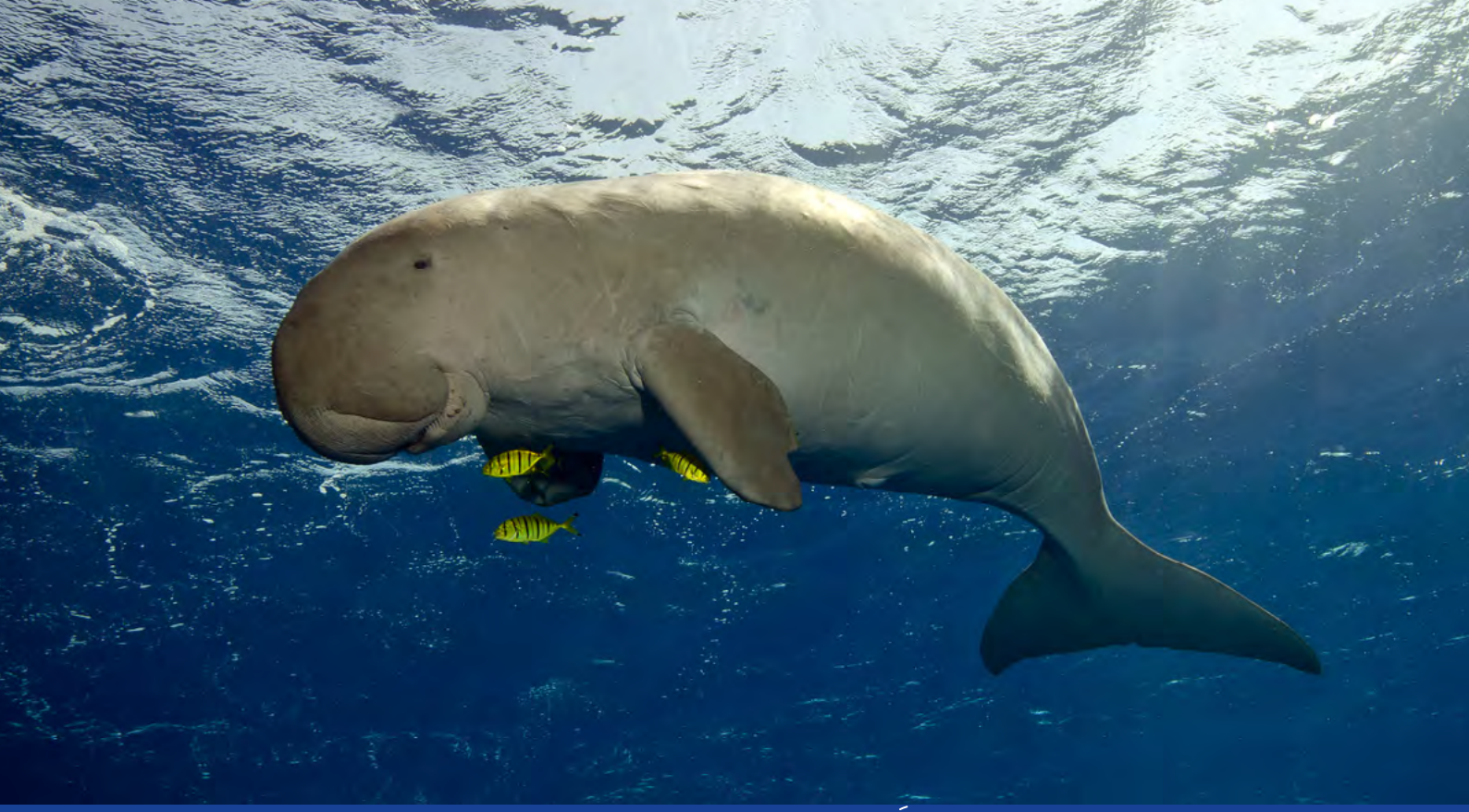

Convention on the
Conservation of Migratory
Species of Wild Animals

A GLOBAL ASSESSMENT OF DUGONG STATUS AND CONSERVATION NEEDS

Executive Summary

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Executive Summary

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edited by
Helene Marsh, Phillipa Loates and Luisa Schramm

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Cover image
Dugong accompanied by juvenile golden trevally, *Gnathanodon speciosus*
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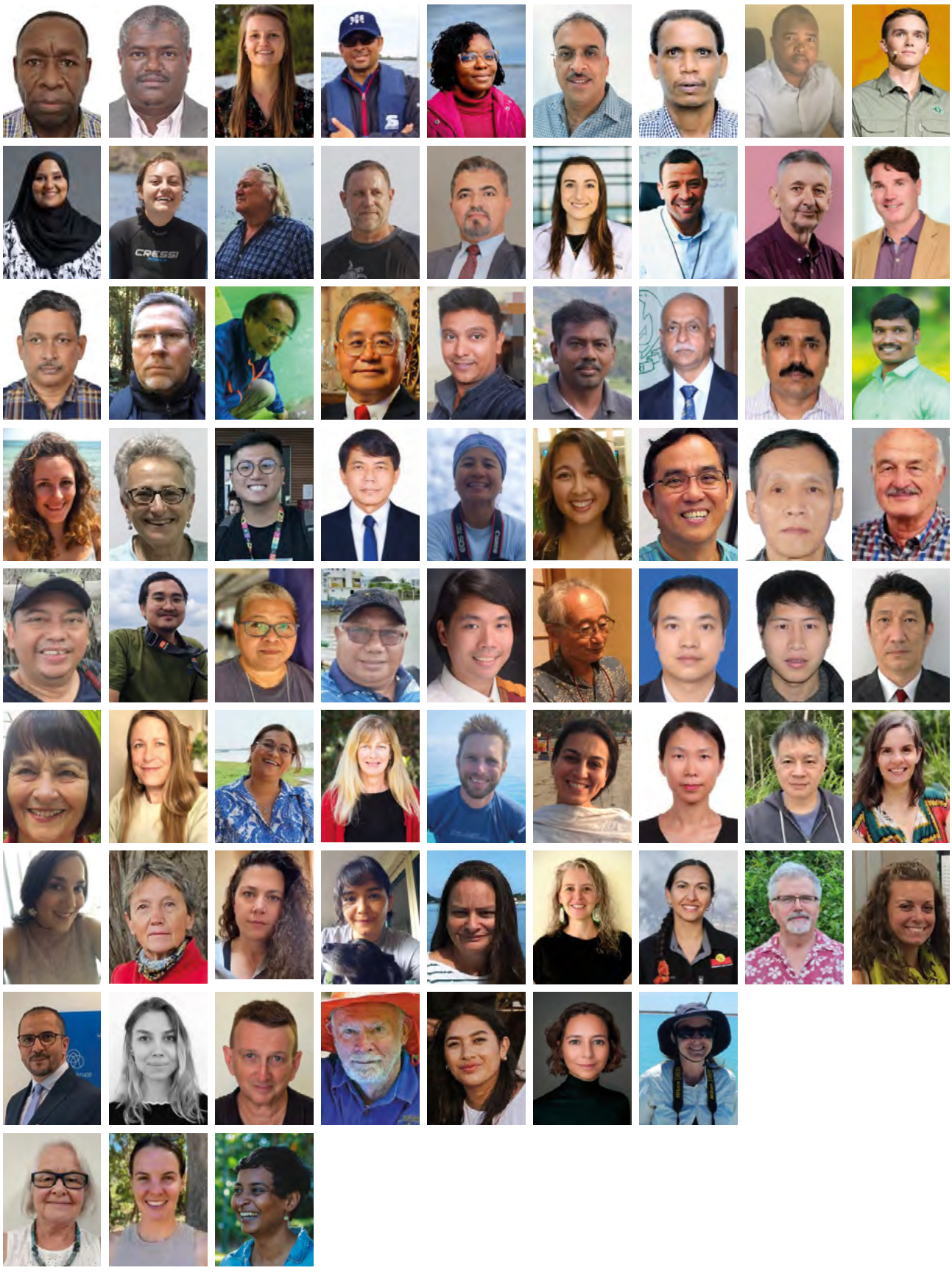
This report was produced on the Bebegu Yumba campus of James Cook University in Townsville, Australia on the lands of the Wulgurukaba and Bindal peoples. We gratefully acknowledge First Nations Custodians of all lands which this report covers. We recognize the deep, lasting connections to Country, and pay respect to Elders past, present and emerging.

Contributors to the Report

The authors of the various chapters are pictured in no particular order in lines 1–8. Some of the experts who provided technical support are in line 9



Executive Summary

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) contracted James Cook University to prepare a new edition of the 2002 publication: 'Dugong: status report and action plans for countries and territories'.

The new edition, which is titled 'A global assessment of dugong status and conservation needs', comprises eleven chapters, each written by the listed co-authors. The report has been edited by Helene Marsh, Philippa Loates and Luisa Schramm and reviewed by Abdelmenam Mohamed, Lauren Lopes, Yasmeen Tel Wala and Harris Wei-Khang. The report is arranged with an Executive Summary and 11 chapters as follows:

- This Executive Summary provides an overview of the project's Key Findings.
- Chapter 1: Global Context provides background material that is relevant to all the regional chapters.
- Chapters 2-10: provide information for each of the following regions: East Africa (Chapter 2), Red Sea (Chapter 3), Arabian/Persian Gulf (Chapter 4), South Asia (Chapter 5), Continental Southeast Asia (Chapter 6), Maritime Southeast Asia (Chapter 7), East Asia (Chapter 8), Pacific Islands (Chapter 9) and Australia (Chapter 10). Each of these regional chapters has been co-authored with several regional experts.
- Chapter 11 summarizes the Key Learnings from this report.

Chapter 1: Global Context

Evolutionary history

- The dugong, *Dugong dugon*, is a medium-sized marine mammal, one of four extant members of the mammalian order Sirenia (sea cows) and the only surviving member of the family Dugongidae.
- The lineage ultimately giving rise to the genus Dugong is thought to have originated in the Atlantic and moved from near modern-day Florida into the Pacific between 12 and 2.8 million years ago (mya), when the Central American Seaway closed.
- The modern species, *Dugong dugon*, might have originated as a result of a long-distance dispersal of an ancestor across the Pacific followed by range expansion from the Indo-Australian region across the Indo-West Pacific.

Geographic range

- The dugong's vast range spans coastal and island waters across approximately 135 degrees of longitude in the Indo-West Pacific and around 50 degrees of latitude; extending approximately 25 degrees both north and south of the equator.
- There are currently 48 countries and territories listed as Range States under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) Memorandum[1] of Understanding on the Conservation and Management of Dugongs (*Dugong dugon*) and their Habitats throughout their Range (Dugong MOU) (https://www.cms.int/dugong/en/signatories-range-states).

Conservation status

- The International Union of the Conservation of Nature's (IUCN) Red List of Threatened Species lists the dugong as Vulnerable to Extinction at a global scale.
- IUCN has also listed the following 'subpopulations' at regional scales: Nansei, Japan (Critically Endangered); Eastern Africa coastal (Critically Endangered); New Caledonia (Endangered).
- The dugong is listed as migratory under Appendix II of the CMS Convention because: (1) individual animals must cross international boundaries on a regular basis at numerous locations throughout its range where Range States have contiguous coastal boundaries, and (2) it is listed as Vulnerable by IUCN.

1 The number of countries and territories listed as dugong Range States under the CMS depends on how France and its dependencies (Mayotte and New Caledonia) are counted.

Life history

- Dugongs are long-lived with a low reproductive rate, long generation time, and a high investment in each offspring.
- The age of sexual maturity is variable in both sexes but tends to be similar for males and females in the same population at the same time.
- Females bear their first calf when they are between six and 17 years old. The gestation period is long (around 12-14 months), with a usual litter size of one.
- The individual variation in dugong life history parameters seems to be linked to the status of their food supply, which in turn can be adversely affected by extreme weather events.
- Dugongs start eating seagrasses soon after birth and grow rapidly during the suckling period when they also receive milk from their mothers.
- A dugong population is unlikely to increase at more than 5% per year (mostly less), even under optimal conditions.

Genetics and population structure

- Dugongs exhibit considerable genetic diversity across their range and several major groupings can be recognized. This implies that regional populations exist that might need to be treated as distinct from one another in conservation planning.
- Dugongs in the Australian region, and especially in northern Australia, can probably be regarded as genetically healthy, with good levels of diversity at nuclear loci and in the mitochondrial genome. Such populations should be better able to respond to changing environmental pressures, including disease, than populations with lower genetic diversity.
- The very low mitochondrial diversity of dugong populations in the Western Indian Ocean, Palau and New Caledonia suggests relatively recent founding events. If low nuclear gene diversity is also typical of these populations, their long-term resilience might be reduced relative to Australian dugongs. This conclusion may also apply to some other populations for which genetic data are lacking.
- Within some regions, there is evidence of limited gene flow among populations. This limited gene flow occurs at a range of spatial scales, but few data are available for most parts of the dugong's range, restricting our ability to define the geographical extent of genetically connected populations. Without such information, it is difficult to use genetic data to inform the appropriate size of management units.
- Genetic data have strengths and limitations that need to be made explicit for correct interpretation and prior to using genetic information in conservation planning, which should be informed not only by genetics, but also by information that may not be associated with genetic structure, including: movements, vital rates, jurisdictional boundaries, and major threats.

Habitat, ecology and behaviour

- The habitat requirements of dugongs generally comprise shallow (less than or equal to 20 m deep), subtropical or tropical coastal waters supporting subtropical and tropical species of seagrass.
- Dugongs are seagrass community specialists. Seagrass is their main food. They feed on nine of the ten genera, and probably on most of the approximately 26 species of seagrass that occur within their range. Dugongs exploit a diet that includes macro-invertebrates and algae at times, as well as seagrasses.
- Dugongs are obligate bottom feeders with ventrally opening mouths. They utilize two different feeding modes: excavating and cropping. Only excavating dugongs leave obvious feeding scars in the sediment.
- Dugongs are limited to the sub-tropics and tropics, presumably because of their sensitivity to low water temperatures.
- Dugongs are usually sighted as solitary individuals or as cows with single calves.
- Dugongs spend a high proportion of their time feeding.
- Loose feeding aggregations of more than 50 and up to several hundred dugongs, including cows with attendant calves, can occur at predictable locations, including Moreton Bay and Shark Bay in Australia and the Gulf of Bahrain/Gulf of Sulwa in the Arabian/Persian Gulf. The determinants of these locations are not known. These aggregations do not occur at all locations that support large numbers of dugongs.
- Dugong vocalizations are social communication signals rather than navigational aids and are apparently particularly important between females and their nursing calves.

- Satellite tracking shows that some individual dugongs and cow-calf pairs can undertake directed movements of several hundred kilometres in a few days. There is no evidence of regular round-trip migrations of entire regional populations, although dugongs may make local adjustments in their space use to adapt to seasonal changes in their environments. No migratory corridors have been identified.
- Periodic seagrass loss driven by extreme weather events is likely to be the most important driver of large-scale movements in dugongs.
- Extra-limital reports of dugongs at locations such as the Cocos (Keeling) Islands and Fiji suggest that individual dugongs can move across deep ocean trenches.

Threatening processes

- Dugongs are vulnerable to anthropogenic influences due to their life history and their dependence on seagrasses in coastal habitats, which are often under pressure from human activities.
- The rate of dugong population change is most sensitive to changes in adult survivorship because of the lengthy period before first breeding, long gestation period and the usual litter size of one, as well as the long period of lactation.
- Given the extensive range of the dugong, individuals are exposed to a variety of threats, some of which are locally unique and some which span its entire range.
- Threats to dugong survivorship include: interactions with fisheries; traditional harvest, vessel strikes, stranding of orphaned calves, and predation.
- Threats to dugong fecundity include: habitat loss and degradation, climate change, acoustic pollution, dugong tourism, diseases, parasites, contaminants and plastics.

Methodologies

- Methodologies used to estimate and monitor dugong population size in ecologically useful time frames include: mark-recapture; abundance aerial surveys, distribution aerial surveys, vessel surveys, fisher surveys, citizen science, genetic techniques and land-based surveys.
- The most appropriate technique for a given location depends on its geography, spatial scale, the capacity of the survey team and the funding available. The results obtained using different techniques are generally not strictly comparable and most techniques are unsuitable for quantifying trends.
- Methodologies used to estimate the extent of seagrass meadows include: aerial photography, drop-down cameras, intertidal walking, scuba-diving and snorkelling, towed cameras, remote sensing and acoustic echo-sounding. The most appropriate technique for a given location depends on its geography, spatial scale, the capacity of the survey team and the funding available.
- Polygon (vector-based) maps have been used to estimate the area of seagrass habitat suitable for dugongs in each Range State in this report. Only seagrass areas that have been mapped with moderate to high confidence have been reported.

Blue Carbon

- Blue Carbon is the ecosystem service provided by the atmospheric carbon dioxide captured and stored in coastal vegetated ecosystems, including the dugong's seagrass habitats.
- The low-biomass seagrass meadows used by dugongs accumulate lower amounts of organic carbon than higher-biomass meadows. Nonetheless, the extent of the seagrass meadows in the dugong's range makes it relevant from a Blue Carbon perspective.
- Quantifying the Blue Carbon value of the dugong's seagrasses habitats and their potential to contribute to climate change mitigation at national or regional levels could provide further rationale for dugong habitat conservation.

Chapter 2: East Africa: Republic of Kenya (Kenya), Republic of Madagascar (Madagascar), France, Department of Mayotte (Mayotte), Republic of Mozambique (Mozambique), Republic of Mauritius (Mauritius), Republic of Seychelles (Seychelles), Federal Republic of Somalia (Somalia), Union of the Comoros (Comoros) and United Republic of Tanzania (Tanzania)

- Hunting and bycatch in fishing nets have caused very serious declines in the dugong populations in East Africa.
- Dugongs are probably extinct in the waters of both Mauritius and Rodrigues and apparently no longer occur in the Comoros outside Mohéli, and in the Seychelles outside Aldabra.
- The International Union for Conservation of Nature's (IUCN) Red List of Threatened Species listed the coastal Eastern Africa subpopulation of dugongs as Critically Endangered in 2022.
- Dugongs in East Africa are likely to have limited resilience to extreme events as the genetic differences between individuals appear to be very low.
- The only location in East Africa where a globally significant number of dugongs is known to occur is the Bazaruto Seascape in Mozambique. This location has been recognized internationally as an Important Marine Mammal Area (IMMA) and a Key Biodiversity Area (KBA).
- Bazaruto dugongs and the threats to them are actively monitored by African Parks. There is significant community engagement in these activities.
- Scientifically designed local-scale surveys informed by local knowledge have the potential to provide important new information about dugongs in Zeyla Archipelago in Somaliland, Mohéli, Mayotte and Aldabra.
- In Madagascar, Nosy Berafia in Sahamalaze National Park, Nosy Hara Marine Park, Ampobofofo, Bay of Rigny Complex, and Ambodivahibe are important habitats for dugongs.
- The 'Northwest Madagascar and Northeast Mozambique Channel' IMMA, which spans the waters of Comoros, Mayotte and Northwest Madagascar, includes the dugong as one of 22 supporting species.
- Outside the Bazaruto Seascape, dugong numbers are apparently so low that management interventions focussed solely on dugongs are unlikely to attract much support. Interventions designed to protect all marine megafauna may be more successful and groups with an interest in the conservation of marine turtles and small cetaceans should be invited to incorporate dugong conservation in their management actions.
- The areas of seagrass habitat coverage in the region are likely to be underestimated. It will be important to undertake further mapping using modern techniques including unoccupied aerial vehicles (UAVs) or drones.
- An updated comprehensive 'Dugong Conservation Strategy in East Africa' would be a timely initiative, especially if a regional spatial risk assessment of the threats to dugongs in areas of local importance for the species were included.

Chapter 3: Red Sea: Arab Republic of Egypt, State of Eritrea, Kingdom of Saudi Arabia, Republic of Djibouti, Republic of Sudan and Republic of Yemen

- The dugong distribution in the Red Sea is fragmented, reflecting the availability of suitable seagrass habitat.
- The dugong population of the Red Sea was estimated to be up to 4,000 animals in the 1980s, an estimate extrapolated from an aerial survey of the number of dugongs in the Saudi Arabian waters of the Red Sea in 1987, plus interview surveys in Yemen in 1988.
- The current size of the dugong population of the Red Sea is unknown.
- Dugong research and conservation in Saudi Arabia and Egypt have increased in recent years. Nonetheless, there are few contemporary, quantitative data on both dugongs and their seagrass habitats for most countries bordering the Red Sea, especially the Range States along the western coast.
- Recent research assessing the status of dugongs in the region is largely conducted on a local-scale, including interviews with fishers, studies of feeding trails and photoidentification of individual dugongs. The results of recent aerial surveys along parts of the Saudi Arabian coast are unpublished at the time of writing.

- The following Important Marine Mammal Areas (IMMAs) of relevance to dugongs have been declared in the Red Sea: the 'Northern Red Sea Islands' and the 'Southern Egyptian Red Sea Bays, Offshore Reefs and Islands' in Egypt; and the 'Farasan Archipelago' in Saudi Arabia.
- In addition, there are Areas of Interest (AoIs) for potential designation as IMMAs for which the dugong is listed as a supporting species: (1) the 'Golfe de Tadjoura' and (2) 'Seven Brothers Islands and Godorya' in Djibouti; (3) 'Dhalak and Adjacent Southern Waters' in Eritrea; (4) 'Dungonab Bay–Mukawar Island', and (5) the 'Suakin Archipelago and Sudanese Southern Red Sea' in Sudan.
- It is likely that dugongs have declined in the Red Sea in recent decades due to human-caused mortalities resulting from past hunting pressure and current incidental bycatch and habitat loss.
- The Programme for the Environment of the Red Sea and Gulf of Aden (PERGSA) offers an established framework for regional cooperation on the marine environment and conservation in the Red Sea. A constructive way forward might be to invite PERSGA to coordinate a regional strategy for dugongs in the Red Sea.
- A key initiative could be a program of coordinated and replicable research on the distribution and abundance of dugongs and their seagrass habitats across the countries of the Red Sea. Such a program should use techniques that are appropriate to the capacity of each country and the known distribution of its dugongs but enable cross-country comparisons.
- Contemporary data on dugong abundance for the entire region could enable an International Union for Conservation of Nature (IUCN) Red List of Threatened Species subregional assessment of the status of the dugong in the Red Sea.

Chapter 4: Arabian/Persian Gulf (the Gulf): Islamic Republic of Iran (Iran), Kingdom of Bahrain (Bahrain), Kingdom of Saudi Arabia (Saudi Arabia), State of Qatar (Qatar) and United Arab Emirates (UAE)

- The core habitat for dugongs in the Gulf 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 this situation.
- The available evidence suggests that the Gulf supports a stable population of approximately 5,000 dugongs, around 3,000 of which are in the UAE. A coordinated series of surveys across the core habitat in the western and southern Gulf is required to confirm the status of the dugong in the Gulf, which may be eligible for a subregional Red List of Threatened Species assessment by the International Union for Conservation of Nature (IUCN).
- The largest dugong aggregations recorded globally occur in the Gulf of Bahrain/Gulf of Salwa region. These fluid groups account for approximately 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 recognized by the declaration of 'the Southern Gulf and Coastal Waters' and 'the Gulf of Salwa' as Important Marine Mammal Areas (IMMAs), 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 (MPAs) spanning all the dugong Range States to conserve the core dugong areas would be highly desirable and should encompass at a minimum: the Murawah MPA and the Al Yasat MPA in the UAE; the waters southwest of the main island down to the Hawar Islands and the two Fashts in Bahrain; the northwest coastal waters of Qatar; and the Gulfs of Bahrain and Salwa between the Kingdom of Saudia Arabia, Bahrain and Qatar.
- The Gulf is the world's hottest sea. The effects of climate change on dugongs and their habitats merit investigation in the context of the other threatening processes they are exposed to in the Gulf including fisheries interactions, coastal development and oil pollution, especially as dugong genetic diversity appears to be low in this region.
- The Regional Organization for the Protection of Marine Environment (ROPME) should be well placed to co-ordinate dugong research, monitoring and conservation management across the Gulf.

Chapter 5: South Asia: Republic of Bangladesh (Bangladesh), Republic of India (India) and Democratic Socialist Republic of Sri Lanka (Sri Lanka)

- Dugong distribution in the South Asian Region is apparently limited to: (1) the Gulf of Kutch in northwestern India; (2) Gulf of Mannar–Palk Bay region (between India and Sri Lanka); and (3) the Andaman and Nicobar Islands in Indian waters in the Bay of Bengal. Dugongs may also occur in some Sri Lankan coastal waters outside the Gulf of Mannar–Palk Bay region.
- No dugongs or seagrasses have been recorded in Pakistan. It is uncertain whether Bangladesh supports a resident dugong population. There is no evidence that dugongs ever occurred in the Laccadive (Lakshadweep) Islands (India) or in the Maldives.
- Research is required to determine if dugongs are resident: (1) along the Chittagong coast of Bangladesh and, (2) in Sri Lanka outside the northwestern region.
- The Gulf of Kutch supports an isolated, resident dugong population. The limited extent of the potential seagrass habitat means it is only able to support a relatively small dugong population, a situation which makes the prospects for their longtime survival there highly uncertain.
- The southern Gulf of Kutch has been identified as an Important Marine Mammal Area (IMMA) with the dugong listed as a qualifying species.
- The transboundary Tamil Nadu–Sri Lanka area, which includes the Gulf of Mannar–Palk Bay region, is the most important habitat for seagrasses and dugongs in South Asia. The 'Palk Bay and the Gulf of Mannar' region has been identified as an IMMA, with the dugong as the only qualifying species. The establishment of a dugong conservation reserve along part of the Tamil Nadu coast is a welcome first step towards dugong conservation in this region.
- Currently the Gulf of Mannar–Palk Bay region supports what appears to be a much lower number of dugongs than in the recent past. Procedures need to be developed to enhance the governance arrangements for this region including a focus on community participation in conservation and management. Targeted research is required to improve the management of dugong populations and their habitat (seagrass communities) in this region, with emphasis on reducing the impacts of fisheries, climate change and other threats on dugong populations and their habitats.
- Dugongs in the Gulf of Mannar–Palk Bay region may also face increased development pressures if India and Sri Lanka are connected by infrastructure across Palk Strait and/or if the petroleum and natural gas are exploited within the Gulf of Mannar Biosphere Reserve.
- The Andaman and Nicobar Islands support an isolated, resident dugong population. The limited extent of shallow coastal water around the Andaman and Nicobar Islands means that these archipelagos can support only a relatively small dugong population, a situation that makes their survival there very challenging for conservation managers.
- The 'Southern Andaman Islands' have been identified as an IMMA with dugongs as a qualifying species.
- Given the small sizes of dugong populations in both the Gulf of Kutch and the Andaman and Nicobar Islands, it may be effective and efficient to develop and implement conservation arrangements for marine megafauna, rather than dugongs *per se*.
- Dugongs in both the Gulf of Kutch and the Andaman and Nicobar Islands likely qualify for separate International Union for Conservation's (IUCN) Red List of Threatened Species 'subpopulation' assessments.
- Robust quantitative information on the size of the Gulf of Mannar–Palk Bay region dugong population would be essential for an IUCN Red List of Threatened Species 'subpopulation' assessment of the dugong population in this region.

Chapter 6: Continental Southeast Asia: Malaysia (Peninsular Malaysia only), Kingdom of Cambodia (Cambodia), Kingdom of Thailand (Thailand), Republic of the Union of Myanmar (Myanmar), Republic of Singapore (Singapore) and Socialist Republic of Viet Nam (Viet Nam)

- Dugongs face significant challenges in this region, primarily from incidental bycatch, habitat loss and degradation. The underlying causes of these threats vary across Range States, but their root causes include inadequate law enforcement, coastal development, and poverty.
- The status of dugongs in this region remains data deficient, despite the efforts by many researchers and NGOs.
- The following globally-important Important Marine Mammal Areas (IMMAs) with the dugong as a qualifying species have been recognized or are in the process of being evaluated: (1) Trang in Thailand (under evaluation); (2) the 'Mersing Archipelago' IMMA, off the eastern coast of Johor in Peninsular Malaysia; (3) the transboundary 'Kien Giang and Kep Archipelago' IMMA, which spans the Kep Province in Cambodia and the Kien Giang Province in Viet Nam; and (4) the 'Côn Đảo' IMMA in Viet Nam.
- The Andaman Sea coast of Thailand and the east coast of Johor in Peninsular Malaysia are the only locations with confirmed populations ranging from tens to hundreds of dugongs. Effective protection of these populations is particularly important.
- Throughout most of the region, dugongs persist in fragmented, relatively small populations in recognized areas of local importance. Thus, it may be more efficient and effective to consider dugong conservation in these locations in the context of the conservation of marine megafauna more generically than to develop specific dugong management plans.
- Increased attention to transboundary management and the conservation of seagrass meadows known to support dugongs would be highly desirable.
- The largest knowledge gaps are: (1) inadequate mapping of seagrass in most countries, particularly Myanmar; (2) lack of quantitative data about most of the dugong populations; (3) lack of understanding of the contemporary transboundary movements of dugongs; (4) the limited understanding of the genetic structure of dugong populations outside Thailand; (5) spatial understanding of the threats posed by fisheries; and (6) understanding the causes of the large-scale seagrass dieback along the Andaman coast of Thailand; (7) the human dimensions of dugong interactions with fisheries and coastal development.
- The dugong population in the Côn Đảo region of Viet Nam must be at high risk because of its isolation and may merit International Union for Conservation of Nature's (IUCN) Red List of Threatened Species evaluation as a 'subpopulation', depending on the availability of data.

Chapter 7: Maritime Southeast Asia: Brunei Darussalam (Brunei), Democratic Republic of Timor-Leste (Timor-Leste), Republic of Indonesia (Indonesia), Malaysia (East Malaysia only) and Republic of the Philippines (Philippines)

- The dugong populations in Maritime Southeast Asia are fragmented and data deficient because information is largely based on local sightings at a subset of possible habitats.
- Important Marine Mammal Areas (IMMAs) with the dugong as a qualifying species have been declared for the following sites in Indonesia: (1) 'Balikpapan, Adang and Apar Bays' in East Kalimantan; (2) 'Tolitoli' in Central Sulawesi; (3) 'Kaimana' in West Papua; and (4) the 'Eastern Lesser Sunda Islands and Timor Coastal Area'.
- The following areas are under evaluation by the Marine Mammal Protected Areas Taskforce (MMPATF) as IMMAs with the dugong as a qualifying species: (1) 'Brunei Bay' bordered by Brunei, the Malaysian state of Sarawak and the Malaysian Federal Territory of Labuan; and (2) 'Mayo and Pujada Bays' on the Pacific coast of Mindanao in the Philippines.
- It has been assumed that dugong populations are declining in the region because of unsustainable, historical hunting, incidental entanglement in gillnets, destructive fishing, boat collisions and seagrass habitat degradation but there are no quantitative trend data.
- It would be desirable to design and apply survey techniques suitable for both: (1) the spatial scale of the distribution of dugongs and their seagrass habitats, and (2) the local capacity in each Range State.

- The following sequence of surveys could provide important new information for management: (1) fisher surveys to identify dugong areas of local importance and threats to dugongs at the desired governance scale; (2) seasonal 'hotspot surveys' using small drones supplemented if possible by eDNA to provide baseline information on dugong distribution and abundance; (3) seagrass surveys using the Seagrass-Watch protocols being applied in the International Climate Initiative (IKI) Seagrass Ecosystem Service (SES) project; (4) focus groups with local experts to identify threats to dugongs and other megafauna and their habitats to inform: (a) a review of the adequacy of existing Marine Protected Areas (MPAs) to protect megafauna, including dugongs and their habitats; and (b) the design of new or modified MPAs to achieve effective conservation management of marine megafauna.
- Especially in Indonesia and the Philippines, there is a mismatch between the spatial scale of marine conservation, which is largely organized at a local level, and strategic planning for dugong conservation, which has been at a national level. Coordinated governance of marine conservation at a regional level could be advantageous.
- Given that most dugong populations are likely small, conservation planning and management may receive more community support if it were organized for marine megafauna rather than dugongs *per se*.
- At the key location of Brunei Bay on the island of Borneo, international coordination across the state government of Sarawak and the federal territory of Labuan in East Malaysia and the country of Brunei would be highly desirable.

Chapter 8: East Asia: 日本 (Japan) and People's Republic of China (China)

- Dugongs are in critically low numbers in the coastal waters of China (Viet Nam-China border to the northern border of the Fujian Province including offshore islands) and Japan (waters of the Nansei Islands).
- It is extremely unlikely that dugongs will recover in this region given the low likelihood of dugongs migrating into the area, successful captive breeding programmes, or translocating dugongs into the region from elsewhere.
- The International Union for Conservation of Nature's (IUCN) Red List of Threatened Species formally classified the Nansei 'subpopulation' as Critically Endangered in 2019. An assessment for the Chinese 'subpopulation' would almost certainly reach the same conclusion.
- Given this situation, interventions designed to protect coastal marine megafauna more generically in China as part of its Ecological Conservation Redline strategy, may be more successful than dugong-specific interventions.
- Some segments of the Japanese public consider the remaining dugong population in Japanese waters to be very important, a situation that could be harnessed to address the threats to marine megafauna in the Nansei Islands region more generically.

Chapter 9: Pacific Islands: Independent State of Papua New Guinea (Papua New Guinea), New Caledonia (Semi-autonomous Territory of France, henceforth New Caledonia), Republic of Palau (Palau), Republic of Vanuatu (Vanuatu) and Solomon Islands (Solomon Islands)

- Dugongs persist in locations of local importance in all the Pacific Island Range States considered in this chapter.
- Information on dugong habitats, abundance and conservation status is limited outside New Caledonia, especially for Papua New Guinea (PNG) and the Solomon Islands. Lack of capacity and funding are the main drivers for this persistent gap in investment in research and monitoring. Designing and implementing survey techniques appropriate to Palau, PNG and Vanuatu to monitor the status of dugongs in each of these Range States should be a high priority.
- The Palau dugong population is not only the most isolated dugong population in the world but appears to have very low genetic diversity.
- The 'Southern Shelf Waters and Reef Edge of Palau' Important Marine Mammal Area (IMMA) was established in 2021 with the dugong as the sole qualifying species.
- The Palau 'subpopulation' may be eligible for the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species listing.
- The 'Main Solomon Islands' IMMA encompasses the coastal and offshore waters of the main group of Solomon Islands. The dugong is believed to be widely distributed within the IMMA and is one of the qualifying species.

- The status and size of the dugong population in Vanuatu is unknown. It is likely that the population is small, fragmented and widely distributed among the islands.
- IUCN listed the New Caledonia 'subpopulation' as Endangered in 2022. This 'subpopulation' appears to have very low genetic diversity.
- The dugong is explicitly cited as an attribute of the Outstanding Universal Value (OUV) in the Lagoons of New Caledonia World Heritage property.
- The 'New Caledonian Lagoons and Shelf Waters' IMMA was listed in 2021, with the dugong as a qualifying species.
- An important priority should be to build on the history of regional cooperation to develop a program of coordinated research on and monitoring of the distribution and abundance of dugongs and their seagrass habitats across the region, using techniques that are appropriate to the capacity of each Range State, but which would enable cross-country comparisons.
- Once this foundational work has been established, consideration should be given to understanding the connectivity between dugongs at locations within the region using modern genetics and tracking techniques, especially as genetic diversity appears to be very low for dugongs in both Palau and New Caledonia.

Chapter 10: Commonwealth of Australia (Australia): Queensland, Northern Territory, and Western Australia from Shark Bay north

- Australia is the most important location for dugongs and their seagrass habitats in the world. The vast areas of shallow continental shelf in northern Australia provide extensive areas of seagrass supporting habitat. The human population density of most of this region is very low.
- The total estimated dugong population is approximately 166,000 ± SE 21,500 animals. The total area of seagrass estimated with moderate to high certainty in the dugong's Australian range is approximately 57,500 km^2, including 24,076 km^2 in waters more than 15 m deep offshore from the urban coast of the Great Barrier Reef World Heritage Area (GBRWHA). This offshore area has not been surveyed for dugongs.
- The dugong is a Matter of National Environmental Significance (MNES) under national law and receives protection under the laws of all relevant jurisdictions in their Australian range.
- Ten Important Marine Mammal Areas (IMMAs) with dugongs as a qualifying species are recognized in Australian coastal waters: five in Queensland, one straddling Queensland and Northern Territory waters, and four in Western Australia. Dugongs in most of these IMMAs receive some statutory protection under marine park and/or fisheries legislation.
- The dugong population is explicitly recognized as an attribute of the Outstanding Universal Value (OUV) in both the Great Barrier Reef (GBR) and the Shark Bay World Heritage Areas.
- The results of the large-scale aerial surveys that have been conducted over dugong habitats in Australia since the 1980s suggest that dugong conservation status varies regionally within Australian coastal waters from increasing along the remote coast of the GBR World Heritage Area, stable along the Gulf of Carpentaria coast of the Northern Territory and Shark Bay World Heritage Area, declining along the urban coast of the GBRWHA, and uncertain in most other parts of their Australian range.
- Confidence in these assessments varies because of regional and temporal differences in survey recency, frequency, and methodological approach. Much of the dugong's range in Western Australia and the Northern Territory has been surveyed only once and key areas have not been surveyed for more than ten years including: Torres Strait, which supports the largest dugong population, the Gulf of Carpentaria coast of Queensland, and the Pilbara coast of Western Australia.
- With further information, the isolated and remote dugong 'subpopulation' of the Ashmore Reef-Sahul Bank region in Australian waters situated between the northwest coast of Western Australia and the island of Rote, Indonesia may be a candidate for an International Union for Conservation of Nature's (IUCN) sub-population listing.
- Dugong hunting by Traditional Owners (Aboriginal or Torres Strait Islander individuals or groups who have a traditional or historical connection, attachment, and/or relationship to an area of land or sea) is legal under Australian Law.
- The process of integrating seagrass data, aerial survey data and Traditional Ecological Knowledge (TEK) to identify the probability of dugong occurrence in Kimberley coastal waters should be explored with Traditional Owners for possible application in other areas.

- Extreme weather events (cyclones, floods, and marine heatwaves) have been the most significant threats to dugongs in their Australian range for at least the last 30 years. Loss of the seagrasses eaten by dugongs results in dugong life history changes including an increase in mortality, especially neonatal and early juvenile mortality, and a decrease in fecundity. In such circumstances, some dugongs undertake temporary emigration, presumably seeking locations where seagrass has not been lost.
- As a very highly developed country, Australia has the potential to conduct research and develop monitoring techniques that inform dugong conservation globally. A high proportion of modern dugong research has been conducted in Australia.
- The development of a national Wildlife Conservation Plan in conjunction with Traditional Owners could enable a more systematic and prioritized approach to research and monitoring than that observed to date. The Biologically Important Areas for dugongs being identified by the Australian Government could be a focus of this plan.

Chapter 11: Key learnings from this report

Need to revise global range information

- The International Union for Conservation of Nature (IUCN) Red List of Threatened Species lists the dugong as Vulnerable to Extinction at a global scale.
- The assessment includes a global range map, which this report indicates needs revision by the IUCN Sirenia Specialist Group.

Potential for additional 'subpopulation' listings

- The IUCN has listed the following dugong 'subpopulations' at a regional scale: Eastern Africa Coastal (Critically Endangered); Nansei, Japan (Critically Endangered); New Caledonia (Endangered).
- This report has identified a further 11 'subpopulations', including three transboundary 'subpopulations', as potentially appropriate for assessment for IUCN Red List of Threatened Species listing as Threatened.
- These assessments should be undertaken by the IUCN Sirenia Specialist Group.

Global prospects

- Dugong Range States are socioeconomically diverse and include some of the world's richest and most highly developed countries as well as some of the poorest and most war-torn.
- The dugong's prospects are uneven across its global range as confirmed by the evidence in Chapters 2-10 of this report and the current and prospective IUCN 'subpopulation' listings.
- Nonetheless, the conservation prospects for the dugong at a global scale should be better than for any other sirenian species because an extensive area of dugong habitat occurs in the waters of very highly developed countries with the capacity to implement effective conservation practices.
- The prospects for dugongs surviving in the coastal waters of Island Range States with low seagrass extent, relatively small areas of coastal waters shallower than 20 m and some level of isolation (e.g., separated from adjacent continental land masses or islands) are likely to be precarious.

Need for additional seagrass mapping

- The area of seagrass in sub-tropical and tropical Indo-Pacific waters shallower than 20 m deep can be used as a crude index of dugong carrying capacity.
- While not all shallow coastal waters are potential seagrass habitat, the area of seagrass known with moderate to high confidence as a proportion of the area of coastal waters less than 20 m deep shows the need to undertake additional seagrass mapping in all regions of the dugong's range, especially the Red Sea, the Asian regions and the Pacific Islands.
- The need to map dugong habitat is recommended for inclusion on the roadmap for the 2030 Seagrass Breakthrough, announced during the United Nations Framework Convention on Climate Change Conference of the Parties No. 28 in December 2023.

Desirability of prioritized revision of Dugong and Seagrass Toolkit

- The Dugong and Seagrass Research Toolkit contains many sections that need to be prioritized for updating.
- The section on estimating dugong abundance, which is of key relevance to evaluating dugong status and trends, is out-of-date.
- The Toolkit is silent on recent advances in methodology, such as in the use of unoccupied aerial vehicles (UAVs or drones) for population assessment and monitoring and condition assessment, eDNA, survey design and the analysis of trends.

Desirability of spatial risk assessment of threats at important locations

- The direct and indirect threats to dugongs are relatively consistent across their range, although their root causes differ with socioeconomic context.
- The relative importance of these threats varies at both regional and local scales.
- An important initiative would be to consider the relative risks, including the climate risks, to the globally and regionally important dugong habitats identified in this report.

Desirability of generic interventions to protect coastal megafauna

- Dugong density is now so low in many locations that there is little community awareness of dugongs or support for dugong-specific interventions.
- In Range States with low dugong density, generic interventions to protect coastal megafauna and their habitats could be a more efficient and effective approach to addressing threats that affect all megafauna, such as gillnetting. This approach also accords with some of the decisions of the Conference of the Parties to the Convention on Migratory Species of Wild Animals (CMS), which foreshadows a generic approach to develop methods to address threats that affect multiple CMS-listed species of marine megafauna.

Desirability of increased regional cooperation

- Regional cooperation on dugong conservation management and research is at various stages of development across dugong Range States.
- It would be highly desirable for each of the regions in the dugong's global range to consider developing or updating a Regional Action Plan to guide the development and delivery of practical and resource-efficient conservation strategies for dugongs and their habitats (and if appropriate, associated marine megafauna).

Opportunity for keeping this report and the Dugong and Seagrass Research toolkit up to date

- The technology now exists to create and modify on-line content in an organized manner, while ensuring that the information remains of high quality. Such an approach could be used to keep this report and the Dugong and Seagrass Research Toolkit up to date with the assistance of the Dugong MOU Dugong Technical Advisory Group (DTAG).

The Convention on the Conservation of Migratory Species of Wild Animals (CMS)

is an environmental treaty of the United Nations that provides a global platform for the conservation and sustainable use of migratory animals and their habitats. This unique treaty brings governments and wildlife experts together to address the conservation needs of terrestrial, aquatic, and avian migratory species and their habitats around the world.

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