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Marine Mammals of the Emirates: Whales, Dolphins, Porpoises and Dugongs

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Chapter 18
Marine Mammals of the Emirates: Whales, Dolphins, Porpoises and Dugongs

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18.1 Marine Mammals from Life on Land to Life Back to Water

Marine mammals comprise a wide range of taxonomic groups that span from polar bears and otters (Carnivora), seals (Pinnipeds), whales, dolphins and porpoises (Cetaceans) and dugongs and manatees (Sirenians). While the survival of each of these groups is tightly dependent on the aquatic environment, only the last two have evolved to spend their entire life in water. Cetaceans (whales, dolphins and porpoises) and Sirenians (dugongs and manatees), in fact, complete all phases of their life cycle in water without relying on returning to land.

Adaptation to the aquatic environment happened independently and at different times for each group of marine mammals (Fig. 18.1). This is supported by the fact that each of them belong to different taxonomic orders that had evolved from different ancestors. Bears, otters and pinnipeds belong to the Order Carnivora, whales, dolphins and porpoises (Cetaceans) belong to the order Artiodactyla (Prothero et al. 2022) and dugongs and manatees (Sirenians) to the superorder Afrotheria (Graphodatsky et al. 2011). The United Arab Emirates, and the broader Arabian region, is home only to marine mammal species belonging to Cetacea and Sirenia, and therefore we will focus our attention on these two main groups.

The infraorder Cetacea evolved approximately 34–40 million years ago (MYA) (McGowen et al. 2009) across the Eocene-Oligocene transition characterized by a drastic climate shift from a warmer planet to an ice dominated one (Hutchinson et al.

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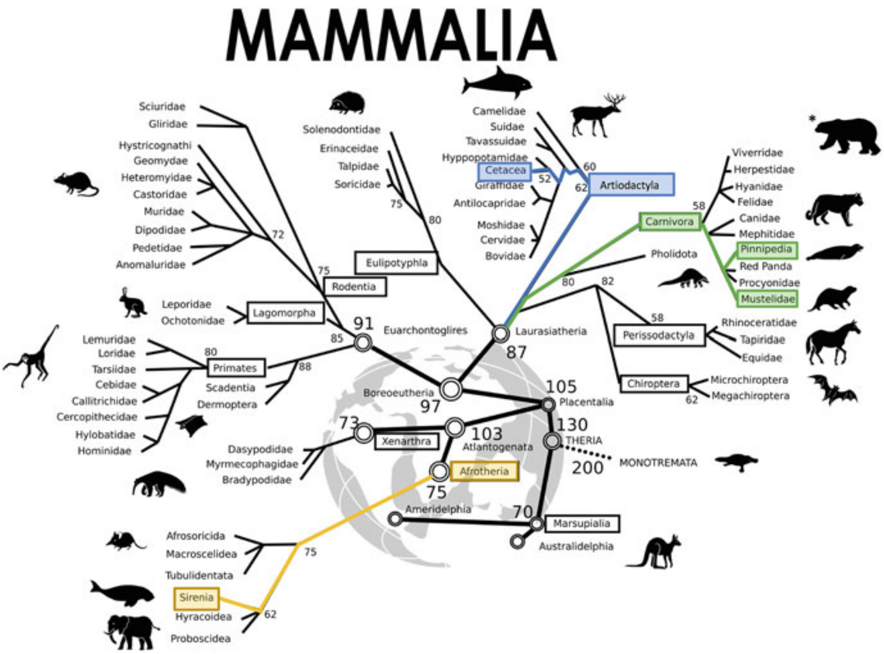

Fig. 18.1 Adaptation to life in water happened independently starting from three different taxonomic groups: Artiodactyla (blue), Carnivora (green) and Afrotheria (yellow). All marine mammals originated from these three groups at different times. Image source: Modified from *An evolutionary tree of mammals* by Pixelsquid, used under Creative Commons (CC-BY-2.0)

2021). This global cooling coincided with the disappearance of the suborder Archaeoceti, whose fossils have been retrieved from around the world. The cooling of ocean waters likely impacted productivity and fuelled the rapid evolutionary radiation of new species more adapted to exploit the newly available resources. The ancestor of modern whales, dolphins and porpoises (Cetacea) has been identified in the genus *Pakicetus* (Fig. 18.2), a four-legged semi-aquatic predator belonging to the late Archaeocetis, which remains were first excavated in Pakistan (Gingerich and Russell 1981; Bajpai and Gingerich 1998).

Cetaceans speciated into two groups both still in existence: Mysticetes and Odontocetes. Currently they comprise a total of 93 officially recognised species (Marine mammal Taxonomy Committee 2022). Mysticetes include all the "real whales" (i.e. baleen whales, as they all have filter-feeding baleen structures instead of teeth) subdivided into 4 families totalling 15 species. The Odontocetes include all the toothed whales, dolphins and porpoises and is subdivided into 10 families for a total of 78 different species, of which one, the river dolphin or "bajii", that used to inhabit the Yangtze River (China) was declared extinct in 2006 (Society of Marine Mammology 2022).

Evidence of the early Sirenians appeared in the Eocene (approximately 56-33.9 MYA), when three of the four families of Sirenians, Prorastomidae, Protosirendiae,

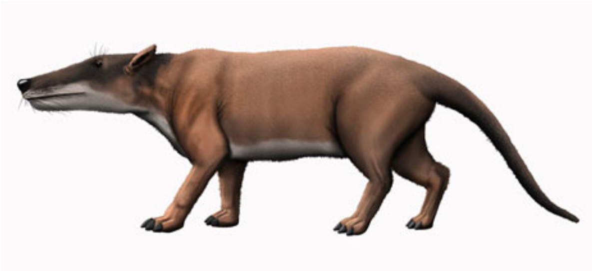

Fig. 18.2 Reconstruction of a species of *Pakicetus* ancestor of whales, dolphins and porpoises, from bone remains. These creatures were endemic to Pakistan approximately 50 MYA (Eocene period). (Source: Pakicetus inachus by Zerosmany, used under Creative Commons (CC-BY-SA 4.0)

Dugongidae occurred, while Tricherchidae only appeared later in the Oligocene (approximately 33.9-23 MYA). Today only two families of the modern Sirenian exist, the families Dugongidae and Tricherchidae. Dugongidae consist of many extinct fossil species and only two modern species: the larger Steller's sea cow (*Hydrodamalis gigas*) which has been declared extinct in 1768, when it was hunted to extinction (Anderson 1995) and the dugong (*Dugong dugon*), still existing today. Tricherchidae also exhibits a number of fossil extinct species, but three species are still extant today. These include the Amazonian manatee (*Trichechus inunguis*), the West Indian manatee (*Trichechus manatus*) and the African manatee (*Trichechus senegalensis*).

For a mammal, adapting to a full life in water involves overcoming some considerable physiological challenges, mostly linked to the different physiochemical characteristics of the aquatic environment versus a terrestrial/air-based habitat. Water is much denser than air, implying higher friction and therefore more energy is required to move through it. On the other hand, it offers more buoyancy enabling bigger size organisms to exist without being overcome by gravity. Sound travels faster and heat is dispersed more quickly in water than in air, whereas diffusion is slower compared to a gaseous medium and light does not travel long distances.

Marine mammals and in particular whales, dolphins, porpoises and dugongs (Cetaceans and Sirenians) evolved to overcome and exploit these characteristics and they are one of the best represented examples, in terms of fossil records, of macroevolutionary adaptation to a new environment (Thewissen and Bajpai 2001; McGowen et al. 2014; Springer et al. 2015).

18.1.1 Mastering Movement in a Liquid Environment

Cetaceans and Sirenians evolved by modifying their body to optimise movement in an aquatic environment, maximising speed and minimising energy consumption.

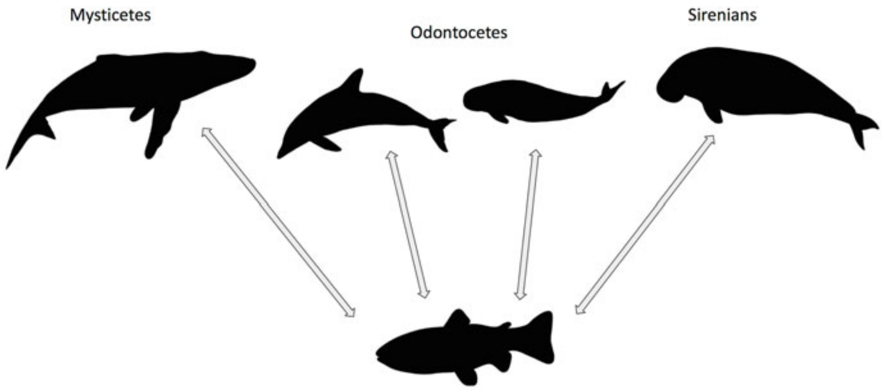

Fig. 18.3 Despite no direct evolutionary link, all marine mammal groups that fully adapted to live in water have converged to a very similar body shape to fish, as this is the most efficient shape to move in water. Note that in all marine mammals the tail is perpendicular to the body axis, whereas in all fish it is positioned on the same axis. Image source: Authors own work; Ada Natoli

The posterior limbs have been reduced to two vestigial bones and the body re-converged to a fusiform fish-like shape, to optimise hydrodynamics (Fig. 18.3).

The propelling force is produced by the fluke connected with strong dorsal muscles (Fish et al. 2008; Domning 2000). Skin also plays an important role to minimise friction. Cetaceans have completely lost any type of hair (few hairs are usually visible only in newborns on top of their snout (or rostrum)) as well as sudoriferous (sweat) and sebaceous (oil) glands, and their skin is extremely compact and smooth compared to terrestrial mammals. The external skin cells are replaced extremely frequently to maintain smoothness and they is covered by a thin layer of jelly-lipid droplets to minimise friction (Hicks et al. 1985). Dugongs still have scattered hair across their body, and it is denser around the muzzle and mouth area. For movement, dugongs also rely on their strong fluke and they manoeuvre using their flippers which are roughly 15% of their body length (Spain and Heinsohn 1975).

18.1.2 Breathing Air While Living in Water

Although they live in water, Cetaceans and Sirenians, being mammals, have lungs and need to breathe air. However, some species can stay underwater for an extended time. For example, sperm whales can spend up to 2 hours immersed without returning to the surface. This is achieved through different adaptive physical and physiological changes. Lungs are proportionally bigger than in terrestrial mammals allowing more air intake in one breath. Furthermore, oxygen is stored principally in the muscles, thanks to the presence of high quantities of a modified myoglobin molecule with a higher affinity to oxygen than the one found in other mammal muscles. Ultimately, during diving, cetaceans are able to reduce the peripheral circulation, channelling the blood, and therefore oxygen, only to the vital organs and muscles needed during the underwater activity. In Cetaceans, the nostrils have moved on the back of the body in what is known as a "blowhole" to facilitate breathing while surfacing. During diving, the nasal passages are closed by the nasal plugs to avoid water entering the upper respiratory tract. Real whales (Mysticetes) have two separated nasal passages and therefore the blowhole presents two openings. In tooth whales, dolphins and porpoises (Odontocetes) instead, the nasal passages are fused and therefore the blowhole has only one opening, except in the sperm whale, where they are fused only at the proximity of the blowhole, causing the sideway blow characteristic of this species (Fig. 18.4).

Unlike Cetaceans, Sirenians do not have blowholes, instead, they have nostril openings located on top of their snout (Nishiwaki and Marsh 1985). They breathe when they break the surface, at times starting to exhale no more than 10 cm below the water, breaking the surface with a loud exhale, wrinkling their snout to elevate their narial openings above the surface to inhale (Anderson and Birtles 1978). Studies showed that dugongs have been recorded at depths of up to 70 m (Marsh and Saalfeld 1989) but they spend over 70% of their time at depths no more than 3 m (Louise Chilvers et al. 2004).

18.1.3 Maintaining Warm Bodies

Being mammals and therefore warm-blooded animals, Cetaceans and Sirenians have developed physiological mechanisms to counteract the faster loss of heat that takes place in water. Under their thick skin, the body is surrounded by a thick layer of blubber, which functions as energy storage, but also importantly as a thermal insulator in cooler waters. Interestingly, it seems that the blubber has also an important function in ensuring a constant temperature in warmer waters, like the UAE waters, where for most of the year the temperature is above 30 °C reaching peaks of 36–38 °C in summer. In this situation, the blubber appears to function as a "heat sink" allowing the body temperature to be maintained at the optimal level (Heath and Ridgway 1999). Furthermore, the overall body circulation is re-organized with deep arteries bringing warm blood from the inner parts of the body, pairing with the veins returning blood from the peripheral areas (bringing colder blood back to the core). This ensures that the temperature of the blood is maintained homogeneously throughout the body.

18.1.4 How to "Smell" Food in Water

Cetaceans and Sirenians have practically lost their sense of smell, as water does not support the fast dispersion of volatile molecules as they do in air. This is an example

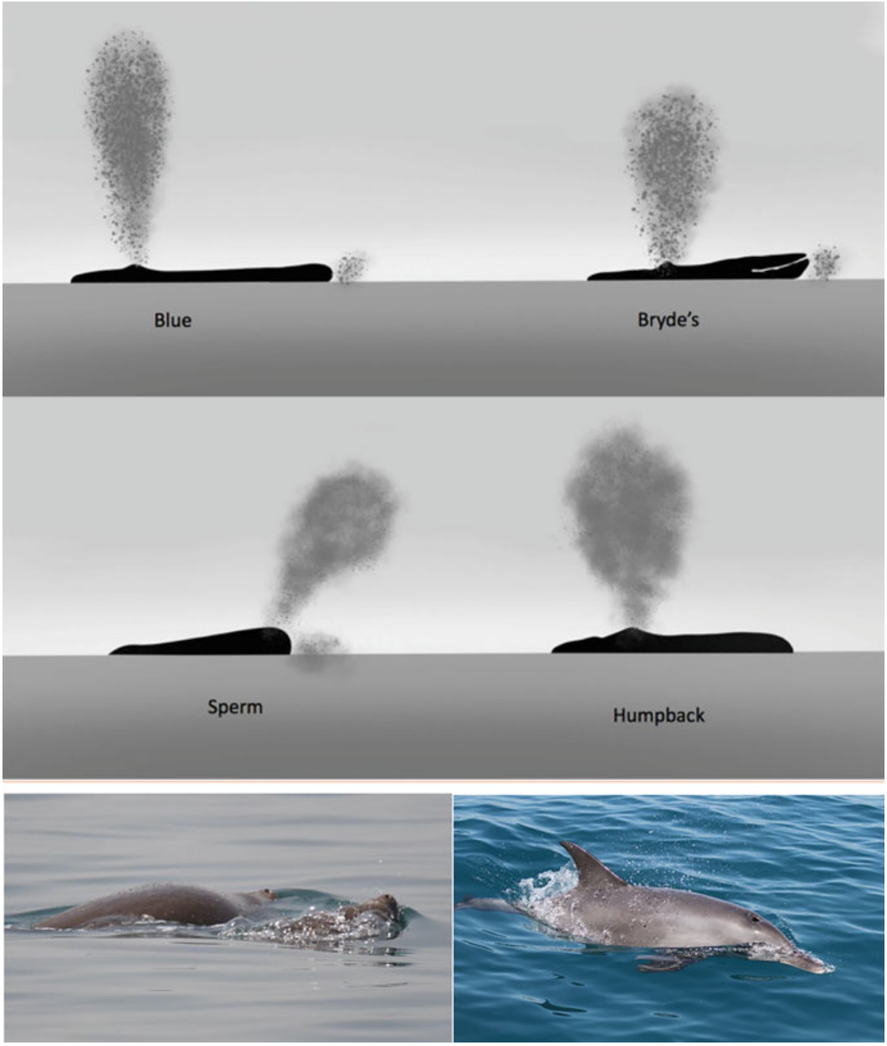

Fig. 18.4 Above: at sea, whales and large toothed whale species can be identified by the shape of the blow, often visible from far away. Below: dolphins (right) and dugongs (left) surfacing. Dolphins and porpoises generally surface with the blowhole curving their body whereas dugongs surface with the nostrils first and then submerge curving their body. Image and photo credits: Ada Natoli

of convergent degeneration of a sense that is not useful in an environment such as water (Liu et al. 2019) and this is also observed in sea snakes (Kishida 2021). On the other hand, these groups of animals have developed other means of navigating and searching for food resources, such as echolocation and somatosensation (Marriott et al. 2013).

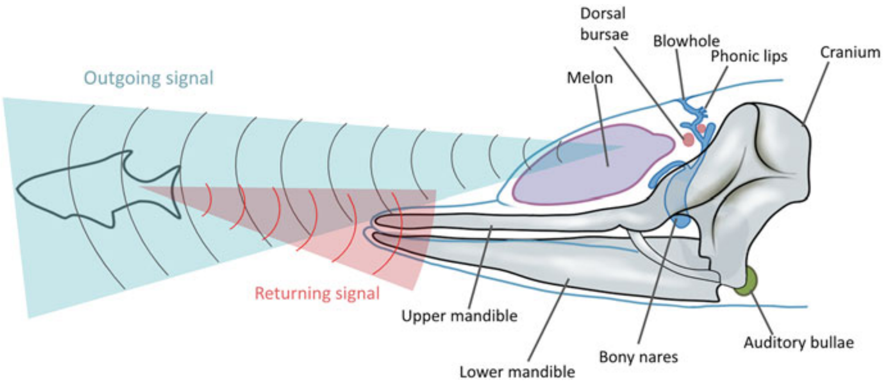

Fig. 18.5 Echolocation in Odontocetes explained. The sound is produced in the nasal area and sent through the melon that regulates its intensity and direction. The returning sound is detected through the lower mandible and ultimately processed by the brain. Modified from *Toothed Whale Echolocation* by Achat (CC BY-SA 4.0) and Toothed whale sound production by Joota (CC BY-SA 4.0)

In real whales (Mysticetes), it is suggested that although reduced in size, the olfactory system is still present and may still play a role in detecting dimethylsulfoxide in the air while surfacing to breathe. This compound is produced during the grazing by zooplankton on phytoplankton (Marriott et al. 2013); detecting this, enables these filter-feeding mammals to identify potentially rich feeding grounds and maximise the catch.

Tooth whales, dolphin and porpoises (Odontocetes), on the other hand, have perfected the use of echolocation, exploiting the fact that in water, sound travels faster than in air. Echolocation involves the production of a beam of sound (clicks) at a certain frequency (usually high frequency sound). The sound travels and hits an object or prey and is reflected back slightly modified, depending on the characteristics of the object (shape consistency, size etc.). The returning sound is detected and the difference in signal is processed by the brain, providing the animal with the information needed to define the object (or prey) detected. The sound is produced in the nasal passage through structures called "monkey-lips" and its intensity and direction are modulated by the melon, a fat-based organ positioned on the forehead of the animal. The returning sound is then detected through a sound sensitive area in the jaw bone (Fig. 18.5). Odontocetes utilise echolocation mainly for hunting, navigating and investigating the surrounding environment.

As light travels shorter distances in water, echolocation has become the main system utilised by tooth whales, dolphins and porpoises (Odontocetes) to "see" their environment. This is particularly true for those species that live in very muddy waters or species that inhabit riverine waters or prefer estuarine shallow areas. Most of the river dolphins have lost the ability of sight and rely solely on echolocation to inspect their surroundings, hunt and navigate. The Arabian Gulf coastal waters are notoriously pretty murky, mainly due to their sandy bottom, and coastal species, such as humpback dolphins and finless porpoises would heavily utilise echolocations. Also deep diving species, like beaked and sperm whales, heavily rely on echolocation. They usually hunt at depths where light cannot penetrate, like in the waters off the Fujairah Emirates, where the continental slope reaches about 700 m depth. In these habitats echolocation is crucial for survival. The sound is not only utilise to locate the prey, but it is often so powerful that stuns the prey so it can be promptly caught.

Dugongs (Sirenians) do not have underwater olfactory capabilities, which led them to adopt and use other ways of sensing their environment. They have a developed tactile sensory system that relies on sensitive whisker-like functional hairs known as vibrissae that function as a sensory organ, helping them navigate, explore their environment and detect seagrass to feed on (Griebel and Schmid 1996; Marriott et al. 2013; Marshall et al. 1998, 2003; Newman and Robinson 2006; Reep et al. 1998). In UAE seagrass meadows are highly concentrated in the central region of the Abu Dhabi Emirate and strictly linked to the presence of dugongs.

18.1.5 Keeping in Touch Underwater

No matter how transparent water may be, light travels a limited distance underwater and therefore sight is not an effective method to navigate or look for food underwater. All Cetaceans and Sirenians have monocular vision, meaning that their eyes are located on the sides of the head. In Cetaceans, visual detection and acuity vary between species, and variation in performance at different light levels and distances is generally linked to preferred habitats and behaviour. Dugongs have very small eyes and generally have poor vision (Wirdzek and Ketten 1999).

In water, as the ability to keep each other in sight is difficult, sound becomes a crucial tool for communication among groups of organisms. Cetaceans rely on strong social structures to ensure survival, and to maintain that, communication among individuals is imperative. Their social structures enable the protection of the individuals and their calves as a group, allows for the implementation of group-hunting techniques to maximise the catch, the successful reproduction and the transfer of knowledge from one generation to the next, and ensures that information such as the location of feeding or breeding grounds and specific hunting techniques suitable for the local environment are not lost (Cantor and Whitehead 2013; Rendell and Whitehead 2001). Dugongs appear to have a strong bond only between mother and calf (Fig. 18.6), but they can gather in the hundreds, and herds of up to 600 individuals have been recorded in the Gulf (Preen 2004). There is no evidence that these herds have a social structure and it is suggested that these aggregations are based on resource availability, like seagrass, shelter, and water temperature (Marsh et al. 2011).

In Cetaceans, sound-based communication can be non-vocal and vocal (Dudzinski et al. 2009). The first one is generally based on behavioural actions such as tail slaps, breaching or leaping of an individual (Fig. 18.7).

Fig. 18.6 Left: a dugong mother-calf pair Marawah, Al Dhafra Region (Credit: Maitha Al Hameli). The mother calf bond appears to be the main strong bond between individuals. Right: a group of Indo-Pacific bottlenose dolphins travelling together. Photo credits: Ada Natoli

Fig. 18.7 Typical dolphin's behavioural events that can be used as non-vocal communication among individuals. From left to right clockwise: tailslap, inverted leap, side leap. Tailslap is usually consider as sign of distress/warning for the group. Photo credits: Ada Natoli

These actions produce a sound that can be heard by other members of the group at long distances. Vocal communication is instead based on sounds produced directly by the individual's larynx, and this can be finely controlled and produced by the animal. Real whales (Mysticetes) generally utilise low-frequency (deep bass) sounds that can travel long distances and allow individuals to keep in contact even if dispersed across areas of thousands of kilometers. Mating songs are among the best known examples, especially for humpback whales, and they are usually population specific. Tooth whales, dolphins and porpoises (Odontocetes) utilise higher frequency sounds (whistles and clicks) to communicate with each other. The frequency and sound profile can be species specific, though some species utilise the same frequency spectrum. Species in this group have a highly complex language that we still do not fully comprehend. Signature whistles have been documented for a number of years both in captive and wild populations and recent studies have confirmed that they are used to call individuals among the group (King et al. 2013).

In Sirenians, especially dugongs, little is known about their communication, but they have been described to communicate in chirps, whistles, squeals, barks, trills and squeaks (Dudzinski et al. 2009). It has also been recorded that mothers and calves exchange communication to keep track of each other. They have also been known to vocalize while foraging (Anderson and Barclay 1995) and vocalization is also believed to be used to attract mates (Reynolds and Odell 1991). As in Cetaceans, in addition to verbal communication, there have been signs of non-verbal communication, like tail slapping (Anderson and Barclay 1995).

18.2 Ecological Role in the Marine Environment

Cetaceans are crucial for maintaining a healthy marine ecosystem. Like all predators, they all have an important role in regulating and controlling their prey populations. Toothed whales, dolphins and porpoises generally feed on other marine species such as fishes and cephalopods (e.g. squid), preying selectively on the weakest individuals of a group, and so strengthening the overall prey population. On the other hand, whales feed aspecifically, principally on copepods and small fish shoals. Due to their considerable body size, and therefore the conspicuous amount of food needed, they can put substantial pressure on their prey population. However, they also strongly promote the ocean's primary production recirculating essential nutrients through their excrement, proportionate to their body size, and this ultimately enhances the growth of the prey populations (Roman et al. 2014). Whales facilitate the exchange of nutrients both across seas, through their migration patterns, promoting the transfer of nutrients from nutrient-rich areas to nutrient-deprived areas. They also move nutrients across the marine column by feeding at different depths and releasing wastes at the surface (Roman and McCarthy 2010).

Due to their size and long lifespan (whales can live up to 100 years with some species reaching up to 200 years), whales represent a very effective long-term carbon sequestration system. When deceased, whales' bodies sink to the bottom of the sea where they also become a hotspot of biodiversity for deep sea scavenger species that recycle the nutrients.

Dugongs are herbivores and feed principally on seagrass and seaweed. They play an extremely important role in maintaining the seagrass beds and increasing seagrass resilience. Their feeding behaviour helps decrease the organic matter in the sediments, which in turn stimulates biodiversity, decreases hypoxia and improves the health of the seagrass beds (Valentine and Duffy 2006). It can also help decrease the risk of harmful algal overgrowth, as well as decrease the number of seagrass leaf diseases (Valentine and Duffy 2006). This means that areas that support large numbers of dugongs can provide better quality food than those that support few or no dugongs (Aragones and Marsh 2000). An explanation of this may be in the fact that grazing allows the necessary natural turnover of nutrients and therefore enhance the seagrass growth. It has also been recorded that the nutritional value of seagrasses can increase after being damaged, including the damage caused by grazing (Karban and Myers 1989). It has also been demonstrated that dugongs assist in the dispersal of seagrass seeds (Tol et al. 2016).

Cetaceans are considered "sentinel species", meaning that their status reflects the health of the whole marine ecosystem. Sitting at the top of the marine food chain, spending the whole life in water, feeding exclusively on seafood and having a long lifespan, their health is directly and immediately affected by changes happening at any level of the marine ecosystem (Bossart 2011; Schwacke et al. 2013). Monitoring their health can give advance notice of the presence of any health risk factor in the marine environment that can ultimately also affect humans. For example, the presence of toxic contaminants, marine litter (Fossi et al. 2020), toxic algae blooms or emerging diseases. Cetaceans are also recognised as indicators of climate change (Williamson et al. 2021).

18.3 Marine Mammal Diversity in UAE

The UAE overlooks both the Arabian Gulf and the Sea of Oman. These two basins exhibit very different oceanographic characteristics. The Gulf is a shallow enclosed sea characterized by extreme fluctuations in water temperature and salinity, whereas the Sea of Oman is part of the northern Indian Ocean and reaches a depth of over 1500 m (See Chap. 4). These characteristics affect the type of marine mammal species encountered in each sea.

Of the 93 species of cetaceans currently recognised to occur worldwide, a total of 17 species of cetaceans have been confirmed to occur in the Emirates: 3 species of real whales (Mysticetes), 14 species among tooth whales, dolphins and porpoises (Odontocetes) and one species of Sirenian, the dugong, with 14 species occurring in the Sea of Oman (Fujairah and Sharjah) and 11 in the Arabian Gulf waters (Table 18.1).

The records for most cetacean species in UAE waters is mainly based on occasional sightings or strandings (Fig. 18.8). Information on population identity, population size, migration routes and residency is still unknown for most species, as dedicated surveys are limited and usually only include coastal areas. The limited information is particularly true for those species that usually frequent areas further offshore, especially on the Arabian Gulf coast, as regular dedicated offshore surveys to investigate the cetacean occurrence have not yet been performed.

The UAE's Sea of Oman waters exhibit a higher number of cetacean species, in particular deep diver species, like the sperm whale and typical pelagic species such

Table 18.1 List of the species of marine mammals recorded in the United Arab Emirates waters with respective common name, scientific name and Arabic name (with correspondent English pronunciation). In UAE some species are locally called as: [a] [illegible] (diqes), [b] [illegible] (feyaymah). The IUCN Global and National Red list status and occurrence in the different basins is also reported

	Classification	Species	English name	Arabic name	English Pronunciation	IUCN Global Red List status	IUCN National Red List status 2019	Gulf	Sea of Oman
1	Artiodactyla, Balaenopteridae	*Balaenoptera edeni*	Bryde's whale	حوت بريدي	Hoot Brydey	LC	DD	x	x
2	Artiodactyla, Balaenopteridae	*Balaenoptera musculus*	Blue whale	حوت أزرق	Hoot Azraq	EN	DD		x
3	Artiodactyla, Balaenopteridae	*Megaptera novaeangliae*	Humpback whale (Arabian Sea subpopulation)	حوت أحدب الظهر	Hoot Ahdab Al Dhaher	EN	EN	x	x
4	Artiodactyla, Physeteridae	*Physeter macrocephalus*	Sperm whale	حوت العنبر	Hoot Al Anmab	VU	DD		x
5	Artiodactyla, Kogiidae	*Kogia sima*	Dwarf sperm whale	حوت العنبر القزم	Hoot Al Anmab Al Gazam	LC	DD	x	x
6	Artiodactyla, Delphinidae	*Delphinus delphis tropicalis*	Indo-Pacific common dolphin	دلفين[a] المحيط الهندي/الهادي الشائع	Dolfeen Al Moheet Al Hindy Al Hadey Al Shaia'a	LC	DD	x	x
7	Artiodactyla, Delphinidae	*Grampus griseus*	Risso's dolphin	دلفين ريسو	Dolfeen riso	LC	DD		x
8	Artiodactyla, Delphinidae	*Orcinus orca*	Killer whale	حوت قاتل	Hoot Gatil	DD	DD	x	x
9	Artiodactyla, Delphinidae	*Pseudorca crassidens*	False killer whale	حوت القاتل الكاذب	Hoot Al Gatil Al Kathib	NT	DD	x	x
10	Artiodactyla, Delphinidae	*Sousa plumbea*	Indian Ocean humpback dolphin	دلفين[a] المحيط الهندي أحدب الظهر	Dolfeen Al Moheet Al Hindy Ahdab Al Dhaher	EN	EN	x	

11	Artiodactyla, Delphinidae	*Stenella attenuata*	Pantropical spotted dolphin	دلفين مداري منقط	Dolfeen Al Madary Al Mnagad	LC	DD		x
12	Artiodactyla, Delphinidae	*Stenella coeruleoalba*	Striped dolphin	دلفين مخطط	Dolfeen Mokhatat	LC	DD		x
13	Artiodactyla, Delphinidae	*Stenella longirostris*	Spinner dolphin	دلفين الدوار	Dolfeen Al Dawar	LC	DD	x	x
14	Artiodactyla, Delphinidae	*Steno bredanensis*	Rough-toothed dolphin	دلفين خشن الأسنان	Dolfeen Khashin Al Asnan	LC	DD		x
15	Artiodactyla, Delphinidae	*Tursiops aduncus*	Indo-Pacific bottlenose dolphin	دلفين[a] الهندي/ الهادي قاروري الأنف	Dolfeen Al Hindy/Al Hadey Garoory Al Anf	NT	EN	x	
16	Artiodactyla, Delphinidae	*Tursiops truncatus*	Common bottlenose dolphin	دلفين شائع قاروري الأنف	Dolfeen Shaia'a Garoory Al Anf	LC	DD		x
17	Artiodactyla, Phocoenidae	*Neophocaena phocaenoides*	Indo-Pacific finless porpoise	خنزير[b] المحيط الهندي/ الهادي عديم الزعنفة	Khanzeer Al Moheet Al Hindy Al Hady Adeem Al Zenofah	VU	EN	x	
18	Sirenia, Dugongidae	*Dugong dugon*	Dugong	بقرة بحر	Bagarat Bahar	VU	NT	x	

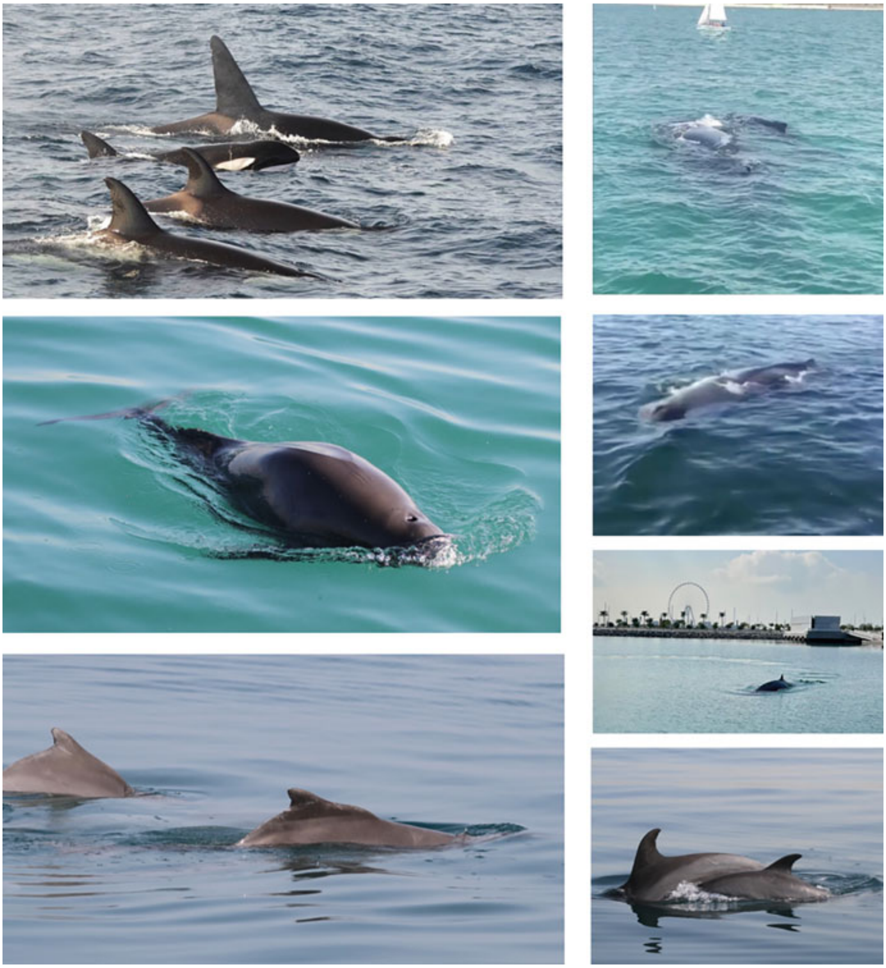

Fig. 18.8 Some of the cetacean species occurring in UAE waters. From top left clockwise: four rare species reported through citizen science "Report a sighting" programme (see Box 18.2). Killer whales, rare but regular in UAE waters. The male (tallest fin) and one of the females reported in this picture have been sighted twice in UAE waters in different years and once in Sri Lanka (Credit: Chammika Kumara/Northern Indian Ocean Killer Whale Alliance) proving long distance migration of this species in the northern Indian Ocean. Arabian Sea humpback whale mother and calf sighted in front of Kite Beach, Dubai in November 2017. A juvenile sperm whale reported off Dibba in February 2016. A juvenile Bryde's whale in Dubai Harbour in January 2022 (Credit: Jasmin Alice). Following, the three most regular coastal species in UAE waters: Indo Pacific bottlenose dolphin (mother and calf), Indian Ocean humpback dolphin and the small Indo-Pacific finless porpoise. Unless otherwise noted, image credits: Ada Natoli)

as the Risso's dolphin, rough-toothed dolphin, and striped dolphins. This is expected considering the oceanographic characteristics of the area that include the presence of a deep canyon that reaches up to 700 m depth. On the other hand, the Gulf UAE coastal waters are home to more resident coastal species, such as the Indian Ocean Humpback dolphin, Indo-Pacific finless porpoise, the Indo-Pacific bottlenose dolphins and the dugong, which generally favour shallow waters. These species do not occur on the UAE's Sea of Oman waters, nor across most of the Oman coast, creating a significant distribution gap.

The genetic and demographic connectivity of the cetacean populations occuring in UAE waters has not been investigated. Considering the young age of the Gulf, which flooded to its current coastline only ca. 6000 years ago due to sea level rise following the cessation of the most recent ice age (See Chap. 4), it is undoubtable that all marine species present in the Gulf waters originated from the northern Indian Ocean populations.

Population differentiation and consequently speciation may happen in a relatively short evolutionary time, especially in species that tend to be resident, and/or if a sudden physical barrier to the movement of individuals across regions appears, and/or in situations of adjacent drastic different environments (see Box 18.1).

Bioregions have been identified as a possible cause of population differentiation in other species (Vargas-Fonseca et al. 2021; Wiszniewski et al. 2010). Although the Strait of Hormuz may not represent a physical barrier to the movement of highly mobile species, such as marine mammals, the environmental characteristics of the Gulf compared to the neighbouring Sea of Oman are drastically different (Chap. 4). Those species that reside in the Gulf were likely forced through a fast adaptation process in order to be able to survive in such a different environment and this specialisation to the local environment may have driven and drive population differentiation.

Genetically distinct populations between the Arabian Gulf and the Sea of Oman have been identified for a number of marine species including coral (Smith et al. 2022; Torquato et al. 2022), scarface rockskipper (Mehraban et al. 2020), silver pomfret (Golestani et al. 2010) and even large mobile species such as sailfish (Hoolihan et al. 2004). Based on these considerations, we cannot exclude that especially for those small cetacean species resident in the Gulf waters, the Gulf populations may be differentiated from their peers inhabiting the Indian Ocean. Both morphological and genetic studies are needed to clarify this, as this has important implications for conservation and management.

For migratory species, this may not be the case. Except for the blue whale, the other two species of Mysticetes, Bryde's and humpback whales have been recorded in both the Arabian Gulf and the Sea of Oman. To date, studies on assessing the migratory movements of these animals in the region have not been conducted and the occurrence in both basins is mainly based on data from citizen science projects across the region. The presence in both basins, however, suggests that it is likely that these species' home ranges include the whole Gulf and the broad northern Indian Ocean and they utilise the Gulf waters periodically. For humpback whales the Gulf has been identified as part of their original home range based on historical records (Dakhteh et al. 2017). The Arabian Sea humpback whale population inhabiting the Northern Indian Ocean has been identified as a distinct population, genetically separated from the other southern hemisphere populations (Pomilla et al. 2014) and the most threatened humpback whale population in the world, with an estimated number of mature individuals below 100 that makes it listed as Endangered according to the IUCN Red List (Minton et al. 2008).

Killer whales represent another example. Despite the deficit of data on this species in the whole Indian Ocean and Arabian region, thanks to citizen science initiatives (e.g. Northern Indian Ocean Killer Whale Alliance, Orca Project Sri Lanka, UAE Dolphin Project Initiative), scientists have been able to demonstrate movements of individuals across the Arabian Gulf and through the northern Indian Ocean. Based on photographic images gathered by the public and published in the news, two individuals, one male and one female, were sighted in Abu Dhabi waters in 2008, then in Sri Lanka in 2015, and then back in UAE waters in 2019 (Natoli, Pers. Comm.). These data, although opportunistically collected, highlighted for the first time the long migratory route that this species is undertaking in this region.

The rare pygmy sperm whale, another deep diving species for which data are extremely scarce worldwide, has also been recorded in both of the UAE's basins, but only based on two individual strandings (one in Dubai and one in Fujairah).

Box 18.1 Speciation Can Happen Fast: The Case of the Black Sea Cetaceans

The Black Sea is an enclosed basin, situated adjacent to the Mediterranean Sea and connected only through the narrow Turkish strait system. Compared to the adjacent Mediterranean Sea, the Black Sea is characterised by lower average temperatures and lower salinity due to the inflow of fresh water from rivers. It is a recent basin that originated around 7800 years ago (Ryan et al. 1997). There are three species of small cetaceans that inhabit the Black Sea: the Black Sea bottlenose dolphin (*Tursiops truncatus ponticus*), the Black Sea common dolphin (*Delphinus delphis ponticus*) and the Black Sea harbour porpoise (*Phocoena phocoena relicta*). Each has been recognised as distinct sub-species of their neighbouring Mediterranean and Atlantic populations based on morphological, genetic and life history data (Natoli et al. 2005, 2008; Viaud-Martínez et al. 2007, 2008; Moura et al. 2013).

18.4 Distribution and Habitats

The distribution of small or sessile species is generally correlated to their inability to move extensive distances or having sedentary lifestyles. Highly mobile species, such as marine mammals, are potentially able to cover great distances and, therefore, defining their distribution is more challenging. Although they can potentially move, not all highly mobile species are ubiquitous, as their distribution (or spatial use) is usually driven by factors such as prey availability that, in turn, are linked to specific habitat characteristics.

In the marine realm identifying these characteristics, and therefore defining habitats, is more challenging than on land as we still do not have a clear understanding of all the interactions between abiotic and biotic factors that are involved in defining a specific habitat. The marine environment also implies a third dimension as different habitats can occur at different depths in the same location. These are characterised not only by the depth but also by other factors such as currents, amount of light, etc. that in turn support the presence of different prey species.

The distribution of different marine mammals is surely influenced by prey availability, as different species specialise in different food resources. For highly specialised species, this means that they will likely occur where their food resources occur and therefore in a specific habitat. Dugongs, for example, feeding solely on seagrass, mainly occur in correspondence of seagrass meadows. Their presence is an indicator of healthy seagrass habitat and their role in maintaining a healthy seagrass meadow is crucial (Cleguer et al. 2020). However, highly opportunistic species, for example, bottlenose dolphins may feed on a wide variety of prey, but still they exhibit a specific distribution, and in many cases individuals of a population unlikely move more than a few hundred km of range. Aside from food resources, distribution in cetaceans is also driven by social structure, behaviour and knowledge transfer across generations.

In UAE coastal waters there are four main species of marine mammal for which there are sufficient data to attempt to define their distribution. Dugong distribution was investigated in 1986 and 1999 with two dedicated aerial surveys that included Saudi Arabia, Bahrain, Qatar and Abu Dhabi waters and found the highest abundance of this species in the Marawah Marine Biosphere Reserve in Abu Dhabi (which was established after this study) and between Bahrain and Qatar (Preen 2004). These surveys act as a baseline for the dugong population in the Gulf. Continuous monitoring in Abu Dhabi waters is conducted yearly by the Environment Agency Abu Dhabi which estimated a fairly stable population of almost 3000 individuals. Overall, the Gulf is believed to host the second largest population of dugongs in the world after Australia, following an estimate of approximately 5800 dugongs reported for the southern and south-western Gulf area in 1989 (Preen 2004). In UAE, Dugongs are rarely reported north of Abu Dhabi city, with occasional rare sightings recorded in Dubai waters (Preen 2004; Natoli, Pers. Comm.). There is archaeological evidence from UAE studies that Dugongs were a means of livelihood for the coastal communities of the Gulf, as a source of meat, oil, fat and hide (Beech 2010). No dugongs have been recorded along the east coast of the UAE.

Two dolphin species, the Indian Ocean humpback dolphin and the Indo-Pacific bottlenose dolphin are regularly utilising the Gulf UAE coastal waters, as well as the only species of porpoise present in the region: the Indo-Pacific finless porpoise (Fig. 18.9). The distribution of these species in UAE waters appears to extensively overlap as they all are found in coastal waters and a number of mixed sightings have also been recorded (Natoli, Pers. Comm.).

However, a more in-depth habitat modelling analysis, based on over 1200 sightings opportunistically reported by the public as part of a citizen science project,

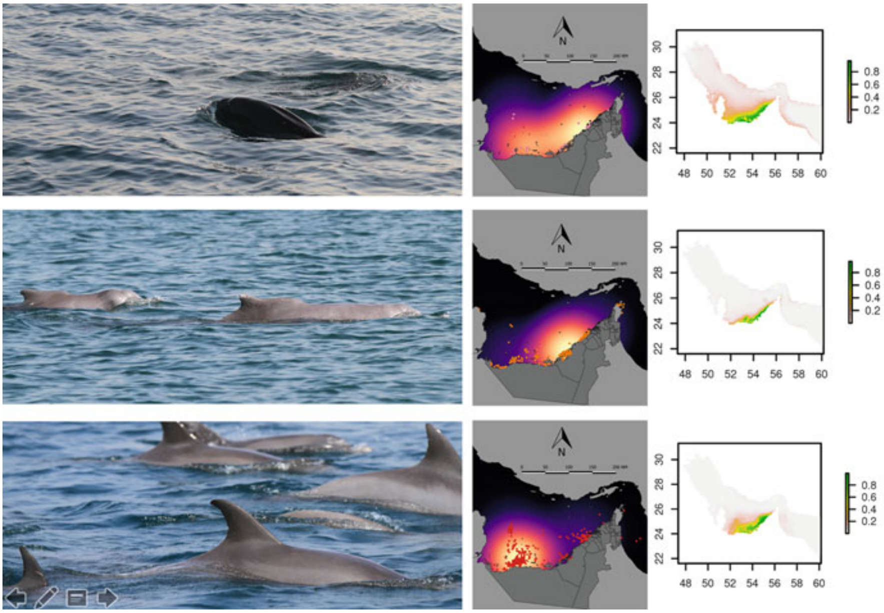

Fig. 18.9 The three main species of small cetaceans regularly occurring in UAE coastal waters, corresponding heat maps representing the density of sightings reported by the public (center) and maps showing the most probable suitable habitat in the Gulf (Maxent habitat suitability model analysis). From the top: Indo-Pacific finless porpoise, Indian ocean humpback dolphin and Indo Pacific Bottlenose dolphin. Photo credits: Ada Natoli; Maps modified from Figs. 18.2 and 18.3 in Natoli et al. (2022), under license

has suggested fine-scale dietary partitioning among them that, in turn, delineates different preferred habitats (Natoli et al. 2022).

The distribution of the Indo-Pacific finless porpoise principally includes the coastline of Abu Dhabi Emirate up to Dubai. It is generally observed close to the coast, but sightings have also been recorded up to 20 km offshore of Dubai. As few offshore surveys have been conducted, we do not have information on whether it may also utilise the offshore waters of the Gulf and whether the deficit of recordings far from shore simply represents a sampling bias. Finless porpoises have never been reported along the east coast of the UAE in Fujairah and Sharjah emirates nor along the Musandam peninsula; in the UAE, its distribution appears to be confined to the Gulf waters. Its presence is confirmed in the Iranian waters of Qeshm Island, along the Pakistan coastline as well as along the west coast of India. In the Gulf, it has also been recorded in Saudi Arabia, between Bahrain and Qatar, and Kuwait waters though not frequently. The ecological niche modelling (Fig. 18.9) revealed that the finless porpoise shows the broadest habitat suitability among the three species and is likely feeding on a different variety of prey sitting at different trophic (feeding) levels than the other two dolphin species (Natoli et al. 2022).

Fig. 18.10 Typical social behaviour observed in Indian ocean bottlenose dolphins (left) and Indian Ocean humpback dolphins (right). Tooth marks and scratches visible on the bodies are results of interactions between individuals. Photo credits: Ada Natoli

The two dolphin species, the Indian Ocean humpback dolphin and the Indo-Pacific bottlenose dolphin instead appear to sit at the same trophic level, possibly feeding on similar species and having similar energy requirements. However, the main factor that appears to play a key role in differentiating their habitat is "distance from coast", with the humpback dolphin strongly favouring waters no more than a few hundred metres away from the shore, whereas bottlenose dolphins prefer coastal waters but further away from the shore. This leaves the Indian Ocean humpback dolphin with a very restricted preferred habitat which is highly anthropogenic impacted, as it overlaps with the waters most utilised by humans, especially in proximity to the UAE main cities.

In Cetaceans, spatial utilisation across a range can also be influenced by behaviour. Cetaceans are highly intelligent species with advanced cognitive abilities and complex language. They exhibit a strong social organisation and this, in turn, can influence their population structure and distribution. For example, in a number of regions, it has been observed that bottlenose dolphins, despite being potentially able to travel thousands of kilometres, form distinct subpopulations with a limited home range of a few hundred kilometres. These subpopulations rarely intersect with the neighbouring subpopulations, and their home range does not overlap in space nor time (Pleslić et al. 2019; Genov et al. 2019). Individuals within a subpopulations form long-term relationships beyond the mother/calf or opportunistic aggregation to better exploit food resources. Individuals often form long-term bonds with peers or among individuals of the same sex, or they develop relationships that follow a hierarchical structure (Fig.18.10). Language and communication also play an extremely important role to connect individuals, and exchange information and knowledge transfer across generations (Rendell and Whitehead 2001). Social organisation can vary among species, with some species exhibiting a more open structure (for example more oceanic species such as common or stripe dolphins) while others exhibit more closed structure, such as coastal bottlenose dolphins or humpback dolphins (Pleslić et al. 2019; Wang et al. 2015). The more subpopulations are isolated, the less resilient to environmental stressors are. The same stressor can affect different subpopulations in a different way, or different subpopulations can be exposed to different environmental stressors. If they are isolated the lack of individual exchange can further exacerbate the stressors' effect.

In the UAE, in particular for coastal species, such as the Indo-Pacific bottlenose dolphin and the Indian Ocean humpback dolphins, it is plausible to believe that distinct subpopulations may occur across the coastline. However, detailed studies aiming to assess the population and social structure have not been conducted, yet.

18.5 Conservation of Marine Mammals in the UAE

In the UAE, there are archaeological records showing the use of marine mammals by humans since prehistoric times (Stewart et al. 2011; Beech and Glover 2005). Despite this long relationship, information on these species in the UAE is still extremely scarce. Also, the general general public is usually unaware of their existence in UAE waters and this makes it even more difficult to promote conservation measures.

Despite a number of marine mammal surveys conducted in the 1980s and onwards, detailed distribution and population abundance estimates are still not available for most of the cetacean species, and for many only occurrence (presence/absence) data over time are available. The first estimate of a population trend for small cetaceans was obtained from two aerial surveys conducted in Abu Dhabi waters in 1986 and in 1999. The comparison of the number of dolphin sightings recorded, reported an alarming decrease and suggested a 71% decline across the 13 years period (Preen 2004). However, specific population abundance estimates for each species were not calculated. To date, the only available population abundance estimates were obtained from boat-based surveys conducted in 2014–2015 in Abu Dhabi coastal waters, and focused only on the Indian Ocean humpback dolphin (701 individuals estimated, 95%CI: 473–845; Díaz López et al. 2017) individuals and the Indo-Pacific bottlenose dolphin (782 individuals, 95%CI: 496–1294; Díaz López et al. 2021).

The lack of historic baseline information raises concerns, as we currently have no means to assess the population trends for these species over time – during a period in which the UAE, and across the region, have been drastically affected by anthropogenic activity (Sheppard et al. 2010). The risk is "shifting baselines": considering that what we experience today is the "natural status" of our environment, not having any means of understanding how it was in the past (Pauly 1995). This is of even more concern for long-living species and those with slow reproduction rates, such as marine mammals. The risk involved is that conservation measures based on recent data may not be sufficient to allow the population to recover to a sustainable level to ensure the long-term persistence of the species. The deficit in monitoring also prevents evaluation of the effectiveness of any management or conservation efforts that have been put in place (e.g. MPA establishment) (Fanning et al. 2021).

The main threats that affect marine mammals are common worldwide: bycatch in fishing activities, disturbance (boat traffic, land reclamation activities), habitat loss, pollution, prey depletion (overfishing), ship strikes, direct capture, underwater noise, and climate change. However, in UAE, and in the broader Arabian region, there have been no detailed threat assessments for factors that may affect each species. It is, therefore, difficult to act in order to minimise these threats through management intervention. No country in the GCC has an effective national stranding network through which mortality is reported or data are shared, preventing cross-border collaboration that is necessary for management of mobile species.

In the UAE marine mammals are protected under "The Federal Law No. 23, Chapter 4, article 28 of the year 1999 concerning Exploitation, Protection and Development of the Living Aquatic Resources In the State Of The United Arab Emirates" that states: "…It is also impermissible to catch whales, sea cows (Alatwam) and other sea mammals of all species and sizes… except for scientific research purposes and after obtaining a written permission from the Competent Authority." However, no specific legislation is in place to enhance their protection or to minimise the primary threats to marine mammals. Specific legislation is considered more urgent for more sedentary, resident coastal species as they are the most affected by the rapid increase in human activities due to their limited movement.

When research information is available, threats can be identified and targeted regulations can be formulated and implemented. In the Abu Dhabi emirate, annual dugong population monitoring has been conducted since the late 1990's. In 2018, surface net-fishing was banned to help the recovery of fish stocks; this change incidentally will help marine mammals - 80 dugongs had been discovered drowned in illegal nets since 2014 (Al Hameli, pers. comm.). Scientific data has also been utilised to define the Marawah Marine Biosphere Reserve. This marine protected area (MPA) was declared a protected area per the Emirate Decree No. 18 of 2001 with the aim of protecting ecosystems, fisheries, and endangered and threatened species such as dugongs and sea turtles. The Marawah Marine Biosphere hosts large seagrass beds and is, therefore, vital for supporting dugong population in the southern Arabian Gulf.

Cetacean information across the UAE remains poorly developed. Based on the IUCN National Red list assessment, 76% of the cetacean species occurring in UAE are data deficient, meaning that insufficient data are available to assess their extinction risk status in UAE waters. No MPA's have been defined based on the habitat requirements of these species in the UAE nor elsewhere in northeastern Arabia.

In the past decade in the UAE a number of new initiatives have taked place that focused on increasing public knowledge of cetaceans. The UAE Dolphin Project Initiative started in 2012 with the aim of gathering scientific information on whales and dolphins in order to support conservation measures for their protection. A public awareness and citizen science campaign was initiated to engage the public to report sightings (Box 18.2: Report a Sighting Campaign). The initiative conducted the first cetacean-dedicated year-long survey in Dubai waters in 2013–2014, under the auspices of Dubai Municipality and with the support of private stakeholders. This campaign confirmed the regular occurrence of three species of cetaceans and collecting photo-identification data for the Indian Ocean Humpback and the Indo-Pacific bottlenose dolphins. The initiative also actively collected stranding information and data across UAE. In collaboration with Zayed University and with the support of private stakeholders, a second boat-based survey was initiated

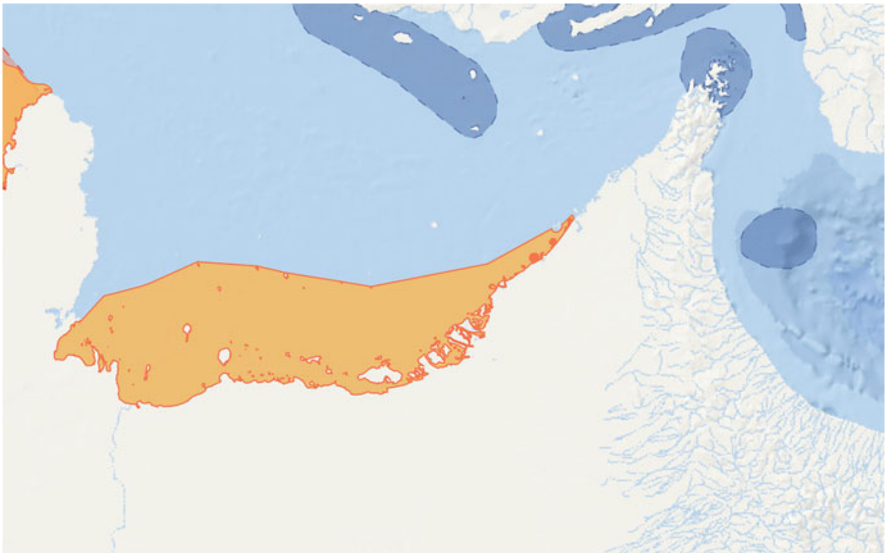

Fig. 18.11 The Southern Gulf and Coastal Waters Important Marine Mammal Area (orange) extends from Qatar to the northern border of the Dubai Emirate. The Offshore Waters of the Emirate of Fujairah Area of Interest (blue) is hoping to be recognised as IMMA in the future if more data will become available to support its importance for marine mammals. Map from IUCN-MMPATF (2023) and reused under their Terms of Service (CC BY-NC-SA 4.0)

in 2021 and continued through 2022, passive acoustic monitoring surveys and stomach contents analyses from stranded cetaceans was added to the research program.

As part of the conservation efforts, the Environment Agency Abu Dhabi started a dedicated vessel-based dolphin survey in 2014, in partnership with the Bottlenose Dolphin Research Institute. The surveys, conducted twice a year, covered the entire coast of the Abu Dhabi emirate, helped delineate Abu Dhabi dolphins' occurrence, population, distribution, abundance and threats (Díaz López et al. 2018, 2021).

Fujairah Whales and Dolphins Project began conducting regular boat-based and aerial surveys in 2015 with the aim to provide information on the marine mammal species occurring in the offshore waters of the Fujairah emirate, which is characterised by deep oceanic waters. To date, the project has reported a remarkable diversity of cetaceans occurring in the area, recording two new species that had not previously been known for the region (Baldwin et al. 2018).

The Sharjah Environment Protected Areas Authority launched a Stranding Response Programme in 2021 aiming to expand the existing knowledge on the biodiversity, ecology, and threats of marine fauna, and support the development of conservation policies while also educating the community on the importance of species conservation.

In 2019, based on the published and unpublished scientific information, the Abu Dhabi and Dubai coastal waters have been internationally identified as Important Marine Mammal Areas (The Southern Gulf and Coastal Waters IMMA), whereas the Offshore Waters of the Emirate of Fujairah have been identified as Area of Interest (AoL) for marine mammals (https://www.marinemammalhabitat.org/immas/) (Fig. 18.11).

This is already a remarkable achievement, but more research and regional scientific collaboration on these species are needed, as well as the urgent formulation and implementation of specific conservation measures to ensure their protection in the UAE and the whole Gulf.

Box 18.2 Report Your Sightings! Everyone Can Contribute to the Conservation of Marine Mammals. If You Encounter a Whale or a Dolphin the Information You Can Collect Is Extremely Useful to Science!

1. Take videos or pictures (if you can). You are there at that moment so you are the scientist! Only you can make a difference! Every image of any quality is better than nothing and will help experts to confirm the species. If you can take pictures and videos when you are on the side of the whale or the dolphins so the fin is clearly visible and can help scientists to track the individuals, but please keep a safe distance!
2. Take note of the date, time, and approximate location (if not GPS is available, a dot on google map works great!). If you can, report how many individuals you see and if there are babies.
3. CALL as soon as possible if you are witnessing a special sighting or you encounter a dead animal so an expert can hopefully reach the site and gather more information.
4. Share your data: www.uaedolphinproject.org, Facebook, Instagram, WhatsApp or call 0566717164.

18.6 Recommended Readings

For more detailed information on the evolution of marine mammals see Sutaria et al. (2015). For more information on the individual marine mammal species discussed here, see Notarbartolo di Sciara et al. (2021).

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