

Chapter 4: ARABIAN/PERSIAN GULF

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Regional Findings

Arabian/Persian Gulf: the Kingdom of Bahrain, the Kingdom of Saudi Arabia, the State of Qatar, the United Arab Emirates and the Islamic Republic of Iran

- The core habitat for dugongs lies in the western and southern Gulf between about Ras Ghanadha, east of Abu Dhabi in the UAE through Bahrain and Qatar to Ras Tanura on the Saudi Arabian central coast.
- Whether the coastal waters of Iran currently support a resident population of dugongs is uncertain and will only be determined by research explicitly designed to investigate the situation.
- Although the status of the dugong in The Gulf region is data deficient, the available evidence suggests that it supports a stable population of ~ 5,000 dugongs, ~ 3,000 of which are in the UAE. A coordinated series of surveys across this core habitat is required to confirm the status of the dugong in The Gulf.
- The largest dugong aggregations recorded globally occur in the Gulf of Bahrain/Gulf of Salwa region. These fluid groups account for ~ 60% of the dugongs found in Bahrain waters and an estimated ~ 12% of all dugongs in The Gulf. The core occupancy area of these aggregations straddles the Bahrain–Qatar border, reflecting their transboundary nature.
- The global importance of The Gulf for dugongs has been recognised by the declaration of ‘the Southern Gulf and Coastal Waters’ and ‘the Gulf of Salwa’ as Important Marine Mammal Areas, both with the dugong as a qualifying species.
- Given the transboundary nature of The Gulf’s dugong population, a regional network of marine protected areas spanning all the dugong range states in The Gulf to conserve the core dugong areas would be highly desirable and should encompass at a minimum: (i) UAE: Murawah Island and Al Yasat Island, (ii) Bahrain: Hawar Island, Fasht Buthur, and Fasht Jarim, (iii) Qatar the north-western waters of Qatar, and (vi) the shallow waters between Saudi Arabia, Qatar, and UAE.
- The Gulf is the world’s hottest sea. The effects of climate change dugongs and their habitats in the context of the other threatening processes they are exposed to in The Gulf merits investigation, especially as dugong genetic diversity appears to be low in this region.

4.1 Regional Setting

4.1.1 Geographic Overview

This chapter considers the status of the dugong along the ~ 7,656 km coastline (including major offshore islands) of the Arabian/Persian Gulf (henceforth the 'Gulf'). The United Nations refers to the region as the 'Persian' Gulf; most dugong Range States in the region prefer the 'Arabian' Gulf. The Gulf is a largely enclosed sea beginning at the Strait of Hormuz and extending along the coasts of the following countries (clockwise from the south-east): Oman, United Arab Emirates (henceforth UAE), State of Qatar (henceforth Qatar), Kingdom of Bahrain (henceforth Bahrain), Kingdom of Saudi Arabia (henceforth Saudi Arabia), State of Kuwait (henceforth Kuwait), Republic of Iraq (henceforth Iraq) and the Islamic Republic of Iran (henceforth Iran). East of the Strait of Hormuz, The Gulf connects with the Gulf of Oman, which is bordered by Oman in the south and Iran in the north (Figure 4.1).

The Gulf, which spans 6 degrees of latitude (24°–30° N), is a shallow sea with an average depth ~ 30m and a maximum depth ~ 100m in the 'shallow subterranean valley' parallel to the Iranian coast (Burt and Paparella 2023). The Gulf has an area of ~ 241,000 km², a length of ~ 990 km, and a width that varies from a maximum of ~ 340 km to a minimum of 55 km in the Strait of Hormuz (Evans 2024; Figure 4.1.). The Strait of Hormuz acts as an 'environmentally isolating bottle neck' at the entrance to The Gulf (Burt and Paparella 2024).

The modern Gulf is one of the world's youngest seas and the contemporary coastline was established only ~ 3000–6000 years ago (Riegl and Purkis 2012; Smith et al. 2022). The Gulf climate is transitional between tropical and subtropical and occurs at the subtropical high-pressure zone that results in low cloud cover, limited precipitation, high solar insolation and high evaporation rates – a climatic setting that results in unusually extreme marine environmental conditions (Paparella and Burt 2023). While geographically situated in the subtropics, the surrounding arid environment results in the summer climate being tropical (Vaughan et al. 2019).

The Gulf is a biogeographic sub province of the northwestern Indian Ocean province (Spalding et al. 2007). Its shallow waters support extensive seagrass meadows, which form part of the Tropical Indo-Pacific seagrass bioregion (McKenzie et al. 2020). The following seagrass areas have been recorded in The Gulf with moderate to high confidence (Figure 4.2): UAE (1,026 km²; EAD 2017; Erftemeijer and Shuail 2012); Qatar (633 km²; Jones 1985; Abdelbary and Al Ashwal 2021); Bahrain 366 km² (Jones 1985; UNEP-WCMC and Short 2021); Saudi Arabia (370 km²; Jones 1985; UNEP-WCMC and Short); Iran (1,262 km² ; Al-Shuail 2007; Erftemeijer and Shuail 2012).

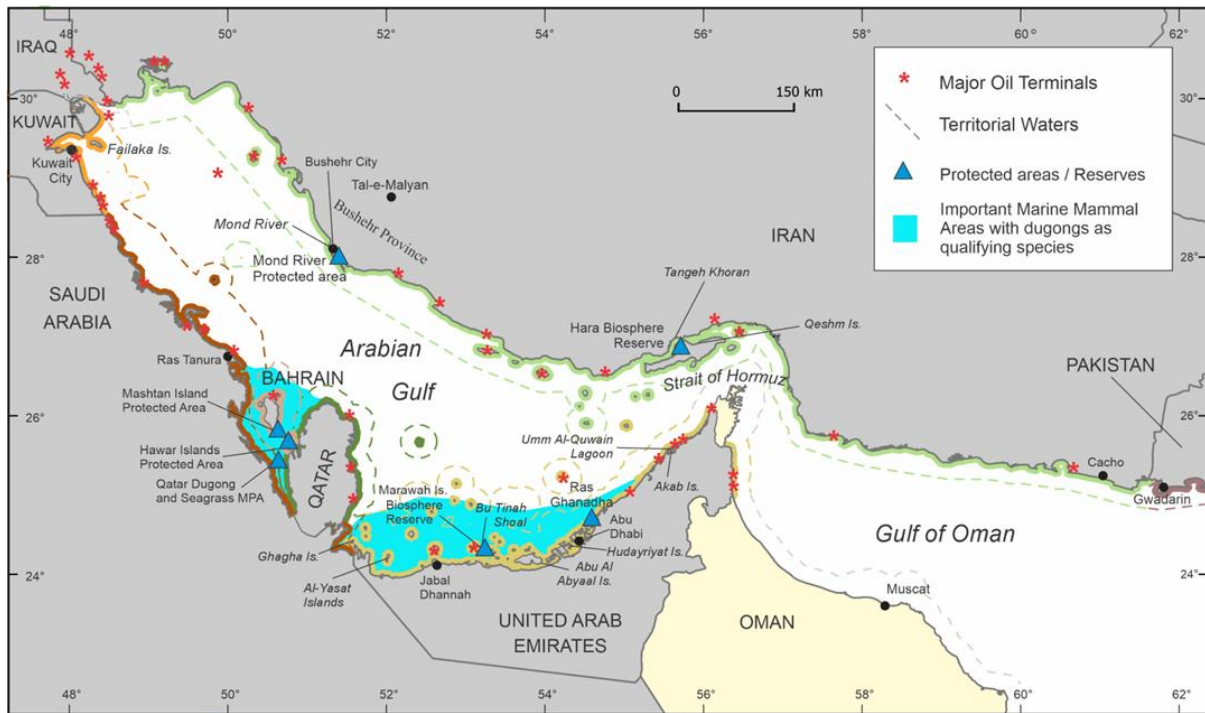


Figure 4.1. Upper figure: Geographic context of The Gulf showing placenames mentioned in the text. Dugong Range States are ordered clockwise around the region starting with the United Arab Emirates (UAE), with coloured coastlines following: UAE (yellow), Qatar (dark green), Saudi Arabia (brown), Bahrain (tan) and Iran (light green). Kuwait (orange) and Iraq (grey) are not considered Range States however have been included due to their archaeological importance. **Left figure:** The Gulfs of Bahrain and Salwa showing placenames mentioned in the text; territorial waters are shown in coloured dashed lines. Figure created by Adella Edwards; reproduced with permission.

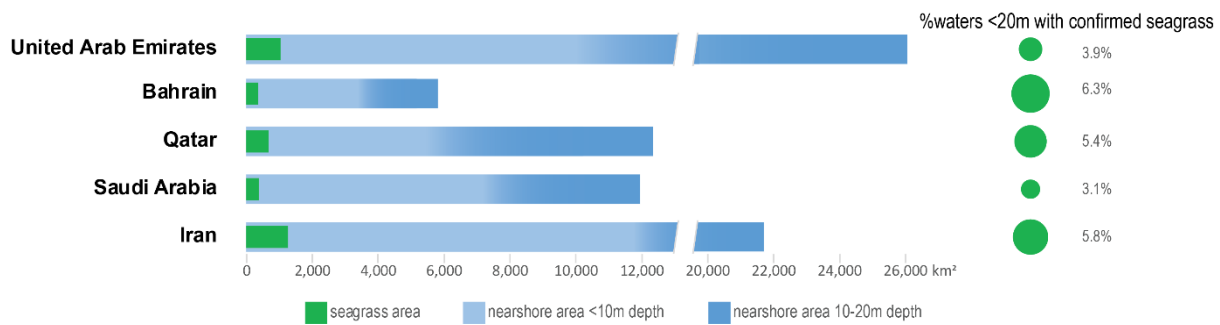


Figure 4.2. Histogram showing the known areas of seagrass and coastal waters < 10 m and < 20 m deep for each dugong Range State in The Gulf region. The areas of seagrass are almost certainly underestimates and do not include reef associated seagrasses. Although not all coastal waters shallower than 20 m will be suitable dugong habitat, the figure highlights the need for further seagrass mapping in the region. Figure created by Len McKenzie, reproduced with permission.

The Gulf is a stressful environment for seagrasses (Erftemeijer and Shuail 2012) with natural salinities in the coastal waters where seagrasses occur ranging from 38 – 70 PSU (Practical Salinity Units) and water temperatures from 10° to 39° C (Price et al. 1993). Vaughan et al. (2019) considered The Gulf to be the hottest sea on the planet during summer, particularly in the shallow southern basin where sea surface temperatures regularly exceed 35°C in August, occasionally exceeding 37° C (Burt et al. 2019). High temperatures and related biological oxygen demand can also result in recurrent periods of hypoxia and occasional anoxic events during summer in shallow regions of the southern Gulf (de Verneil et al. 2021), and there is a large and growing oxygen minimum zone in the central Gulf that represents a looming threat to coastal ecosystems and fauna (Lachkar et al. 2022).

Only three species of seagrass occur in The Gulf: *Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis*. Species of *Halodule* and *Halophila* are eaten by dugongs at many locations in their global range (Marsh et al. 2011) and there are aerial observations of dugongs feeding in *Halodule uninervis* and *Halophila ovalis* communities in The Gulf (Marshall et al. 2018). Dugongs have been observed foraging on mixed *Halodule* and *Halophila* sea grass meadows (Marshall et al. 2018; A. Khamis, personal communication 2024). Nonetheless, not all areas of seagrass in The Gulf are potentially suitable dugong habitat, because in some inshore areas of the northern Gulf (i.e., northern Saudi Arabia and Kuwait), the water is almost certainly too cold for them to over winter (Preen 2004, Preen et al. 2012), with sea surface temperatures reaching minima of 13–15° C (Burt and Paparella 2024). In contrast, during summer, dugongs have been found to consume marine algae in the absence of seagrass as evidenced by necropsy (H. Das, personal communication 2024). In addition, the confirmed area of seagrass in Kuwait is only 7.6 km² (Al-Shuail 2007; Erftemeijer and Shuail 2012).

Preen (1989, 2004) and Preen et al. (2012) considered that the core habitat for dugongs lies in the western and southern Gulf between about Ras Ghanadha, east of Abu Dhabi in the UAE through Bahrain and Qatar to Ras Tanura on the Saudi central coast (Figure 4.1).

The information regarding dugongs outside this core area follows:

- Preen (1989, 2004) and Preen et al. (2012) report small numbers of dugongs in the limited seagrass habitat east between the Oman border and Ras Ghanadha in the UAE. Beech (2010) report four archaeological sites containing dugong remains in the region; Al-Abdulrazzak and Pauly (2017) report two post 1950 records (Figures 4.1, 4.5).
- Neither Beech (2010) or Al-Abdulrazzak and Pauly (2017) provided any evidence of dugongs occurring in the coastal waters of Saudi Arabia north of Ras Tanura. Interview surveys with fishers along the Saudi Arabian Gulf coast in 2018 did not report sightings of dugongs north of the Abu Ali peninsula 27.3° N (T. Alqahtani, personal communication 2024), with all 33 reports of dugongs occurring below this latitude.
- Beech (2010) (see also Al-Abdulrazzak and Pauly (2017)) reported two archaeological sites with dugong remains in Kuwait dating from 50 BC–700 AD and 300 BC–100 AD, including ‘moderate’ quantities of dugong bones from the excavation on Failaka Island including a rib with butchery chop marks.
- There are no known records of dugongs from Iraq, which has a very short (~ 60 km) coastline and highly turbid waters unsuitable for seagrass growth as a result of the discharge of the Tigris and Euphrates rivers.

The geography of the region indicates that it is extremely unlikely that The Gulf dugong population is currently ecologically connected to the Red Sea dugong population, which is ~ 2,880 km away, separated by the open Indian Ocean coast of the Arabian Peninsula. This conclusion is strengthened by the lack of suitable habitats to act as steppingstones for genetic transfer between the two regions, as no seagrasses are known to occur on the Arabian Sea coast of Oman and Yemen, and only a few isolated areas in northern Oman (Green and Short 2003).

If dugongs are resident in Iran, they may be connected to the animals in the southern and western Gulf, a distance which is within the range of recorded large-scale movements in Australia (Deutsch et al. 2022). The nearest known dugong population to the east is the small, isolated population in the Gulf of Kutch in India (Chapter 5), ~ 1,900 km from the easternmost unsubstantiated record in Iran (Figures 4.1, 4.5).

4.1.2 Geo-Political and Socio-Economic Overview

This information is provided as an indication of the challenge for each of the various Range States in the region to consider the conservation of dugongs and their habitats in the context of their socioeconomic development needs. The nations bordering the western and southern Gulf have experienced unprecedented population growth in the past 50 years due to the regional oil boom of the 1970s (Burt 2014). Such rapid growth has resulted in large-scale urban development, primarily in coastal areas, where population centres have ‘evolved from small fishing and trading villages into globally interconnected megacities’ (Burt and Bartholomew 2019).

The Human Development status and Gross Domestic Product (GDP) of the dugong Range States bordering The Gulf (Table 4.1) indicate that all have a Very High or High Human Development Index (HDI) and per capita GDP ranking.

Table 4.1. Human Development Index (HDI) status and rank and Gross Domestic Product (GDP) per capita rank of the Dugong Range States in The Gulf. Consistent with the remainder of this Chapter, the countries in this table are ordered clockwise around the Gulf starting with the UAE. The ranks are ordered so that countries with the highest HDI or GDP have the lowest ranks. 189 countries were ranked for both indices.

Range State	HDI	HDI Rank 2023 ¹	GDP per capita rank 2023 ²
UAE	Very High	26	6
Qatar	Very High	42	4
Bahrain	Very High	35	23
Saudi Arabia	Very High	35	15
Iran	High	78	78

¹ 2023 HDI data from <https://hdr.undp.org/data-center/country-insights#/ranks> (downloaded from the internet January 2024);

²2023 per capita GDP from [https://en.wikipedia.org/wiki/List_of_countries_by_GDP_\(PPP\)_per_capita](https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita) (downloaded from the internet January 2024)

The geopolitical situation between the countries bordering The Gulf is complex, delicate and changeable. While there have been some successes in cross-border collaboration in environmental research and monitoring (e.g., Burt et al. 2021), for the most part the geopolitical situation complicates collaboration between regional nations with regards to research, conservation, and management (Fawzi et al. 2022; Fieseler et al. 2023). There can also be complications within countries. In the UAE, each of the seven emirates has its own environmental regulatory authority. In addition, fiscal structures within government agencies often preclude covering costs outside direct agency expenses.

This situation has presented challenges for collaboration between and within Range States with regards to research, monitoring and conservation of dugongs and their seagrass habitats in the past, but this appears to be settling in recent years. For example, work has resumed on new causeway between Bahrain and Qatar as a result of the lifting of the embargo placed on Qatar by neighbouring nations. At a recent regional meeting in Abu Dhabi (May 2023), there was a commitment and a call by dugong specialists from these countries to increase collaboration on research and conservation efforts (UNEP/CMS 2023).

4.1.3 Genetics of dugongs in The Gulf

For an overview of techniques, relevant genetic studies and general findings, refer to Chapter 1.

The Gulf was a freshwater wetland ~ 20,000 years ago at the Last Glacier Maximum (LGM). (Friis et al. 2024). As with the Red Sea (Chapter 3), dugongs can only have dispersed into The Gulf during post-glacial sea-level rise. During the LGM, the Gulf of Oman likely had little shallow water suitable for seagrass growth (Ludt and Rocha 2015), so was likely not a suitable glacial refuge for dugongs.

Pyenson et al. (2022) reported the finding of a sirenian rib, suspected as being from a dugong, in a Pleistocene deposit in Qatar. This was dated to about 125 thousand years ago. This finding hints at the presence of dugongs in The Gulf during the interglacial period before the present one, at a time when sea levels would be similar to those of today. Extraction of DNA from this or other ancient samples has not been attempted.

There have been no studies on dugongs from The Gulf using nuclear genetic markers. Twelve previously unpublished mitochondrial control region sequences (410 bp) from the UAE (now in GenBank with accession number PP317829) are all identical. Plön et al. (2019) published 18 sequences derived from historical museum material from The Gulf. The museum collections came from the UAE and Bahrain. All but one of these sequences were also identical with the most common West Indian Ocean haplotype (Figure 1.x). The exception (MH704326) had affinities with the widespread haplogroup (Chapters 9 and 10) but had several ambiguities at diagnostic sites, suggesting technical difficulties in determining the sequence. Tikel (1997) reported a short (194 bp) mitochondrial sequence from a dugong from The Gulf as being identical with the commonest haplotype of the Australian restricted haplogroup (Chapter 10).

- As for the Red Sea (Chapter 3) and the Western Indian Ocean more generally (Chapters 2 and 5), the available mitochondrial sequences from dugongs from The Gulf indicate limited genetic diversity.

4.2 Distribution, abundance and trends in confirmed dugong Range States

The Gulf is believed to host the largest population of dugongs in the world after Australia. Based on comprehensive strip-transect aerial surveys and using the *Marsh and Sinclair Method* (1989) methodology to correct for detection bias, Preen (1989) estimated that The Gulf's dugong population was $\sim 7,300 \pm SE 1300$ dugongs in the summer of 1986. Preen (2004) reanalysed his data and revised this estimate to $\sim 5,400 \pm SE 930$.

Preen et al. (2012) concluded that the most important dugong areas were (Figure 4.1):

1. The Marawah Island area, between Abu al Abyad Island, Jabal Dhannah, and Bu Tinah shoal in the UAE;
2. Between UAE and Qatar in the southern Gulf;
3. Between Bahrain and Qatar;
4. Between Bahrain, and Saudi Arabia, south of the King Fahad Causeway and north of Al Uquair, Khawr Duwayhin, including Ghaghah Island in Saudi Arabia

4.2.1 UAE

Preen's 1986 surveys provided a robust baseline for further work on the dugong population in The Gulf. Preen replicated the UAE component of his 1986 surveys in 1999 (Preen 2004). Since then, monitoring in Abu Dhabi waters has been conducted by the Environment Agency Abu Dhabi (EAD) (e.g., Das et al. 2021). Preen et al. (2012) pointed out that the results of these surveys are not strictly comparable with the results of the surveys he led in 1986 and 1999 because of the differences in areal and transect coverage and analysis including corrections for detection bias. Nonetheless, Preen et al. (2012) concluded that the important finding was that dugong numbers in the UAE remain relatively constant. Based on the long-term monitoring conducted in the UAE, Das et al. (2021) concluded that the population of almost 3,000 dugongs in the UAE was fairly stable. Differences were observed between surveys in the distributions of individuals and large groups.

The Southern Gulf and Coastal Waters Important Marine Mammal Area (IUCN-MMPATF 2021b) extends through the coastal waters of UAE from Qatar to the northern border of the Dubai emirate.

- Long-term monitoring suggests that UAE waters support a relatively stable population of almost 3,000 dugongs.
- Dugong distribution within the coastal waters of UAE, including the distribution of large groups, can differ between surveys.
- The Southern Gulf and Coastal Waters Important Marine Mammal Area extends through the coastal waters of UAE from Qatar to the northern border of the Dubai Emirate.

4.2.2 Bahrain, Qatar and Saudi Arabia

These Range States are considered together because all three border The Gulf of Bahrain/Gulf of Salwa region (Figure 4.1), a key habitat for dugongs in The Gulf. During his comprehensive survey of the waters of the southern Gulf, Preen (1989) detected two neighbouring, very large, aggregations of dugongs close to the Qatar-Bahrain border in the winter of 1986: one containing an estimated 577 animals; the other 97. He did not see such aggregations during his summer 1986 survey and concluded that the grouping behaviour was a winter phenomenon.

Hodgson (2009) conducted a large-scale survey in the waters of Bahrain to the 10m isobath in October 2006 (autumn). Sightings included a large aggregation of > 50 dugongs in the north of the survey region. Preen et al. (2012) noted that the results of Hodgson's survey were not strictly comparable with the results of the surveys Preen led in 1986 due to differences in areal and transect coverage and analysis.

The occurrence of large aggregations of dugongs in this region in the winter has been reinforced by recent studies of large dugong groups or aggregations (> 500 animals) (Marshall et al. 2018; Khamis et al. 2023). Aggregations of up to 700 animals were sighted on several occasions along the northwest Qatar-Bahrain border, the Hawar Islands and Bahraini coastal waters (Figures 4.3, 4.4). Recent, but as yet unpublished, data using unmanned aerial vehicles indicated group sizes of > 1,100 individuals in this region (C. Marshall, personal communication 2024).

Khamis et al. (2023) provided convincing evidence that that large fluid aggregations of dugongs occur almost year-round in this region on the basis of historical records, structured interview surveys, citizen science network reports, and boat, helicopter and unoccupied aerial vehicle (UAV) surveys covering nearly all Bahrain waters up to the 10m isobath. These aggregations, which are the largest dugong groupings recorded globally, account for an estimated 60% of the dugongs found in Bahrain and ~ 12% of all dugongs in The Gulf (Khamis et al. 2023). Their core occupancy area (145 km²) straddles the Bahrain–Qatar border, reflecting their transboundary nature (Khamis et al. (2023; Figures 4.3, 4.4). The Qatar peninsula protects the waters of this region from the north-westerly shamal winds that blow down The Gulf, and from the most severe storms and extreme summer temperatures (Burt and Paparella 2024) (Figure 4.1), which may influence the quality of the area as an aggregation site.

The Gulf of Salwa IMMA (Figure 4.1) spans the Gulfs of Bahrain and Salwa.

A project funded jointly by the Convention for Migratory Species (CMS Secretariat) and the Arab Regional Centre for World Heritage (ARC-WH) used the CMS Standardised Dugong Catch/Bycatch

Questionnaire to obtain information from fishers from Bahrain to better understand the factors driving the behavior of the large dugong aggregations around the Hawar Islands by establishing a citizen science observer network. A key finding from interviews with 44 fishers was that large herds of dugongs were seen between Bahrain Island and Fasht Jarim in the north, as well as between Bahrain Island and Hawar Islands to the southwest (Anon. 2023).



Figure 4.3 An aerial photograph of a large dugong aggregation (> 50 dugongs) encountered in summer (October 4, 2021) to the north of Hawar Island, Bahrain. Janez Lotric photograph, Diplomatic Protocol Communications. Reproduced from Khamis et al. (2023) (RightsLink Licence number 5722730990410).

Rabaoui et al. (2021) used fisher questionnaires, opportunistic sighting records, and boat-based transect surveys between February 2016 and 2020) to: (1) determine the distribution and density of different species of marine mammals present in Saudi Arabian Gulf waters, and (2) characterize the ecological traits of these animals, paying special attention to the effect of environmental factors on their distribution in this area. Cetaceans were their primary focus and apart from the fisher surveys, the methods they used were unsuitable for dugongs. They concluded that there were few dugongs in Saudi waters, that sightings were more frequent during the cool season (November–February) in the Gulf of Salwa and Ras Abu Gamis (at the Saudi border with Qatar and United Arab Emirates) and that cross-jurisdictional conservation strategy was required to protect dugongs. Alqahtani (T. alaquanti

unpublished data 2024) also used the CMS interview questionnaires to determine dugong presence along the Saudi coast of The Gulf in 2018 and documented 33 sighting records, of which only one was of a stranded dugong, the balance all being live sightings.

- Large fluid aggregations of dugongs occur during most of the year in the Gulf of Bahrain/Gulf of Salwa region.
- These aggregations, which are the largest dugong groupings ever recorded globally, account for an estimated 60% of the dugongs found in Bahrain and ~ 12% of all dugongs in The Gulf.
- A core occupancy area of these aggregations straddles the Bahrain–Qatar border, reflecting their transboundary nature.
- The global importance of this region has been recognised by its designation as the Gulf of Salwa IMMA with the dugong as a qualifying species.

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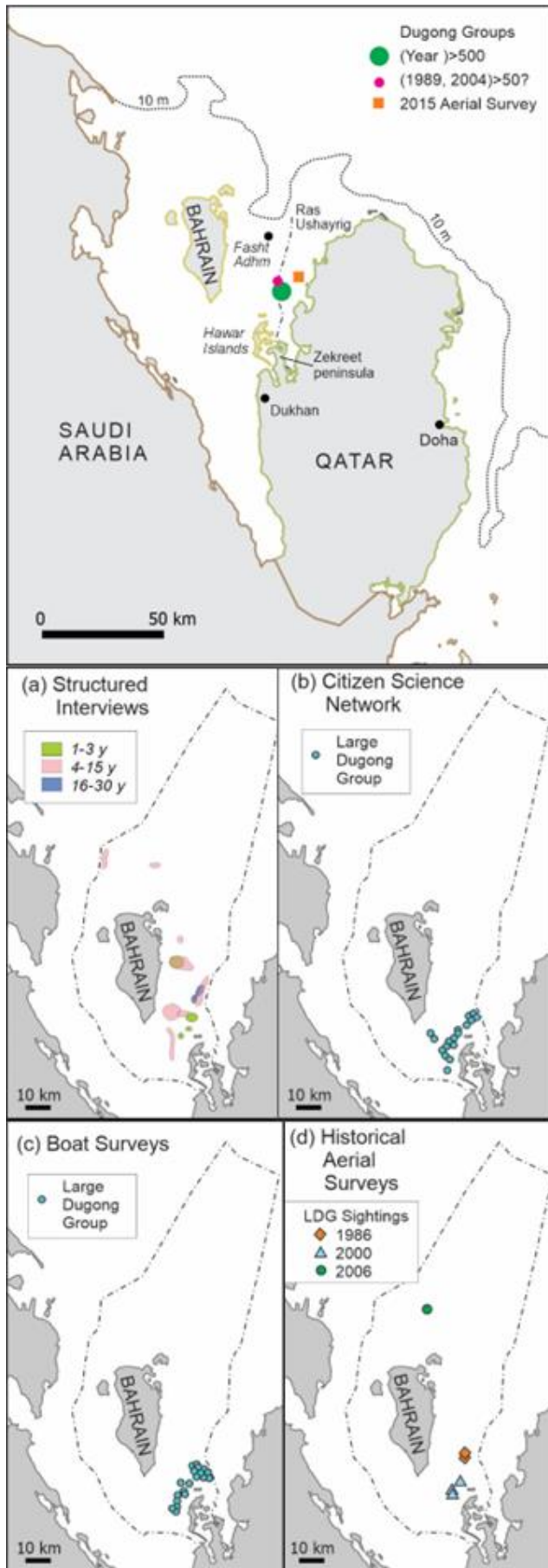


Figure 4.4. Geographic context of the Gulfs of Bahrain and Salwa showing the locations and approximate timings of the large dugong groups (LDG) reported by Preen (1986); Bell (2001), Hodgson (2009), Marshall et al. (2018) and Khamis (2023) (LDG) redrawn from Marshall et al. (2018) (RightsLink licence number 5722730522049) and Khamis et al. (2023) (RightsLink Licence number 5722730990410). Figure created by Adella Edwards; reproduced with permission.

4.2.3 Iran

Dugongs remains have been recorded in southern Iran since archaeological times but whether the coastal waters currently support a resident population is uncertain. The following information suggests that a small resident population may currently exist there:

- Based on bathymetry and latitude, Preen et al. (2012) predicted that dugongs could potentially occur around Qeshm Island (26° N) in the Strait of Hormuz (Figure 4.1). Qeshm Island (120 km long and up to 30 km wide) is separated from the Iranian coast by the narrow Tangeh Khoran (Khoran Strait) and is the site of the Hara Biosphere Reserve (2,062 km²). Braulik et al. (2010) noted: (1) two sightings of dugongs in the mangroves of the Hara Protected Area, including a single dugong (Keijl and van der Have 2002) in January 2000; and (2) a record of three separate individuals in November 2000 (Green 2000).
- In 2012, a report was made to the Plan for the Land Society that a deceased female dugong was found stranded along the coast near Cacho village, eastern Chabahar, Sistan and Baluchistan Province (N. Mohsenian, personal communication 2024).
- There are several reports of dugongs in Bushehr Province of Iran (Figures 4.1, 4.5) including:
 - archaeological records from Siraf (27.67° N, 52.34° E) dating from 400 AD 1600 AD (Beech 2010),
 - an unconfirmed, sighting of two individuals in the Mond River estuary (~ 100 km south of Bushehr City) (Firouz 2005), and
 - recent confirmed records of two adult dugongs in the Mond Protected Area; (29.92° N, 51.15° E) in 2021 and 2022 Tollab et al. (2023): (1) a moderately decomposed, probable female, found floating in offshore waters of the Motaf fishing ground on 30 April 2021 (spring), and (2) another adult female entangled in a set gillnet in inshore waters of the same area on 29 December 2022 (winter). The second animal was released alive.
- There have also been anecdotal reports of dugong sightings in Gwadarin, the Gulf of Oman near the Iran-Pakistan border (Braulik et al. 2010).
- The area of seagrass that can be confirmed with high confidence is significant (1,262 km²; Section 4.1.1).

Four hundred interview surveys were conducted in 2022 to obtain information regarding sea turtle and shark and ray bycatch and their overlaps with fisheries, along the entire coast of Iran. No dugong sightings were reported (N. Pilcher, personal communication 2024). If a resident dugong population occurs in Iran, the numbers are likely small.

- More research is required to confirm whether Iran supports a resident dugong population.

4.3 Cultural values

In The Gulf, dugongs are variously known as: bugarah al bahr (cow of the sea) or alatwam (Bahrain, Qatar, and UAE) or, arus al bahr (bride of the sea: Saudi Arabia, and Bahrain) (Preen et al. 2012).

People have exploited Gulf dugongs since before the modern coastline was established ~ 7,000 or more years ago (Burt and Paparella 2024). Dugongs were exploited by both pre-historical and historic coastal peoples. The oldest site at the island of Marawah in Abu Dhabi emirate dates to more than 7,500 years ago (Beech 2010). The waters around the island of Marawah are: (1) very important contemporary dugong habitat (Figure 4.1 and Section 4.2), where large dugong aggregations are sighted (Das et al. 2021), and (2) the site of the UNESCO Marawah Marine Biosphere Reserve.

Dugongs were a source of economically valuable products such as meat, oil, fat and hide (Beech 2010). The meat and bone marrow were eaten, the hide used to make sandals, and tusks used to fashion the handles for Sheikh's swords. Artefacts were also manufactured from dugong bones and tusks at several prehistoric sites (Beech 2010). Dugong remains have been found at Tal-e-Malyan, a second millennium BC highland urban site in Iran (Beech 2010; Figure 4.5), suggesting that they were traded.

Dugongs were also used for ritual purposes. Based on the initial excavations, Prieur and Guerin (1991) and Jousse et al. (2002) interpreted the site they studied on Akab Island in Umm al-Quwain lagoon in north-eastern UAE (Figure 4.6), which dates from ~ 5,500 years ago, as a small butchery camp, which specialized in dugong fishing. After further excavations, Charpentier and Méry (2008) and Méry et al. (2009) reinterpreted the 'dugong mound' as a ritual site featuring a structured platform of dugong bones, containing skulls laid parallel and ribs in sets, together with artefacts of the Neolithic period. They considered that the site was the oldest known ritual site in Arabia and the world's oldest known ritual site associated with the dugong. Its excavation has provided new data on the relations between humans and their environment in Neolithic Arabia, in particular on the symbolic use of animals, which lies at the core of the system of cultural and social representations. In another example of ritual use of dugong remains, Beech (2010) discovered their use in association with an Islamic burial practice during the recent historical period on Marawah Island in Abu Dhabi emirate.

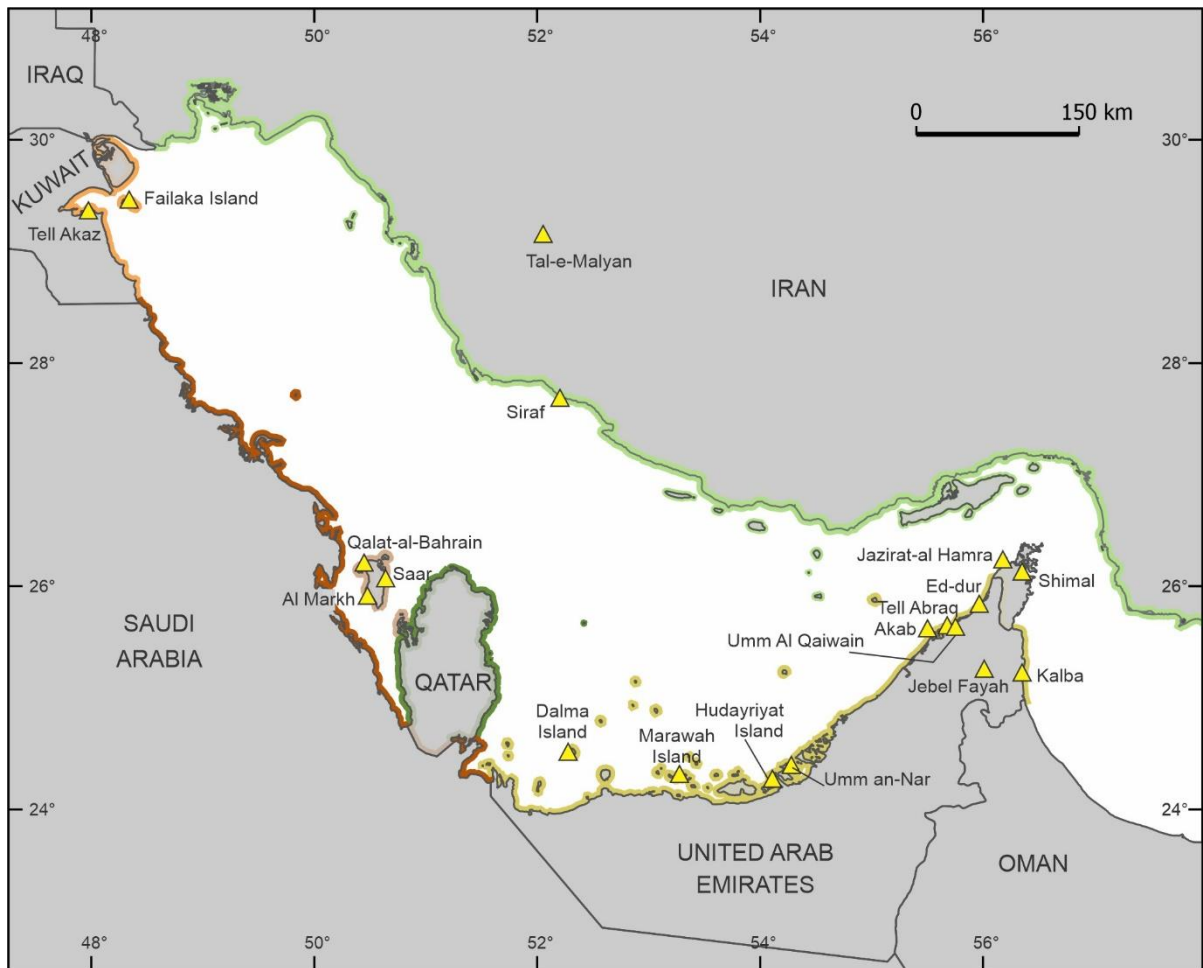


Figure 4.5. Records of dugongs at archaeological sites in The Gulf redrawn from Beech (2010) and showing contemporary placenames mentioned in the text. Figure created by Adella Edwards; reproduced with permission.

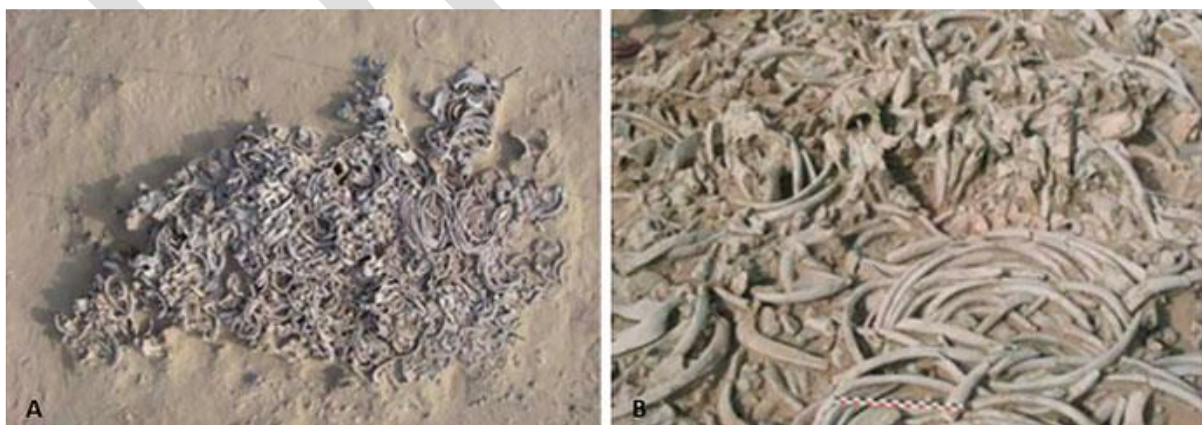


Figure 4.6. (A) Dugong bone mound and (B) the rostra and skulls of dugongs placed in anatomical positions and aligned ribs in Akab Island, Umm Al Quwain lagoon. Reproduced from Méry et al. (2009) (RightsLink licence number 5722760958242).

Ancient dugong bone mounds are found on many of the islands in Abu Dhabi emirate with most unstudied (H. Das, personal communication to Lousia Ponnampalam 2021 in Ponnampalam et al. 2022). All this archaeological evidence demonstrates the apparent longevity of the importance of dugongs in The Gulf.

Beech (2010) detailed the extensive archaeological evidence of the use of dugongs at 14 sites around The Gulf (Figure 4.1) as follows: UAE (9 sites), Bahrain (3 sites), Kuwait (2 sites) and Iran (1 site). These locations include six sites in the present core area in the southwestern Gulf and eight locations where suitable habitat is now rare.

Since Beech (2010), an additional six archaeological sites from the UAE have been identified. These include one Neolithic site from Jebel Fayah, Sharjah emirate, UAE, and three Neolithic coastal sites in Umm Al Qaiwain in the UAE. A pendant made from raw dugong ivory was located from Jebel Fayah (Uerpmann et al. 2012, Figure 11); there was a raw piece of dugong tusk at the same site which is dated between ~ 4,900 – 4,200 BC. This may be amongst the earliest evidence for the use of dugong ivory, pre-dating a statuette from Mesopotamia (now south-central Iraq) dated between ~ 2,250 and 2,120 BC (Caubet and Poplain 2003). The discovery of further dugong bones at Neolithic sites located near the Umm Al Qaiwain lagoon further confirms the importance of dugongs in the local area.

Dugong remains have also been reported from the recent archaeological excavations at the Bronze-Iron Age settlement site at Kalba, located on the east coast of the UAE (K. Lidour, personal communication 2024). This result is interesting since there are no shallow waters with seagrass in this area and the waters become deep close to the shore. A late Islamic period midden of butchered dugong, turtle, shark and fish bones has been discovered in the southern shoreline of Hudayriyat Island, just adjacent to the capital - Abu Dhabi Island. This midden included a large number of marine shells, mainly *Pinctada radiata* pearl oyster shells, and results from the traditional communities, which were primarily involved in fishing and pearling. This site is now fenced off and protected by the Department of Culture and Tourism (DCT Abu Dhabi), Modon and the Department of Municipalities and Transport, along with a cluster of other shell middens as part of the Hudayriyat Heritage Trail. Heritage information signs are provided which inform visitors about the traditional use of these marine resources.

The fact that The Gulf currently supports the second largest dugong population globally is an ongoing source of pride in the UAE. In 2009, the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Environment Agency Abu Dhabi (EAD) signed a partnership agreement establishing a CMS Office in Abu Dhabi, which hosts the CMS Dugong MOU Secretariat. In Qatar a 15m-tall dugong balloon graces the Corniche in the heart of Doha city (Figure 4.7).



Figure 4.7. Dugong balloon in Doha City, Qatar. Nicolas Pilcher photograph; reproduced with permission.

4.4 Threatening processes

The main threats that affect dugongs in The Gulf are common throughout its range: incidental and deliberate capture in fishing gear, mortality from vessel-strike, pollution, habitat loss, and climate change. Each of these threatening processes is discussed below. However, as pointed out by Natoli and Al-Hameli (2023): (1) there have been no systematic threat assessments to inform management interventions; and (2) no country in The Gulf has a stranding network that enables standardised data sharing across jurisdictions. This situation prevents the cross-border collaborations that are desirable for management of species than can undertake large-scale movements such as the dugong. The situation is further complicated by the complex geopolitical situation.

4.4.1 Incidental and deliberate capture in fishing gear

Pilcher et al. (2017), Marshall et al. (2018) and Marsh and Soltzick (2019) concluded that incidental capture in mesh nets was a major threat to dugongs in most parts of their range and is likely to be the most significant chronic threat in The Gulf (Preen et al. 2012). In the UAE, Preen (1989 and 2004) estimated that net mortality was unsustainable in the 1980s on the basis of his 1986 survey results and the mortality estimates he inferred from interview surveys. In 1998, 12 dugong carcasses were found tied under mangroves on Marawah Island, near an area where large-meshed gillnets were set (Preen 2004, Preen et al. 2012) and in the same area where the remains of 28 dugongs were reported by Baldwin and Cockcroft (1995). The sale of dugong meat in the UAE was banned in 1999 (Preen et al. 2012; Section 4.5).

Hodgson (2009) and Preen et al. (2012) reported that most gillnet fishers were using a drift

technique in Bahrain. This technique was prohibited, but operations were run at night and no records were being kept that allowed the level of bycatch to be estimated (Preen et al. 2012). A Ministerial decree banning the deliberate killing or sale of dugongs was issued in Bahrain in 2003 (Preen et al. 2012, Section 4.5).

One of the dugongs reported from Iran in 2020 by Tollab et al. (2023) had been caught in a gillnet set by recreational fishers who untangled the dugong by cutting the net. The animal was released alive into the sea at high tide, two hours later.

The archaeological evidence (Section 4.3) indicates that dugongs were harvested in The Gulf for thousands of years. Dugongs were located in or chased into shallow water where they were surrounded by many people and clubbed to death (Preen 1989). According to fishers in Abu Dhabi interviewed by Preen (1989) in 1986, active dugong hunting had ceased after Sheik Zayd, ruler of the Abu Dhabi emirate some 20 years earlier, decreed that fishers should not actively hunt dugongs and that only animals caught in nets could be sold. Netting replaced hunting as the main cause of mortality for dugongs in The Gulf.

Based on interviews with the manager and two fishers in the Abu Dhabi fish souk (market) in 1986, Preen (1989) estimated that between 70 and 100 dugongs were sold in the market annually and concluded that this did not represent the total number being caught at that time.

4.4.2 Vessel strike

Industrialization and urbanization of coastal areas often increases marine traffic, escalating the risk of vessel strikes which can cause dugong mortality, although the threat is less problematic for dugongs than for Florida manatees (Ponnampalam et al. 2022). Quantitative data are not available for The Gulf. Wong and Patel (2023) reported one adult and four neonatal dugong carcasses from the southeastern shore of Qatar with wounds attributed to the propellers of jet skis or speed boats.

4.4.3 Habitat loss and degradation

Burt (2014) concluded that ‘as a result of cumulative impacts from coastal development, overfishing, industrial expansion and other population-driven stressors’, The Gulf is ‘now considered among the most degraded marine eco-regions in the world’. The coastal marine environment of the southwestern Gulf has experienced extremely rapid urbanization and industrialization since the 1970s, leading to declines in marine ecosystems and their associated fauna (Burt 2014; Burt et al. 2023 for the UAE; Burt et al. 2017 for Qatar; and Burt et al. 2013 for Bahrain – three key dugong areas). Al-Mansoori and Das (2023) concluded that seagrass beds have been under acute pressure from coastal development, island creation, dredging and sedimentation in some of the most heavily modified areas in the UAE (e.g., lagoons and in shallow environments around oil concessions).

Unfortunately, seagrass surveys only began in the late 1990s in the UAE, and it is unknown to what extent seagrass beds were impacted by earlier developments there or in the other countries in the core dugong habitats in the southern and western Gulf.

The ongoing occurrence of dugongs in the waters around the main island of Singapore (Chapter 6) demonstrates that dugongs can continue to exist on hyper-urbanized coastlines (Ng et al. 2022a,b). There is increasing evidence from Florida manatees that: (1) sirenians have a highly developed spatial memory; (2) information is transmitted from mother to calf during the long period of calf dependency; and (3) females return to their place of birth to give birth (natal philopatry) (Deutsch et al. 2022; O’Shea et al. 2022). It is plausible that the extensive changes to the coastline in the core area of dugong habitat in the southern and western Gulf is contributing to the recent spate of reports of live stranded neonatal calves (Wong 2022).

4.4.4 Pollution

The Gulf has 68% of the world’s oil reserves and more than 40% of gas resources; around 60% of global oil transportation takes place through the region (Hassanshahian et al. 2020). Much of the core dugong habitat in the southern and western Gulf is close to offshore oilfields making oil exploration, extraction, treatment, and transfer potential threats (Figure 4.1; Preen et al. 2012). Oil contamination is a chronic ongoing threat to dugongs and seagrass communities. Even though Gulf dugongs have demonstrated resilience to low-level oil pollution (Preen et al. 2012), the levels of petrogenically-sourced Polycyclic Aromatic Hydrocarbons (PAHs) in their tissues have not been measured, despite Yaghmour et al.’s (2020) finding that 71% of the 22 stranded green sea turtles they examined from the Gulf of Oman coast of the UAE between 2016-2018 contained harmful levels of these compounds in their tissues. Levels of PAHs in Gulf seagrasses or sediments were not available at the time of writing (March 2024).

The risk of a catastrophic oil spill is an ongoing concern. The Gulf has experienced major oil spills including the Noruz oil spill in 1983 and The Gulf War spill of 1991 (Preen, 2004, Preen et al. 2012). At least 37 dugongs washed up on the shores of Saudi Arabia and Bahrain after the Noruz oil spill (Preen 1989). Their causes of death were not confirmed as no necropsies were conducted.

Nonetheless, Preen et al. (2012) estimated that 150 dugongs were killed by this event after adjusting for areas not searched, the distribution of dugongs and the dispersal patterns of the oil. No dugongs were encountered after the 1991 oil spill despite extensive daily searches for strandings along the Saudi Arabian coastline (N. Pilcher, personal communication 2024).

Twenty-five of the green turtles examined by Yaghmour et al. (2020) also contained harmful levels of organochlorine pesticides including DDT in their tissues. Plastic contamination in dugongs or

seagrasses has not been studied in The Gulf despite it being of increasing concern elsewhere, including in 14 stranded green turtles on the Gulf of Oman coast of the UAE (Yaghmour et al. (2018).

4.4.5 Climate change

As for other regions in the dugong's range (Marsh et al. 2022), the impacts of climate change on dugongs and their seagrass habitats are difficult to predict, especially as the upper limit of the thermal tolerance of dugongs is unknown. Marsh et al. (2022) concluded that most of the adverse changes relevant to dugongs would be to their demography (delayed breeding and increased mortality) and movements and to the distribution and community composition of seagrasses. They also pointed out that climate change would be a threat multiplier exacerbating other anthropogenic stressors such as those listed above. The Gulf is already a harsh environment for seagrasses, supporting only three species that tolerate a wide range of temperatures and salinities (Section 4.1). However, other adverse changes to dugongs and their seagrass habitats seem inevitable (Marsh et al. 2022).

4.5 Conservation initiatives

4.5.1 International conventions

Excepting Saudi Arabia, all confirmed Dugong Range States in The Gulf are parties to the Convention on Biological Diversity. All except Qatar and Iran are signatories to the Convention on Migratory Species and its associated Dugong Memorandum of Understanding (CMS Dugong MOU). Bahrain and Iran are signatories to the United Nations Framework Convention on Climate Change; UAE, Qatar and Saudi Arabia have ratified that convention. All are signatories to the Convention on International Trade in Endangered Species (CITES).

4.5.2 National laws

4.5.2.1 UAE

After completing a regional red-list assessment, dugongs were listed as a threatened species in the Abu Dhabi emirate (Javed et al. 2020)

In the UAE, marine mammals are protected under *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* which 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."

Dugongs in UAE waters are protected by *Federal Law No. 23 (1999) for Protection of the Marine Environment, Article 28/2000 of the Amiri Decree*, which prohibits the exploitation of dugongs in the UAE, and by *Federal Law No. (24) of 1999 for the Protection and Development of the Environment*.

4.5.2.2 Bahrain

Dugong and seagrass meadows are protected by the *Environment Law*, which aims to combat against all forms of pollution through activities and practices related to environmental protection, and the *Wildlife Law*, which focuses on preserving species and rehabilitating suitable habitats for wildlife. *Article 1 of Ministerial Order No. 4 (1986)* explicitly prohibits the fishing of dugongs throughout the Kingdom of Bahrain. The dugong is listed in the national red list as vulnerable to extinction.

4.5.2.3 Saudi Arabia

Dugongs are protected by the Environment Law issued by the *Royal Decree No. (m/165)*, dated 19/11/1441 Hijri, with the responsibility for implementing the law in relation to dugongs and seagrasses undertaken by the National Center for Wildlife. The law has provisions for enforcement and issuance of fines not exceeding SAR 20 million.

4.5.2.4 Qatar

The legal framework and guidelines for protection of Qatar marine resource including dugongs are as follows:

- *Decree 55 of 1978* provides guidelines for the protection of marine environment from pollution.
- *Law 4/2002* regulates hunting of animals, birds, and reptiles and legally bans hunting in protected areas.
- *Law 7/2006* declares Qatar NW Al Reem as a UNESCO Man and the Biosphere reserve, protecting terrestrial animals and plants as well as marine animals including dugongs, sea turtles, sea birds and seagrass habitat.

In 2008, the Qatar government declared the Qatar National Vision 2030 and announced the Protection Area Action Plan 2008-2013 Call for designation of protected area. This empowered the Ministry of Environment Wildlife Department to prohibit and control activities in natural habitats that cause damage to protect endangered species.

The Qatar National Development Strategy 2011-2016 provided guidelines for Biodiversity Protection. In 2021, Qatar National Marine Resource Conservation and Management Action Plan was adopted, and marine protected areas were identified to cover 30% of the Exclusive Economic Area including the NW Qatar water for the protection of dugongs and seagrass.

The Ministry of Environment and Climate Change has recently appointed a team of in-house marine scientists to study dugongs in Qatar and to provide advice for the conservation of dugongs in the country.

4.5.2.5 Iran

Dugongs are not formally protected in Iran though there are laws protecting the nation's wider wildlife. Iran's Constitution includes a statement regarding the protection of the environment and the prevention of pollution and degradation. The *Law on Hunting and Fishing 1967* requires those wishing to hunt or fish to first obtain a licence, issued by the Fishing and Hunting Organisation, later replaced by the Department of Environment in 1971.

The *Environmental Protection Law 1975* states that the Department of Environment and the High Council for Environmental Protection are responsible for establishing a system of supervision and monitoring for wildlife and marine resources, as well as establishing limitations for hunting and shooting in some protected areas.

4.5.3 Protected Areas of relevance

The protected areas in the various range states of relevance to dugongs are listed below. Van Lavieren and Klaus (2013) question their effectiveness. Naser (2016) sought the views of conservation practitioners, academics, and other relevant bodies on the management of Bahrain's Marine Protected Areas (MPAs). He concluded that although MPAs are contributing to the protection of critical coastal and marine habitats and their associated flora and fauna, their effectiveness could be enhanced by developing management plans, implementing regulatory measures, and investing in long-term monitoring and research.

Given the transboundary nature of The Gulf's dugong population, it will be important to work towards a regional network of protected areas as suggested by Khamis et al. (2023) and in Section 4.7 below.

4.5.3.1 UAE

- **UNESCO designated the Marawah Biosphere Reserve (MMBR)** in 2007. This reserve was declared a protected area through the *Emirate Decree No. 18 of 2001*. The total area of the Reserve is 4,255 km² and has a core area of 606 km² which includes marine and terrestrial habitats comprising numerous islands and a coastline stretching over 120 km. Seagrass communities (three species of seagrass), coral reefs, macroalgae outcrops and mangrove vegetation are included. There are also buffer and transition zones. UNESCO rates Marawah Biosphere reserve to be of 'global importance' as a shelter and feeding ground for dugongs. Fishing is allowed only in designated areas and is limited to traditional fishing methods that

include fixed net (*Hadhra*), shore net (*Al Sakkar*), and seine nets (*Daffara*). The reserve is managed by the Environment Agency Abu Dhabi (EAD).

- **Al Yasat Marine Protected Area (MPA) in the western coastal waters of Abu-Dhabi emirate** is a ~ 2256 km² MPA (IUCN category IV) which was established in 2005 and is managed by EAD.

4.5.3.2 Qatar

In 2017, a Plan for the Conservation and Management of Dugongs within the State of Qatar, including a plan for establishing a dugong stranding program was submitted to the Ministry of the Environment by Marshall and ExxonMobil Research Qatar, although not formally adopted by the government. Most (~ 1650 km²) of Qatar's western territorial waters to its borders with Bahrain and Saudi Arabia were designated a Dugong and Seagrass Marine Protected Area In 2022 by the Ministry of Environment and Climate Change (Wong and Patel 2023).

4.5.3.3 Bahrain

Most of the information in this section has been sourced from Naser (2016).

- **Hawar Islands Protected Area.** Nationally, the Hawar Islands were declared as a wildlife sanctuary by the Prime Minister Order No. 16 of 1996 in accordance with the Legislative Decree No. 2 of 1995 with respect to the Protection of Wildlife. Several subsequent regulations were issued to support the protection of the Islands and their territorial waters, including the Ministerial Order No. 6 of 1996 with respect to the relevant recommendations of the National Commission for Wildlife Protection. This order prevents all forms of fishing around Hawar Islands and their territorial waters and only allows the use of traditional fishing gear such as *hadrah* (an intertidal fixed stake trap), cages, and trolls. Fishing around Hawar Islands was regulated by the Order of the Public Commission for the Protection of Marine Resources, Environment and Wildlife No. 13 of 2005 that prohibits fishing in commercial quantities and overfishing around Hawar Islands and their territorial waters. It also prevents the use of any tools, machines, or materials that can pose a threat to the marine resources in the region. An amendment of this order based on the Order No. 4 of 2010 has now restricted the use of *hadrah* to a license from the General Directorate for the Protection of Marine Resources. The Hawar Islands were designated as a Ramsar (Convention on Wetlands of International Importance) site in 1997 due to the abundance of globally significant, rare, and endangered bird species.

The Islands are on the tentative list of natural World Heritage sites and are being assessed by local authorities as a potential Man and Biosphere Reserve (A. Khamis, personal

communication 2024).

- **Mashtan Island Protected Area.** Mashtan is a small offshore sandy island (0.2 km²) located between Bahrain and the Hawar Islands (Figure 4.1). The waters surrounding Mashtan Island are characterized by widespread growth of seagrass beds that provide feeding grounds for many species, including dugongs. Mashtan Island is nationally protected based on relevant provisions of the Order of the National Commission of Wildlife Protection No.1 of 2002.

4.5.3.4 Iran

- Iran is home to an UNESCO Biosphere Reserve: the **Hara Biosphere Reserve**. The reserve is located in the Mehran River delta in the south of Iran, near the Straits of Khuran between Qeshm Island and the mainland. The site is a key biodiversity area due to its *Avicennia* mangrove ecosystem and, while dugongs are not listed in the ecological characteristics, the site may offer some protected habitat.
- **The Mond Marine Protected Area** is located southwest of Bushehr Province in the Bord Khun District. The protected area was established in 1976. The MPA may offer some protected habitat for dugongs.
- Iran has three Ramsar sites along The Gulf coast, ordered west to east: **Sheedvar Island**, located in Hormozgan Province, the Khuran Straits, located in the lower Mehran River delta and, **the Deltas of Rud-e-Shirin and Rud-e-Minab**. These protected wetlands could offer some protection to the marine environment adjacent to them.

4.5.4 Other conservation initiatives of potential relevance to dugongs

- Surface net-fishing was banned in the waters of Abu Dhabi emirate in UAE in 2018, following Resolution No. 542 issued by the Ministry of Climate Change and Environment on the amendment of the provisions of Ministerial Resolution No. 598 of 2017. The ban was made to help the recovery of fish stocks; this change should also reduce dugong mortality (H. Das, personal communication 2024).
- In Saudi waters, oil and gas installations are surrounded by an exclusion radius of 500 m, which fishermen and other unauthorized vessels are prohibited from entering (Rabaoui et al. 2021).
- Orphaned neonatal calves are rescued in UAE and Qatar (Wong, 2022; Wong and Patel 2023). As in the rest of the world (Marsh 2022), none of these animals has been confirmed as surviving after release. One dugong, named “Malqout” is being successfully reared in captivity in the UAE.

- Exxon Mobil Research Qatar (EMRQ) has established a stranding network and has been involved in the rescue and rehabilitation of dugong calves since 2015 (C. Marshall, personal communication 2024). EMRQ has been working in collaboration with Qatar University (QU) and Texas A&M University after signing a tri-party agreement with support from the Private Engineering Office (PEO) and the Ministry of Environment in 2014.

4.6 Research and monitoring initiatives.

4.6.1 Techniques used to date

Preen's (1986) quantitative aerial surveys remain the benchmark for systematic surveys for dugongs in the region and have informed the monitoring conducted by the UAE for more than 20 years (e.g., Das et al. 2021). Marshall et al. (2018) and Khamis et al. (2023) have used a range of techniques to study the large dugong groups in the Gulf of Bahrain, including historical records, structured interview surveys, citizen science network reports together with boat, helicopter, and UAV surveys at several spatial scales. Additionally, Marshall and ExxonMobil Research Qatar (EMRQ, a subsidiary of ExxonMobil) have been actively promoting to the Ministry of the Environment and Municipality, dugong recovery plans, fishermen interviews, and standardized stranding efforts in Qatar, as well as rehabilitation efforts of stranded calves. Stranding efforts include the collections of tusks and body size for age determination, as well as documenting bycatch incidents. In Bahrain, extensive seagrass and dugong herbivory in-water surveys were conducted to explore seagrass-dugong interactions under the harsh environmental settings of The Gulf (A. Khamis, personal communication 2024).

4.6.2 Future research and monitoring

The most urgent priority, which is under active development in 2024 (Section 4.7.1), is the development and implementation of a coordinated cross-jurisdictional survey and monitoring strategy for the dugong in The Gulf. It is likely that no single survey technique will be appropriate for every Range State. The challenges are to maximise the likelihood that the data from each jurisdiction will be high quality and comparable, and that the data collection technique will minimise the likelihood of major cross-jurisdictional movement within the period of the survey, a situation that will be particularly challenging in the Gulf of Bahrain/Gulf of Salwa region.

Other research and monitoring initiatives that could be considered in cross-jurisdictional workshop(s) include:

1. **Satellite tracking of dugongs** to evaluate their movement patterns and delineate their migration corridors. Experience in other parts of the dugong's range (Deutsch et al. 2022)

indicates that movements of individual animals are variable, and it will be necessary to track a substantial number of animals (suggest > 20) to obtain a clear understanding of movement patterns. These studies should be conducted only by experienced experts in dugong tracking and under strict protocols, paying due consideration to all relevant animal welfare ethics.

2. **Establishing a coordinated Gulf marine wildlife carcass salvage program**, which enables standardized data collection protocols and data sharing, including:
 - a. determining the cause of death using established veterinary standards as is done in Abu Dhabi;
 - b. measuring the levels of heavy metals, organic contaminants and plastics in tissues using standardized techniques;
 - c. stable isotope analyses to obtain additional information on dugong diet (Thibault et al. 2024); and
 - d. determining the (nuclear) genetic diversity in dugongs of The Gulf, along with information on their demographic history and levels of inbreeding.
3. **Explicitly investigating whether dugongs are resident in Iran** using a range of techniques including fisher interviews, citizen science, eDNA (environmental DNA), and UAV surveys of locations where dugongs have been seen this century such as the Hara Protected Area north of Qeshm Island, and the coastal waters of Bushehr Province.

4.7 Regional co-operation

The Cooperation Council for the Arab States of The Gulf (مجلس التعاون لدول خليج العربية), also known as The Gulf Cooperation Council (GCC مجلس التعاون الخليجي), is a regional, intergovernmental, political, and economic union comprising Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE. Following the CMS/Dugong MOU Regional Meeting on Science and Management for Dugongs in The Gulf in 2023 (CMS Dugong MOU Secretariat 2023), the UAE, Qatar, Bahrain and Saudi Arabia are discussing how to implement coordinated dugong aerial surveys. The GCC has endorsed a regional convention calling for the conservation of threatened species, including dugongs (A. Khamis, personal communication 2024). Recent efforts by the Smithsonian Institution and colleagues, both in and out of the region, have been promoting science diplomacy in the Qatar region and the need for international data sharing and scientific cooperation (Fieseler et al. 2023; Al-Mudaffar et al. 2022).

Khamis et al. (2023) proposed establishing a regional network of marine protected areas spanning all the dugong range states in The Gulf to conserve dugong core areas and any migration corridors. The proposed network would encompass, at minimum: (i) UAE: Murawah Island and Al Yasat Island, (ii)

Bahrain: Hawar Island, Fasht Buthur, and Fasht Jarim, (iii) Qatar the north-western waters of Qatar, and (vi) the shallow waters between Saudi Arabia, Qatar, and United Arab Emirates.

4.8 Summary

The status of the dugong in The Gulf is uncertain. Al-Abdulrazzak and Pauly (2017) examined historical changes in dugong distribution and estimated that the dugong range in The Gulf may have contracted by 25% since 1959. The authors attribute the decrease to a number of threats including: coastal development and dredging, trawling and land reclamation, as well as incidental bycatch and oil spills. This conclusion must be regarded as tentative given the large number of unstated assumptions in their analysis. In contrast, recent studies suggest that The Gulf dugong population may be stable. These studies include: (1) the survey conducted by Abu Dhabi (i.e., Das et al. 2021); and (2) the research by Khamis et al. (2023) in the Gulf of Bahrain. The 2021 winter survey of UAE conducted by Das et al. (2021) recorded 16.7% calves suggesting a reproductively healthy population. In comparison, the percentage of calves reported between Qatar and Bahrain was 5.4–9.9% and 6–6.4% Marshall et al. (2018) and Khamis et al. (2023), respectively.

Table 4.2. Summary of confirmed significant dugong locations in The Gulf by country clockwise starting with the UAE.

Country	Region
UAE	Coastal waters from Ras Ghanadha to border with Qatar, around Marawah Island
Qatar	Gulfs of Bahrain and Salwa
Bahrain	Gulf of Bahrain, especially around Hawar Islands and Fasht Jarrim
Saudi Arabia	Coastal waters from southern Gulf of Salwa to Ras Tanura

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