharks and Rays	*Taeniura meyeni*	Black-blotched stingray	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2ad+3d+4ad ver 3.1	unknown
Sharks and Rays	*Alopias superciliosus*	Bigeye thresher shark	Known to exist in Coral Sea	Status: Vulnerable A2bd ver 3.1	decreasing
Sharks and Rays	*Carcharhinus obscurus*	Dusky shark	Known to exist in Coral Sea	Status: Vulnerable A2bd ver 3.1	decreasing
Sharks and Rays	*Squatina albipunctata*	Eastern angel shark	Known to exist in Coral Sea	Status: Vulnerable A2bd ver 3.1	decreasing
Sharks and Rays	*Urogymnus asperrimus*	Porcupine ray	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd ver 3.1	unknown
Sharks and Rays	*Urolophus bucculentus*	Sandyback stingaree	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd ver 3.1	decreasing
Sharks and Rays	*Urolophus sufflavus*	Yellowback stingaree	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd ver 3.1	decreasing
Sharks and Rays	*Urolophus viridis*	Greenback stingaree	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd ver 3.1	decreasing
Sharks and Rays	*Himantura gerrardi*	Whitespotted whipray	May occur (likely to exclude these)	Status: Vulnerable A2bd+3bd ver 3.1	unknown
Sharks and Rays	*Alopias vulpinus*	Common thresher shark	Known to exist in Coral Sea	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing
Sharks and Rays	*Hemipristis elongatus*	Snaggletooth shark	Known to exist in Coral Sea	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing
Sharks and Rays	*Rhynchobatus laevis*	Smoothnose wedgefish	May occur (likely to exclude these)	Status: Vulnerable A2bd+3bd+4bd ver 3.1	unknown
Sharks and Rays	*Himantura uarnak*	Reticulate whipray	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing
Sharks and Rays	*Himantura undulata*	Bleeker's variegated whipray	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing
Sharks and Rays	*Rhina ancylostoma*	Bowmouth guitarfish	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing
Sharks and Rays	*Rhinobatos typus*	Common shovelnose ray	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing
Sharks and Rays	*Rhynchobatus australiae*	White-spotted guitarfish	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing
Sharks and Rays	*Sphyrna zygaena*	Smooth hammerhead	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd+3bd+4bd ver 3.1	decreasing

Taxonomic Group	Latin Name	Common Name	Occurrence in CS	IUCN Status	Population Trend
Sharks and Rays	*Rhincodon typus*	Whale shark	Known to exist in Coral Sea	Status: Vulnerable A2bd+3d ver 3.1	decreasing
Sharks and Rays	*Isurus paucus*	Longfin mako	Known to exist in Coral Sea	Status: Vulnerable A2bd+3d+4bd ver 3.1	decreasing
Sharks and Rays	*Rhinobatos granulatus*	Sharpnose guitarfish	May occur (likely to exclude these)	Status: Vulnerable A2bd+3d+4d ver 3.1	decreasing
Sharks and Rays	*Carcharhinus plumbeus*	Sandbar shark	Known to exist in Coral Sea	Status: Vulnerable A2bd+4bd ver 3.1	decreasing
Sharks and Rays	*Odontaspis ferox*	Small-tooth sand tiger shark	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2bd+4bd ver 3.1	decreasing
Sharks and Rays	*Carcharodon carcharias*	Great white shark	Known to exist in Coral Sea	Status: Vulnerable A2cd+3cd ver 3.1	unknown
Sharks and Rays	*Rhinoptera javanica*	Javanese cownose ray	May occur (likely to exclude these)	Status: Vulnerable A2d+3cd+4cd ver 3.1	unknown
Sharks and Rays	*Aetomylaeus nichofii*	Banded eagle ray	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable A2d+3d+4d ver 3.1	decreasing
Sharks and Rays	*Alopias pelagicus*	Pelagic thresher	Known to exist in Coral Sea	Status: Vulnerable A2d+4d ver 3.1	decreasing
Sharks and Rays	*Aulohalaelurus kanakorum*	New Caledonia catshark	May occur (likely to exclude these)	Status: Vulnerable B1ab(iii) ver 3.1	unknown
Sharks and Rays	*Hemiscyllium hallstromi*	Papuan epaulette shark	Presumed to occur in Coral Sea (records adjacent)	Status: Vulnerable B1ab(iii) ver 3.1	unknown
Sharks and Rays	*Heteroscyllium colcloughi*	Bluegrey carpetshark	Known to exist in Coral Sea	Status: Vulnerable C2a(ii) ver 3.1	unknown
Sirenia	*Dugong dugon*	Dugong	May occur (likely to exclude these)	Status: Vulnerable A2bcd ver 3.1	unknown
Turtle	*Dermochelys coriacea*	Leatherback turtle	Known to exist in Coral Sea	Status: Critically Endangered A1abd ver 2.3	decreasing
Turtle	*Eretmochelys imbricata*	Hawksbill turtle	Known to exist in Coral Sea	Status: Critically Endangered A2bd ver 3.1	decreasing
Turtle	*Natator depressus*	Flatback turtle	Presumed to occur in Coral Sea (records adjacent)	Status: Data Deficient ver 3.1	needs updating
Turtle	*Chelonia mydas*	Green turtle	Known to exist in Coral Sea	Status: Endangered A2bd ver 3.1	decreasing
Turtle	*Caretta caretta*	Loggerhead turtle	Known to exist in Coral Sea	Status: Vulnerable A1abd ver 3.1	needs updating
Turtle	*Lepidochelys olivacea*	Olive Ridley turtle	Known to exist in Coral Sea	Status: Vulnerable A2bd ver 3.1	decreasing

Appendix 2 – Species listed on the *EPBC (1999) Act* and international agreements (CITES, JAMBA, CAMBA and ROKAMBA)

Species listed under the *EPBC Act* and their status under four international agreements. Ce: Cetaceans, Mi: Migratory species, Ma: Marine species, V: Vulnerable, E: Endangered, CD: Conservation Dependent, CE: Critically Endangered. CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) species are listed under either Appendix I () or II. J/C/ROKAMBA refers to species listed under the Japan/China/Republic of Korea – Australia Migratory Bird Agreements. *Protected species known to occur in the East Marine region but have no identified important areas in the Coral Sea section of the region.

Taxonomic Group	Species	Common Name	EPBC	CITES	JAMBA	CAMBA	CAMBA
Cetacean	*Orcinus orca*	Killer whale	Ce, Mi	II			
	Globicephala macrorhynchus	Short-finned pilot whale	Ce	II			
	Pseudorca crassidens	False killer whale	Ce	II			
	Feresa attenuata	Pygmy killer whale*	Ce	II			
	Kogia breviceps	Pygmy sperm whale*	Ce	II			
	Kogia sima	Dwarf sperm whale*	Ce	II			
	Physeter macrocephalus	Sperm whale	Ce, Mi	I			
	Megaptera novaeangliae	Humpback whale	V,Ce, Mi	I			
	Balaenoptera acutorostrata	Dwarf minke whale	Ce	I			
	Balaenoptera bonaerensis	Antarctic minke whale *	Ce, Mi	I			
	Balaenoptera borealis	Sei whale*	V,Ce, Mi	I			
	Balaenoptera edeni	Bryde's whale*	Ce, Mi	I			

Taxonomic Group	Species	Common Name	EPBC	CITES	JAMBA	CAMBA	CAMBA
	Balaenoptera musculus	Blue whale*	E,Ce, Mi	I			
	Mesoplodon densirostris	Blainville's beaked whale	Ce	II			
	Mesoplodon ginkgoensis	Ginkgo-toothed beaked whale*	Ce	II			
	Ziphius cavirostris	Cuvier's beaked whale	Ce	II			
	Peponocephala electra	Melon-headed whale	Ce	II			
	Orcaella heinsohni	Australian snubfin dolphin*	Ce	I			
	Sousa chinensis	Indo-Pacific hump-backed dolphin*	Ce	I			
	Steno brendanensis	Rough-toothed dolphin*	Ce	II			
	Grampus griseus	Risso's dolphin*	Ce	II			
	Lagenodelphis hosei	Fraser's dolphin*	Ce	II			
	Stenella attenuata	Pantropical spotted dolphin*	Ce	II			
	Stenella coeruleoalba	Spinner dolphin*	Ce	II			
	Stenella longirostris	Striped dolphin*	Ce	II			
	Delphinus delphis	Common dolphin*	Ce	II			
	Tursiops truncatus	Bottlenose dolphin*	Ce	II			
	Tursiops aduncus	Indo-Pacific bottlenose dolphin*	Ce	II			
Seabird	*Fregata ariel*	Lesser frigatebird	Mi, Ma		✓	✓	✓
	Fregata minor	Great frigatebird	Mi, Ma			✓	
	Sula sula	Red-footed booby	Mi, Ma		✓	✓	
	Sula leucogaster	Brown booby	Mi, Ma		✓	✓	✓
	Puffinus griseus	Sooty shearwater	Mi, Ma		✓	✓	
	Anous stolidus	Common noddy	Mi, Ma		✓	✓	
	Sterna anaethetus	Bridled tern*	Mi, Ma		✓	✓	
	Sterna sumatrana	Black-naped tern*	Mi, Ma		✓	✓	
	Thalasseus bengalensis	Lesser crested tern*	Mi, Ma			✓	

Taxonomic Group	Species	Common Name	EPBC	CITES	JAMBA	CAMBA	CAMBA
	Oceanites oceanicus	Storm-petrel	Mi, Ma		✓		
	Pterodroma heraldica	Herald petrel	CE				
	Sula dactylatra	Masked booby	Mi, Ma		✓		✓
	Sterna albifrons	Little tern*	Mi, Ma		✓	✓	✓
	Sterna bergii	Crested tern*	Mi, Ma		✓		
	Sterna hirundo	Common tern*	Mi, Ma			✓	✓
	Procelsterna cerulea	Grey ternlet*	Ma				
	Pandion haliaetus	Osprey*	Mi, Ma				
	Phaethon lepturus	White-tailed tropic bird*	Mi, Ma		✓	✓	
	Puffinus assimilis	Little shearwater*	Ma				
	Puffinus pacificus	Wedge-tailed shearwater	Mi, Ma		✓		
	Puffinus carneipes	Flesh-footed shearwater	Mi, Ma		✓	✓	✓
	Puffinus tenuirostris	Short-tailed shearwater	Mi, Ma				✓
	Phaethon rubricauda	Red-tailed tropicbird	Ma				
Shark	*Carcharodon carcharias*	Great white shark	V,Mi	II			
	Rhincodon typus	Whale shark*	V,Mi	II			
	Galeorhinus galeus	School shark	CD				
Turtle	*Dermochelys coriacea*	Leatherback turtle	V,Mi, Ma	I			
	Natator depressus	Flatback turtle	V,Mi, Ma				
	Chelonia mydas	Green turtle	V,Mi, Ma				
	Eretmochelys imbricata	Hawksbill turtle	V,Mi, Ma				
	Caretta caretta	Loggerhead turtle	E				
	Lepidochelys olivacea	Olive Ridley turtle*	E				
Fish	*Syngnathidae & Solenostomidae**	Seahorses, pipefishes	Ma	I (Hippocampus spp.)			
Sea snakes	*Hydrophiidae*	Sea snakes*	Ma				

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