

Chapter 7: MARITIME SOUTHEAST ASIA

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Regional Findings

Maritime Southeast Asia: Brunei, Indonesia, Malaysia (East Malaysia only), the Philippines and Timor Leste

- 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 with the dugong as a qualifying species have been declared for the following sites in Indonesia: (1) 'Balikpapan, Adang and Appia Bays' in East Kalimantan; (2) 'Tolitoli' in Central Sulawesi; (3) 'Kaimana in West Papua'; and (4) the 'Eastern Lesser Sunda Islands and Timor coast'.
- The following areas are under evaluation as Important Marine Mammal Areas with the dugong as a qualifying species: (1) 'Brunei Bay' bordered by Brunei and 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 gill nets, destructive fishing, boat collisions and seagrass habitat degradation but there are no quantitative trend data.
- 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.
- 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) 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 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) project, (4) focus groups with local experts to identify threats to dugongs and other megafauna and their habitats could inform: (a) a review of the adequacy of existing 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.
- Given that most dugong populations are likely small, conservation planning and management might receive more community support if it were organised for 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.

7.1 Regional Setting

7.1.1 Geographic overview

This chapter considers the status of dugongs in Maritime Southeast Asia, which includes the following island nations ordered by their western boundaries: Indonesia, East Malaysia (otherwise known as Malaysian Borneo), Brunei Darussalam (henceforth Brunei), Philippines and Democratic Republic of Timor-Leste (henceforth Timor-Leste) (Figure 7.1). The region has an estimated total coastline length of 94,709 km, 57% of which lies in Indonesia (54,716 km), 38% in the Philippines (36,289 km), ~ 3% in East Malaysia (2,837 km) and < 1% each in Timor-Leste (706 km) and Brunei (161 km). Although this region represents an estimated 40% of the coastline in the dugong's global range (Marsh et al. 2011), it is unlikely to represent such a high percentage of dugong habitat as the area of shallow sea surrounding the islands is generally narrow and the seagrass meadows are restricted to the shallow coastal and reef nearshore areas (Figure 7.2).

All dugong Range States in Maritime Southeast Asia are in the Indo-Pacific seagrass bioregion, and the estimated seagrass areas known with moderate to high confidence (Figure 7.2) are as follows (countries are ordered by their western boundaries, consistent with this chapter): Indonesia 2,938 km² (Sjafrie et al. 2018; Sudo et al. 2021; Bonnet 2016; McKenzie et al. 2023), East Malaysia 10 km² (Hossain et al. 2015a, b; Hossain et al. 2016; Jaaman et al. 2011; Rajamani and Marsh 2015), Philippines 992 km² (Samonte-Tan et al. 2007; Fortes 2008; Tamondong et al. 2013; Japitana and Bermoy 2015; Sudo et al. 2021; McKenzie et al. 2023), and Timor-Leste 44 km² (Boggs et al. 2012; Joyce 2013; McKenzie et al. 2023). Lamit et al. (2017) roughly estimated the area of seagrass in Brunei Darussalam to be 1.5 km² however no seagrass polygon maps were available at the time of writing (McKenzie et al. 2020). Recent estimates from the Allen Coral Atlas (2020) predict the spatial extent of reef-associated seagrass meadows to be 5,584 km² in Indonesia and 1,988 km² in the Philippines (areas not included in the above totals), indicating the critical need for further seagrass meadow mapping efforts within these countries.

The dugong populations in Maritime Southeast Asia are fragmented. Their status is data deficient (Marsh et al. 2011) because information is largely based on local sightings at a subset of possible habitats as outlined in the country reports below. It has been assumed that dugong populations are declining in the region as a result of unsustainable, historical hunting, incidental entanglement, destructive fishing (Aragones et al. 2017, 2022), coastal development, boat collisions and seagrass habitat degradation (Persoon et al. 1996; Jaaman et al. 2008, 2009; Johnson et al. 2023) but there are no quantitative trend data.

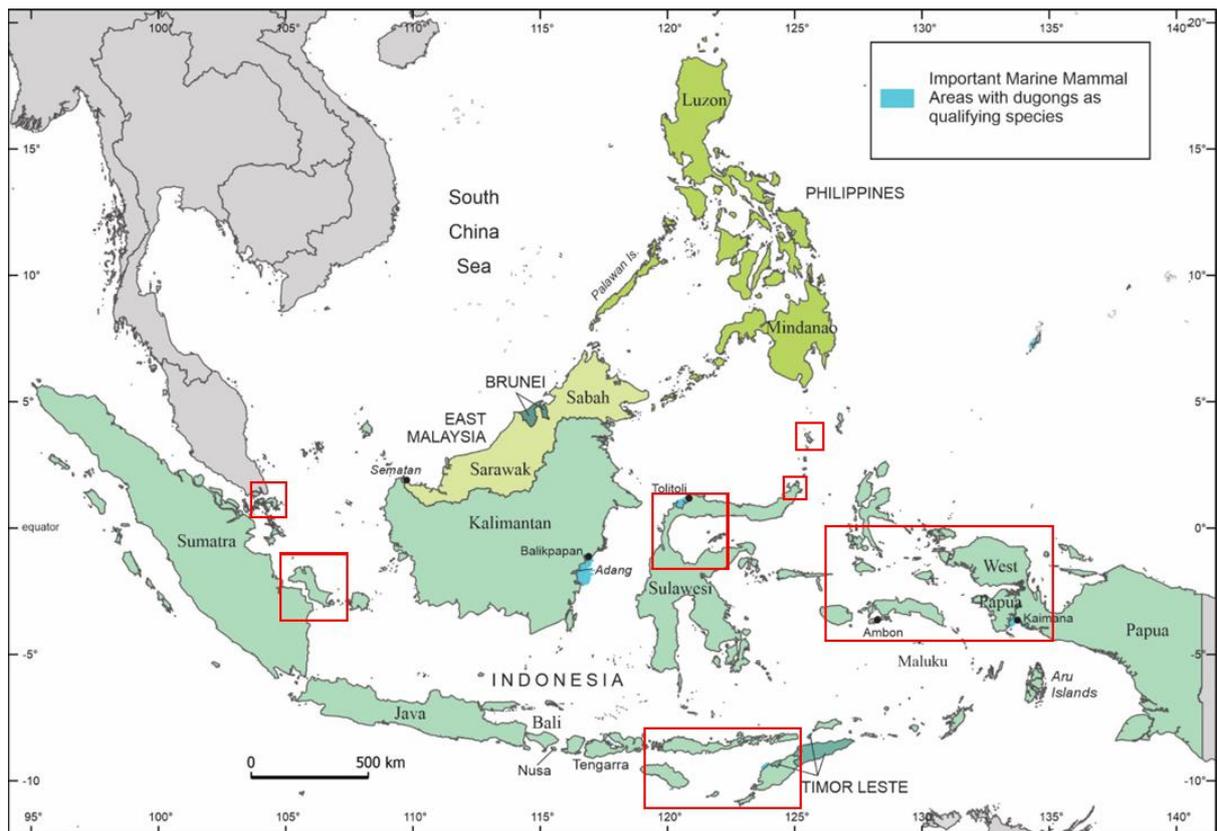


Figure 7.1. Geographic context of Maritime Southeast Asia showing placenames mentioned in the text. Dugong Range States are (ordered by their western boundaries): Indonesia, East Malaysia, Brunei, Philippines and Timor-Leste. Important Marine Mammal Areas with the dugong as a qualifying species are shown in blue. The areas of dugong concentration in Indonesia (2010-2022) identified by Digdo et al. (2024) are outlined by red boxes (clockwise around the region starting with the southernmost box): Nusa Tenggara Timur, Kepulauan Bangka-Belitung, Kepulauan Riau, Sulawesi Tengah, Sulawesi Utara – Minahasa Utara, Sulawesi Utara – Sangihe, Papua Barat.

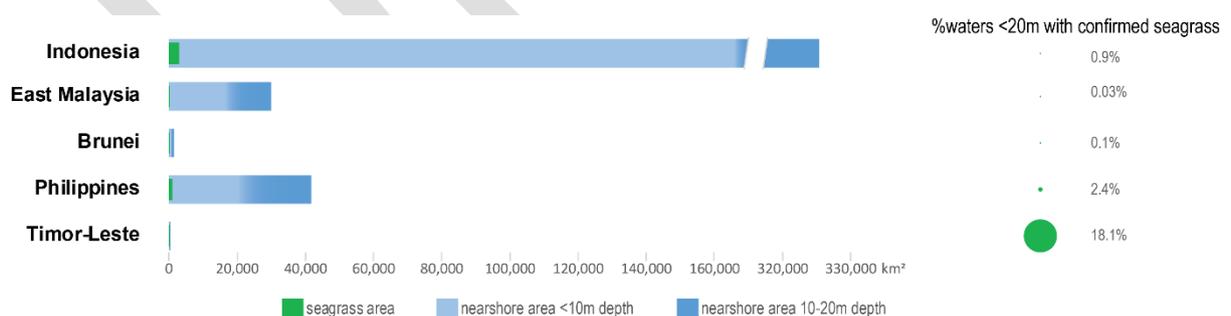


Figure 7.2. Histogram showing the known areas of seagrass and coastal waters < 10m and < 20 m deep for each dugong Range State in the Maritime Southeast Asia region. The areas of seagrass are almost certainly underestimates and do not include reef associated seagrasses. Figure created by Len McKenzie; reproduced with permission.

Indonesia encompasses over 17,500 islands and is the largest archipelago in the world to form a single country. Indonesia consists of five main islands or parts of islands (ordered west to east): Sumatra, Java, Kalimantan, Sulawesi, and Papua; two major archipelagos (Nusa Tenggara and Maluku) and 60 smaller archipelagos (McDivitt et al. 2023) (Figure 7.1).

East Malaysia (Lockard et al. 2023) is situated on the northern part of the island of Borneo and separated from Peninsular Malaysia by ~ 640 km of the South China Sea. East Malaysia is bordered by Kalimantan in Indonesia to the south and surrounds the land border of Brunei, an independent Sultanate. East Malaysia consists of the states of Sabah and Sarawak and the Federal Territory of Labuan (Figures 7.1, 7.4).

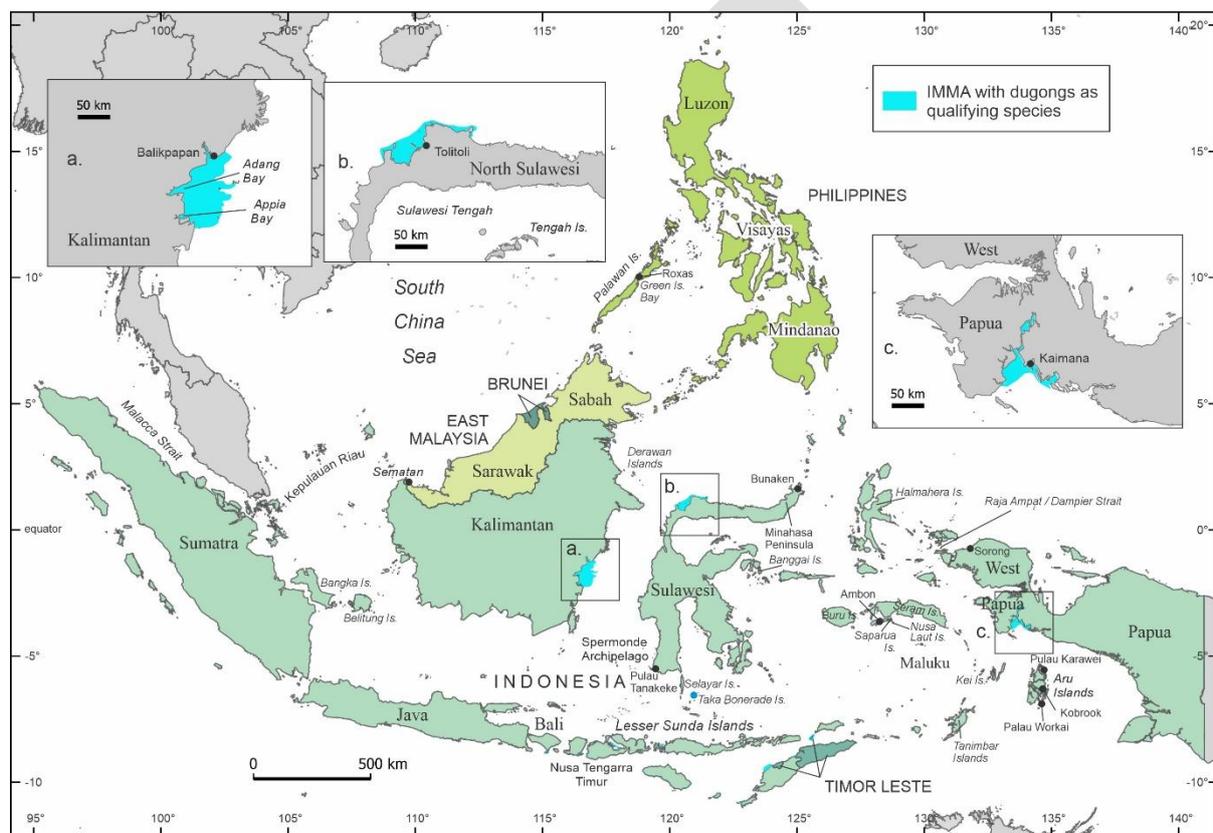


Figure 7.3. Geographic context of Maritime Southeast Asia showing Indonesian Important Marine Mammal Areas (IMMAs) with the dugong as a qualifying species mentioned in the text. IMMAs are shown in blue. Insets: (a) Balikpapan, Adang and Apar Bays in East Kalimantan; (b) Tolitoli in Central Sulawesi; (c) Kaimana in West Papua; and (d) the Eastern Lesser Sunda Islands and Timor Coast Area. Figure created by Adella Edwards; reproduced with permission.

Brunei is divided into two disconnected segments by the Malaysian State of Sarawak, with the larger of the two segments comprising three districts (Belait, Tutong, and Brunei-Muara), bordering the South China Sea to the north and to a small extent Brunei Bay to the northeast (Figures 7.1, 7.4). The

smaller segment comprising the Temburong District, lies between Lawas and Limbang (Malaysia) and is bordered only by the semi-enclosed Brunei Bay (Figure 7.4).

The Philippines is an archipelago of more than 7,000 islands and islets lying about 800 km off the coast of Vietnam. The large islands can be grouped as follows: (1) the Luzon group in the north and west, consisting of Luzon, Mindoro, and Palawan; (2) the Visayas group in the centre; consisting of Bohol, Cebu, Leyte, Masbate, Negros, Panay, and Samar; and (3) Mindanao in the south (Figure 7.3, 7.5).

Timor-Leste (East Timor) (Britannica, the Editors of Encyclopedia 2023a) is located in the eastern Lesser Sunda Islands. The nation occupies the eastern half of the island of Timor, the small nearby islands of Atauro (Kambing) and Jaco, and the enclave of Ambeno, including the town of Pante Makasar, on the northwestern coast of Timor (Figures 7.1, 7.3).

7.1.2. Geo-political and socio-economic overview

This information is provided as an indication of the challenge for each of the Range States in the region to consider the conservation of dugongs and their habitats in the context of their socioeconomic development needs. Economic development in the countries of Maritime Southeast Asia has increased within the past 25 years, but the extent of this development varies by country (Yeung 2022) as summarized below.

Table 7.1. Human Development Index (HDI) status rank and Gross Domestic Product (GDP) per capita rank of the Dugong Range States in Maritime Southeast Asia. Consistent with the remainder of this chapter, the countries in this table are ordered by their western boundaries starting with Indonesia. 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 ²
Indonesia	High	114	97
Malaysia	Very High	62	54
Brunei	Very High	51	4
Philippines	Medium	116	116
Timor-Leste	Medium	140	154

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

² 2023 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)

Indonesia, the world's fourth most populous country (Yeung 2022), has a High Human Development Index (HDI) of 0.705 (ranked 114), a GDP of USD \$1.3 trillion (The World Bank 2022), and a population of ~ 273 million (UNDP 2022). **Malaysia** (Peninsula Malaysia and East Malaysia combined) has a Very High HDI of 0.803 and a GDP of USD 407 billion (The World Bank 2022). Around 6 million people live in East Malaysia (Britannica, The Editors of Encyclopedia (2023b)). **Brunei** has a Very High HDI of 0.829, a GDP of USD 16.7 billion (The World Bank 2022), and a population of ~ 455,000 people (UNDP 2022). **Philippines** has a Medium HDI of 0.699, a GDP of USD 404.3 billion (The World Bank 2022), and a population of ~ 113 million (UNDP 2022). **Timor-Leste** has a Medium HDI of 0.607, a GDP of USD 3.2 billion and a population of ~ 1.3 million people (UNDP 2022).

7.1.3 Genetics of dugong subpopulations

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

No genetic studies have focused on dugongs from this region. The only data are several mitochondrial partial control region sequences of varying lengths reported by Tikel (1997); Blair et al. (2014) and Plön et al. (2019).

One principal haplogroup spans Maritime Southeast Asia and regions peripheral to it. This is the “north-eastern haplogroup”, as depicted in Chapter 1, Figure 1.x, which includes several sequences (410 bp) from Indonesia (n=2, Ambon, Maluku, eastern Indonesia), East Malaysia (n=1, Kuala Prayi, Sabah) and the Philippines (n=1, Taytay, Palawan). These haplotypes are quite similar to one another, but geographically well separated. Shorter sequences reported by Plön et al. (2019) also belong within this haplogroup. These are from Sorong (West Papua, Figure 7.3), and Rote Island, East Nusa Tenggara (Figure 7.7). They are also similar to haplotypes from localities external to the Maritime Southeast Asia region: Okinawa (Japan, Chapter 8); Ashmore Reef (Australia, Chapter 10); Thailand (both Andaman Sea coast and Gulf of Thailand, (Chapter 6) and Palau (Chapter 9).

The East Indian Ocean haplogroup is represented in the region by one of Plön's sequences: MH704314 from Belitung Island, Indonesia.

Surprisingly, the Australasian widespread haplogroup remains almost completely undetected in the region. To date, the only possible example (MH704315) is from Plön et al. (2019) from an unknown locality in the “Indian Archipelago”, likely Indonesia.

That one haplogroup spans this entire region and extends beyond it is unexpected given the size of the region, its complex marine biogeography (e.g., Carpenter et al. 2011; Crandall et al. 2019) and its history of sea-level changes (Ludt and Rocha 2015; Voris 2000). It is also surprising given the example of genetic subdivision at smaller scales in Australian waters (Chapter 10). However,

sampling remains very limited and data from nuclear genetic markers are not yet available: our ignorance of dugong population-genetic structure in this region is near total.

- The only genetic data for dugongs from Maritime Southeast Asia consists of several mitochondrial partial control region sequences. Almost all of these belong to the northeastern haplogroup.
- The impression is of relatively limited diversity in the region, but the genetic sampling is too inadequate for conclusions to be drawn.
- Increased sampling is required. In particular, whole-genome data for a few individuals would greatly increase our understanding of dugong populations in the region.

7.2 Distribution, abundance and trends in Range States

7.2.1 Indonesia

The first written record of a dugong occurrence in Indonesia was made in 1712 by Samuel Falours, a Dutchman employed by the United East Indies Company (Hines 2012). He described a juvenile dugong being kept for four days in a bathtub in Ambon (Pietsch 1991).

Contemporary data on dugong distribution and abundance, are largely limited to anecdotal information supplemented by local-scale sightings and records obtained using a variety of techniques as summarized in Table 7.2. There are few data from aerial surveys. In central Maluku, de longh et al. (1995) observed 17 dugongs during an aerial survey across the islands of Ambon, Haruku, Saparua and Nusa Laut in 1990. As part of the IKI Seagrass Ecosystem Services (SES) project, YAPEKA conducted drone surveys off the western side of North Minahasa where fisher surveys had suggested dugong presence, however no dugongs were recorded (A. Hodgson, personal communication 2024).

In addition, Digdo et al. (2024) developed a database of 1,033 dugong sighting and stranding records for the Indonesian archipelago between 2010 and 2022. The database comprises 337 incidental reports documented via the internet, news, and social media and 696 cases based on publications and grey literature and includes records for 24 of the 37 Indonesian provinces. There were > 50 reported sighting from five provinces (Sulawesi Utara, Kepulauan Banka Belitung, Sulawesi Tengah, Nusa Tenggara Timur and Kepulauan Riau) (Figures 7.1, 7.3). Sulawesi Utara and Kepulauan Bangka Belitung had > 100 reported sightings.

Digdo et al. (2024) identified six main clusters of dugong sightings: four around small island groups surrounding the Banda Sea and two ~ 1,000 km to the north-west between South Sumatra and the Mallacca Straits (Figure 7.1). Overall sightings were associated with known areas of seagrass, However, surprisingly few dugong sightings were reported from a large area of seagrass along the

Indian Ocean coast of Sumatra or from the Indian Ocean coast of Central and West Java. Mortality records were highest in the Kepulauan Bangka Belitung and Kepulauan Riau archipelagos on the north-west side of the Java Sea.

Collectively, this information suggests that: (1) dugongs occur in all the major geographic regions of Indonesia; (2) local populations are small and fragmented; (3) there is a lack of systematically acquired information or quantitative data about the distribution and abundance of dugongs in Indonesia; and (4) an absence of robust data about trends. This situation is a major gap in our understanding of the global status of the dugong, given the vast extent of known and potential seagrass habitat in Indonesia. Previous estimates of dugong population size (e.g., 1,000-10,000 Marsh et al. 2011) are guesses.

As detailed in the Important Marine Mammal Area (IMMA) e-Atlas, IMMAs with the dugong as a qualifying species have been declared for the following sites in Indonesia (Figure 7.3): (1) Balikpapan, Adang and Apar Bays in East Kalimantan (IUCN-MMPATF 2022a); (2) Tolitoli in Central Sulawesi (IUCN-MMPATF 2022d), where the IMMA boundary overlaps the Convention on Biological Diversity – Ecological or Biological Significant Area (EBSA); (3) Kaimana in West Papua (IUCN-MMPATF 2022c), which is part of the Raja Ampat Protected Areas MPA network and Bird’s Head Seascape; and (4) the Eastern Lesser Sunda Islands and Timor Coast Area (IUCN-MMPATF 2022b), which includes 25 locations where dugongs have been sighted within the coastal areas of Sabu Islands, Rote Islands, Eastern Flores and Timor Island. This IMMA shares a border with Timor-Leste and northern Australia. In addition, a candidate IMMA with dugong as a qualifying species is under consideration in Raja Ampat and Dampier Strait region of West Papua.

- Dugongs occur in all the major geographic regions of Indonesia.
- Local populations are small and fragmented.
- There is a lack of systematically acquired information or quantitative data about the distribution and abundance of dugongs in Indonesia, and an absence of robust data about trends.
- This situation is a major gap in our understanding of the global status of the dugong, given the vast extent of known and potential area of seagrass habitat in Indonesia.
- It is likely to be efficient and effective to address the threats to dugongs as part of generic programs of threat abatement to marine megafauna at an appropriate spatial scale of governance.
- Important Marine Mammal Areas 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 coast.

Table 7.2. Summary of information on the distribution and abundance of dugongs in Indonesia. This table does not include the unpublished locations in Digdo et al. (2024) that are based on dugong sighting and stranding records for the Indonesian archipelago between 2010 and 2022.

Geographical region	Methods	Result	References
Sumatra	Anecdotal information from 1975-2017 Bangka Island: Interviews 135 local informants aged 20-50 2017; sightings from the Agency for Marine and Fisheries of Bangka Belitung Islands Province, local newspapers and publications 1976-2014	Riau and Belitung Islands Bangka Island: 20 records (22 dugongs) 56% from Central Bangka Island District, 25% from South Banka, 13% from Bangka District and 6% from Pangkalpinang City; older records limited to Bangka, South Bangka and West Bangka; and all new records from Bangka Island's east. 82% of recorded dead dugongs (50% entangled in gillnets, 41% stranded and 9% in <i>sero</i> (traditional barrier trap net).	Hendrokusumo et al. (1979); Marsh et al. (2002); Syafutra et al. (2018); Panyawai and Prathep (2022).
Java	Anecdotal information	Ujung Kulon National Park, along Cilegon and Labuhan coasts, south of Cilacap, Segara Anakan, southeast of Blambangan, Banten Bay	Hendrokusumo et al. (1979); de longh et al. (1997); Marsh et al. (2002); Panyawai and Prathep (2022)
Kalimantan	Vessel surveys Balikpapan Bay	Balikpapan Bay: 15 dugongs sighted during vessel surveys in the early 2000s, maximum herd size of 3	de longh (2005); de longh et al. (2007); Panyawai and Prathep (2022)

Nusa Tenggara (Lesser Sunda Islands)	Anecdotal information; fisher interviews Rote Island, Solor-Alor Islands 2004	Bali, Lembata, Mali, Nusa Tenggara Timur, Rote Island, Solor-Alor Islands	Marsh et al. (2002); Mustika (2006); de longh et al. (2009a); Lee and Nijiman (2015); Sirimorok and Asfriyanto (2020); Plaimo et al. (2021); Panyawai and Prathep (2022)
Sulawesi	Anecdotal information	North Sulawesi; Central Sulawesi: Lingayan Island, Tolitoli; South Sulawesi: Togean (Tongian), Banggai, Spermonde (where the dugong may be extinct), Taka Bone Rate/Selayar, and Tanakeke Islands	Marimba et al. (2019); Moore et al. (2017); Satyaningtijas et al. (2020); Sondita et al. (2020); Panyawai and Prathep (2022)
Maluku Islands	Anecdotal information from 1976; local scale shoreline aerial surveys Lease Islands 1990, 1992; strandings.	Lease Islands, Buano Island, Aru Tenggara. Aerial surveys recorded 22-37 individuals; pregnant dugong caught by local fishers at East Halmahera 2011; in 2016, two carcasses found stranded at Morotai Island; two dugongs captured as tourist attraction at Kokoya Island, released by the Ministry of Marine Affairs and fisheries, March 2016.	Allen et al. (1976); de longh et al. (1995a, b); Persoon et al. (1996); Marsh et al. (2002); Mamayu Utami et al. (2018); Panyawai and Prathep (2022)
Papua	Anecdotal information (sightings and strandings) from 1976; shoreline aerial surveys 1981, 2008.	Bird's Head Seascape, Papua Barat. 14 dugongs recorded during 1981 aerial survey along coasts of Teluk Wondama, Roon Island, and Mioswaar Islands; 2008 aerial survey recorded 24 dugongs around Raja Ampat Islands; local fisher Kiat village, West Fafka trapped dugong as tourist attraction.	Allen et al. (1976); WWF (1981); Marsh et al. (2002); de longh et al. (2009a); Kahn (2015); Mangubhai et al. (2012); Mamayu Utami et al. (2018); Panyawai and Prathep (2022)

7.2.2 East Malaysia

Jaaman et al. (2009) conducted 753 interviews in the 16 districts along the coastline of Sabah between March 1997 and December 2004, and 358 interviews across 15 districts in Sarawak between November 1998 and October 2000. Fishers reported sighting dugongs in Limbang and Lawas (northern Sarawak) and two respondents in Sematan (southern Sarawak) reported dugongs near the Kalimantan (Indonesian) border on multiple occasions (Jaaman et al. 2009). All districts in Sabah (n=16) recorded incidental bycatch of dugongs; in Sarawak, only those in the northern region reported incidentally catching dugongs (Jaaman et al. 2009).

Rajamani and Marsh (2010) conducted aerial surveys in 2003 and 2005–2006 along ~ 1,448 km of Sabah's coastline to identify areas of dugong abundance at a regional scale. A total of 53 dugongs (including nine calves) were observed. The largest number of individuals were sighted around Labuan Island followed by Sandakan Bay (n=8), Brunei Bay (n=6), Jambongan Island and Kudat (each with three individuals sighted) (Rajamani and Marsh 2010).

In Brunei Bay and Lawas, Sarawak (Figure 7.4), dugongs were sighted feeding and swimming slowly during each of the local-scale, aerial surveys conducted by Jaaman et al. (2001); Jaaman and Lah-Anyi (2003) and Bali et al. (2008). Sightings included a cow-calf pair. The mean group size was 2.4 dugongs and the maximum group size was eight (S. Jaaman, personal communication 2024). Results of these surveys suggested that there is a small breeding population of dugongs in Lawas waters. Feeding trails of dugong on seagrass beds have also been sighted regularly during seagrass monitoring conducted periodically in the area (S. Jaaman, personal communication 2024).

Rajamani and Marsh (2010) conducted focus groups and interviews with fishers at Banggi Island and Mantanani Island in 2002 (Figure 7.4) to identify habitats at a local scale. Ten groups and 13 individual fishers were interviewed in September 2002 at Banggi Island at the following locations: Kampung Lok Tohog, Kampung Kobong, Kampung Molleangan, Kampung Indalupi, Kampung Kaligau, Kampung Laksian and Kampung Garib. Rajamani and Marsh (2010) also interviewed nine groups and two individuals in February 2002 in the villages of Kampung Pandang and Kampung Siring Bukit on Mantanani Island. All interviewees at Banggi Island had observed dugongs. Sightings were rare with 48% of fishers having observed a dugong only once in 2001; the remainder had not seen any that year. Sightings were most often of one adult (58%) or a cow-calf pair (31%). On Mantanani Island, 91% of fishers had observed dugongs: nine sightings of individuals, two strandings and two incidental catches.

Rajamani and Marsh (2010) developed a community monitoring program at Banggi Island. Many of the reports were of a single, adult male dugong that frequently interacted with people on

Mantanani Island including the villagers' children, Mantanani resort staff and tourists. This animal has not been seen since 2007. These observations also suggested that at least five dugongs were resident or transient at Mantanani Island between 2001 and 2003 and that three adult dugongs and a cow-calf pair were observed in the Banggi Island region in 2002. In 2001, at Banggi Island, one incidental capture and one hunting incident were recorded.

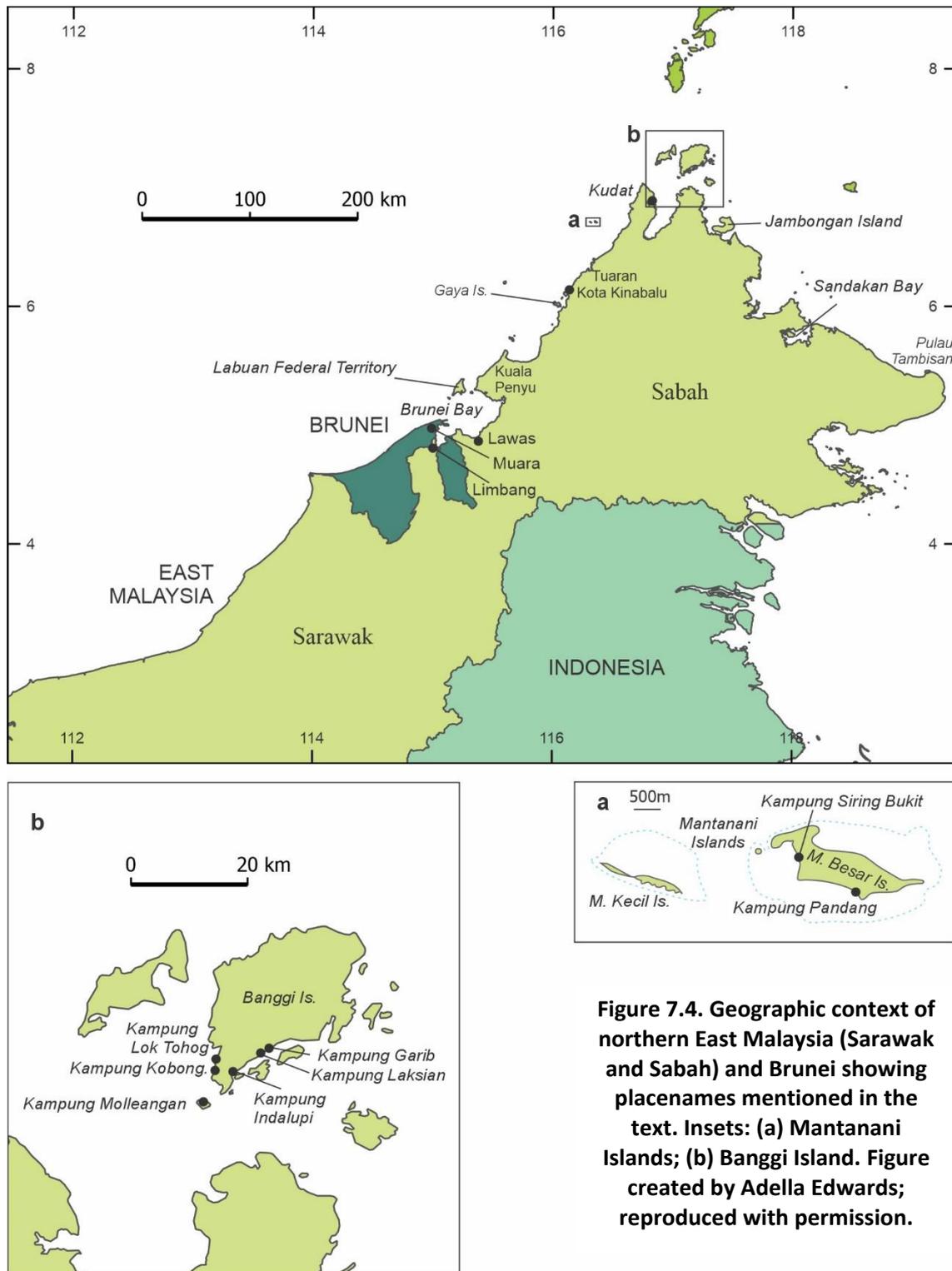


Figure 7.4. Geographic context of northern East Malaysia (Sarawak and Sabah) and Brunei showing placenames mentioned in the text. Insets: (a) Mantanani Islands; (b) Banggi Island. Figure created by Adella Edwards; reproduced with permission.

A rapid assessment interview survey protocol (Moore et al. 2010) was deployed among 2,170 respondents from 161 coastal communities in 2007 (Pilcher et al. 2008). The survey documented 17 dugong interactions with small scale fisheries in the preceding year. Ten of the 17 interactions were with gillnets, one dugong was caught in a trawl net, and one was reportedly entangled in a hook and line.

Dugongs have also been recorded in Pulau Tambisan (Dolar et al. 1997; Marsh et al. 2002); coastal waters close to Kota Kinabalu (Jaaman, 2000; Jaaman and Lah-Anyi, 2003; N. Pilcher, personal communication 2024); Tuaran, Kuala Penyu, Labuan, Gaya Island and Pulau Manukan (Jaaman and Lah-anyi 2003; Rajamani 2009).

Taken together, these results indicated that dugong populations in Sabah are small and clumped, and urgently require management intervention at local scales in the regionally important dugong habitats identified by the various surveys.

- The dugong is widely distributed in East Malaysia in small, clumped populations.
- The status of these populations is data deficient.
- Management interventions are required at local scales at the regionally important habitats identified by the various surveys.
- It is likely to be efficient and effective to address the threats to dugongs in East Malaysia as part of generic programs of threat abatement to marine megafauna at an appropriate spatial scale of governance.

7.2.3 Brunei

Brunei Bay, an important dugong habitat (Rajamani and Marsh 2010) is bordered by Brunei to the southwest, the Malaysian state of Sarawak to the southeast, and the Malaysian Federal Territory of Labuan to the north. Thus, these jurisdictions share a dugong population (Panyawai and Prathep 2022). Four confirmed sightings of dugongs, including three live sightings and one dead animal were reported by UNEP/CMS (2015). Three such incidents have been in the Muara area of Brunei (Figure 7.4). A 1.75m dugong found entangled in fishing nets was later released by divers from Fisheries Department (Wong and Ahmad, 1996).

Brunei Bay is an IMMA area of interest (Aoi) with the dugong as a qualifying species (IUCN-MMPATF).

- Brunei Bay is important dugong habitat is bordered by Brunei, the Malaysian state of Sarawak and the Malaysian Federal Territory of Labuan
- It would be advantageous for these jurisdictions to collaborate in the management of threats to dugongs and other marine megafauna in Brunei Bay.

7.2.4 Philippines

Historically, dugongs were believed to have occurred throughout the waters of the Philippines, across the three main island groups of Luzon, Visayas and Mindanao (Figure 7.3), however, their populations are now fragmented (Nishiwaki and Marsh 1985; Kataoka et al. 1995; Panyawai and Prathep 2022).

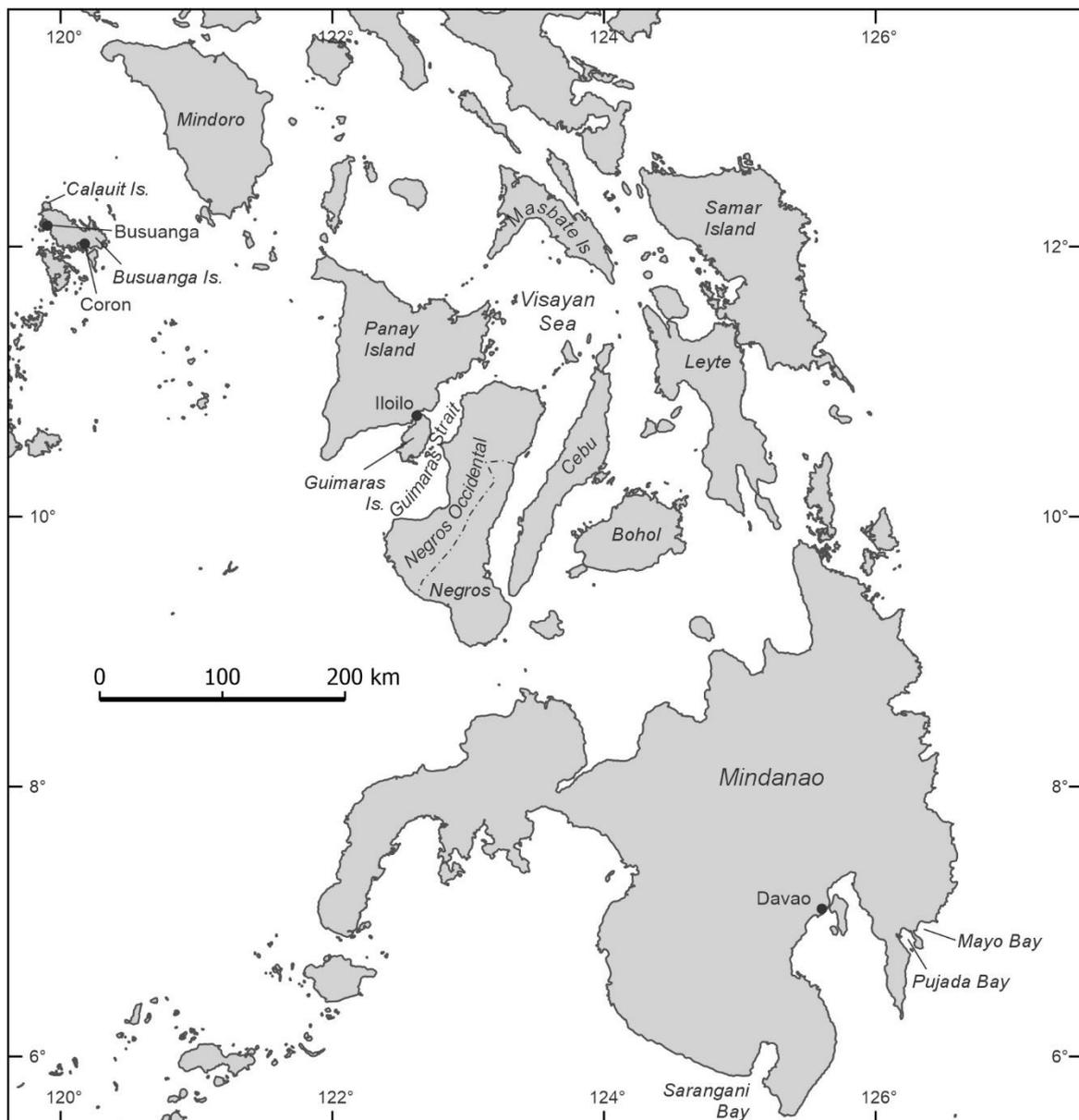


Figure 7.5. Geographic context of the southeastern Philippines with placenames mentioned in the text.

Dugongs have been sighted in Mindoro off the southwest coast of Luzon (Baltazar and Yaptinchay 1998) and at several sites in the Palawan Islands group (Aragones 1994, Hines 2012, Poonian and Lopez 2016, Molina 2023); Guimaras Island (Baltazar and Yaptinchay 1998; Dolar et al. 2005) and

Negros Occidental (de la Paz et al. 2021) in the Western Visayas region. In Mindanao dugongs have been sighted in northern Mindanao (Marsh et al. 2002) and Davao (Figure 7.5; Mizuno et al. 2017; Abreo et al. 2018).

An IMMA Aol with the dugong as a qualifying species is under consideration in neighboring Mayo and Pujada Bays on the Pacific coast of Mindanao (IUCN-MMPATF).

Field surveys of dugong populations in the Philippines are sparse, with most information obtained from interviews and strandings (Aragones 1994; Aragones et al. 2010; de la Paz et al. 2021; Molina 2023). Aragones (1994) developed and applied a technique using simultaneous land-based surveys to identify important dugong habitats around the island at Calauit in Northern Busuanga, Palawan. Molina (2023) extended this technique in 2019 to 32 monitoring stations (most operated by local indigenous peoples) in the Calamian Island group (Figure 7.6), along with surveys of local fishers. The combined techniques enabled important dugong habitats to be identified in the island group and demonstrated that the location is an important dugong area in Palawan with calf sightings indicating a reproducing population.

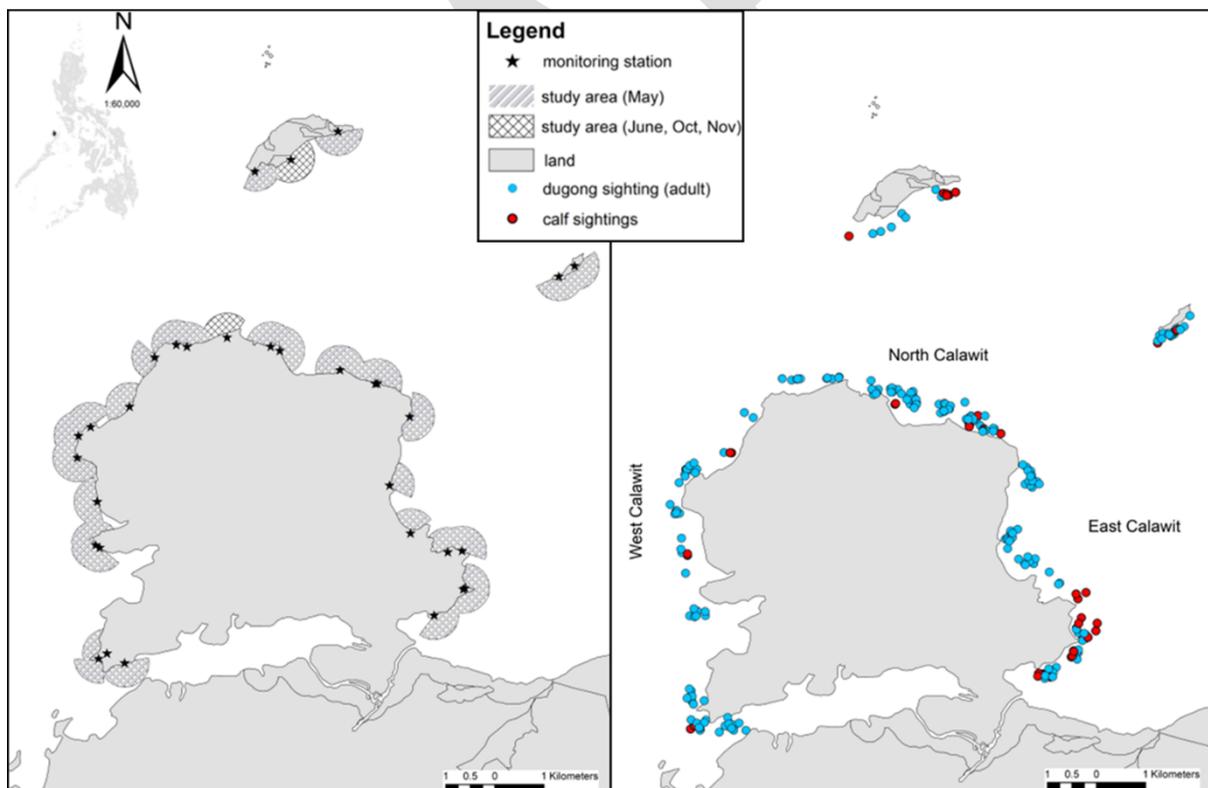


Figure 7.6: Map of Calauit (Calawit) Island north Palawan, Philippines showing the land-based, citizen-science, method of recording dugong sightings for vantage points on a high island. Left figure shows simultaneous monitoring stations and the viewing area covered from each vantage point; right figure shows dugong sightings in 2019 based on simultaneous land-based surveys in May, June, October and November 2019. Reproduced from Molina (2024) with permission.

Within the Calamian Islands, dugongs are known to feed in Busuanga and Coron and have shown strong fidelity to at least one feeding site that has become a tourist destination (T. Aquino, personal communication 2024). Dugongs are also known to occur around the island of Guimaras and the Panay Island in the Visayas (Figure 7.5). All fishers interviewed by Dolar et al. (2005) reported sightings of and/or encounters with dugongs. Dugong presence was further validated by grazing tracks found in the area during the study.

Strandings, mostly of dead dugongs, have been recorded across the three main island groups (Aragones et al. 2010; de la Paz et al. 2021; L. Aragones, personal communication 2024). Dugong populations in the Philippines are presumed to be decreasing (Aquino et al. 2009; Al-Asif et al. 2022), but the data to support or refute this presumption are limited.

- Historically dugongs were believed to have occurred throughout the coastal waters of the Philippines, however, their populations are now fragmented and their status data deficient.
- It is likely to be efficient and effective to address the threats to dugongs in the Philippines as part of generic programs of threat abatement to marine megafauna at an appropriate spatial scale of governance.

7.2.5 Timor-Leste

Inferences about dugong abundance in Timor-Leste (Figure 7.6) are largely based on anecdotal sightings. Dethmers et al. (2009) conducted monthly shoreline marine megafauna surveys along the Timor-Leste coastline from April to November in 2008. Dugong sightings were relatively rare; with individuals recorded in June (n=1) and November (n=5). Anecdotal sightings of dugongs have been reported throughout the north of the island both East of Dilli and at popular dive sites west of Dili, and from Atauro Island (McKenzie and Yoshida 2019). A resident animal 'Douglas' frequented Roda Reef, Tasi Tolu and Dili Rock East and was often sighted by divers. Other popular dive sites for dugong sightings are Pertamina Pier in Dili and Secret Garden (east of Dili). In 2017, a small juvenile dugong was reported to be accompanying 'Douglas' (It is unknown whether Douglas is a female, and the juvenile was her calf (McKenzie and Yoshida 2019) or if Douglas was alive at the time of writing).

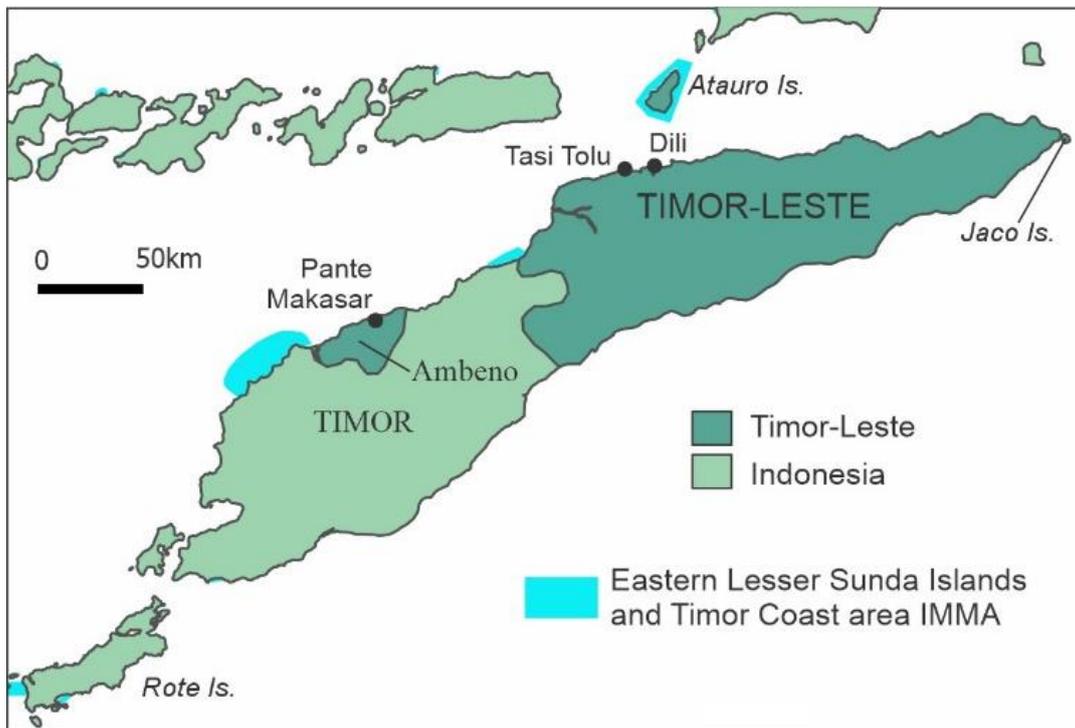


Figure 7.7. Geographic context of Timor-Leste with placenames mentioned in the text.

- Inferences about dugong abundance in Timor-Leste are largely based on anecdotal sightings, which have been reported throughout the north of the island both East of Dilli and at popular dive sites west of Dili, and from Atauro Island.
- The Eastern Lesser Sunda Islands and Timor coast Important Marine Mammal area would benefit from cross-jurisdictional management involving Indonesia, Timor Leste and Australia.
- It is likely to be efficient and effective to address the threats to dugongs in Timor Leste as part of generic programs of threat abatement to marine megafauna at an appropriate spatial scale of governance.

7.3 Cultural values

7.3.1 Indonesia

In some areas of Indonesia, dugongs are considered sacred and are valued and protected, while in other areas they are hunted and exploited for the perceived magical and aphroditic properties of their bones, teeth, tusks and gall bladder (Dugong and Seagrass Hub no date (a)). James Fox (personal communication to Mustika 2006) claimed that the people of the island of Roti considered the dugongs to be a female human and dead dugongs were buried formally in dugong cemeteries.

In the Aru Islands, dugong meat was sold at a local market in 1998 for USD \$1 per kg (Marsh et al. 2002). During a survey of tourist stores in Southern Bali in June 2013, Lee and Nijman (2015)

recorded over 130 dugong parts, including raw bones and teeth but also many carved items and some derivatives. The most common items were cigarette pipes usually carved from dugong ribs, and decorative carvings from bone and teeth. Lee and Nijman (2015) reported that dugong carvings cost USD \$1,500 to \$3,000 and were used for decorations. Some carvings made of dugong teeth were believed to ward off bad luck (Syafutra et al. 2018). Additionally, dugong tears were also extracted from entangled or live, trapped individuals and used as love potions (Syafutra et al. 2018). Moore et al. (2017) compiled and evaluated data and information (mostly unpublished) on the distribution, exploitation and community perceptions of dugongs in the Togeang, Banggai, Spermonde, Taka Bonerate/Selayar and Tanakeke Islands of Sulawesi. They found that: (1) some small island communities in Sulawesi have dugong princess (putri duyung) legends; (2) many fishing communities consider dugong meat superior to beef and see it as a welcome change from fish; and (3) certain body parts fetch a high price, as do dugong tears.

7.3.2 East Malaysia

Dugong hunting may have been practiced as early as the 1600s, with dugong exploitation related to: (1) the consumption of their meat, which was considered a delicacy and typically eaten during special occasions such as weddings, and (2) the perceived medicinal properties of their oil and ground bones. Other dugong body parts (e.g., tusks, ribs, bones, teeth, tears) were made into carvings, decorations, and/or love potions (Marsh et al. 2002; Rajamani et al. 2006). In the early 2000s, some locals still believed and practiced traditional medicine, using dugong body parts (Jaaman 2000; Jaaman et al. 2000; Jaaman et al. 2001; Jaaman and Lah-Anyi 2002; Jaaman and Lah-Anyi 2003; Jaaman 2004). More recent studies do not provide updates on whether these practices continue. Ubian and Bajau communities in Sabah use dugong tusk and bone for treatment of asthma, back pain, and shock (Rajamani et al. 2006). Dugong tears were believed to be used as an attractant to members of the opposite sex (Rajamani et al. 2006). Similar practices and beliefs have been recorded in Sarawak. Nonetheless, some locals find dugongs to be inedible as they believe the is a reincarnation of a cursed pregnant woman.

In Banggi and Kudat, dugongs were often trapped in fishing nets such as *pukat udang* (prawn nets), *kelong* (fish traps) and *pukat Rantau tenggelam* and *tanasi* (gillnets) (Rajamani et al. 2006). Traditionally, the Bajau Pelauh people of Sabah hunted dugongs for marriage dowries and as a symbol of manhood. Typically, dugongs were hunted at night with a sail/rowboat in Sabah, with three-to-five-inch portions of dugong meat sold at USD \$1.30 in the market and whole dugongs sold at USD \$25-100 depending on size (Marsh et al. 2002).

7.3.3 Brunei

Dugong hunting is likely to have occurred because of the high quality of dugong meat and locals believing that dugong body parts (e.g., bones, tusks, tears) have medicinal properties (Rajamani et al. 2006). Dugongs were hunted using harpoons, javelins, nets, and dynamite in some areas (Jaaman et al. 1999; Marsh et al. 2002).

7.3.4 Philippines

Historically, dugongs were hunted in the Philippines, with spears and dynamite (Kataoka et al. 1995; Marsh et al. 2002). Dugong hunting was usually for consumption, and some fishers believed that parts of their skeletal, digestive, reproductive, and integumentary systems could be used as medicine (Marsh et al. 2002).

7.3.5 Timor Leste

Hunting dugongs is now uncommon in Timor-Leste (Dugong and Seagrass Hub no date (b)) because it is believed that they are sacred animals that act as mediums of their ancestors when they are called on for help (McWilliam 2007).

7.4 Threatening processes

Hunting, incidental entanglement, and degradation of seagrass meadows are the major threats to dugongs in Maritime Southeast Asia (Marsh et al. 2002; Hines 2012; Pilcher et al. 2017; Al-Asif et al. 2022; Johnson et al. 2023). The cumulative impacts of these threats are considered likely to have exacerbated the decline of naturally fragmented dugong populations (Jaaman et al. 2008, 2009; Rajamani and Marsh 2010) but contemporary estimates of the magnitude of these threats are not available.

Some examples of these threats are considered below.

7.4.1 Hunting (past and present)

Although dugong hunting is now prohibited in all Range States in Maritime Southeast Asia, the examples below indicate that hunting has been substantial in the recent past. In addition, laws are often inadequately enforced, with dugong poachers rarely punished significantly (Jaaman et al. 2008).

Dugongs were intentionally hunted in Indonesia using illegal blast and cyanide methods (Marsh 2002). An estimated 80-200 dugongs were killed in Kobroor, eastern Aru, Maluku in 1979; 20-40 individuals in 1989 (Marsh et al. 2002). Compost (1980) estimated that the annual dugong catch from the main fishing areas of Aru ranged from 545 to 1,020 individuals in the late 1970s and noted

that dugongs were “still quite common” there. Brasseur and de Jong (1991) (cited in Moss and Van der Wal 1998) reported that 59–90 dugongs were caught in east Aru in 1989, and that catch numbers dropped to 29–36 dugongs in 1990. Their estimates were obtained by interviewing people from 14 villages between Pulau Karawei and Pulau Workai, which constitutes almost a third of the east Aru coast.

Jaaman et al. (2008) used interviews to determine the nature and magnitude of directed catches of marine mammals in Sabah, East Malaysia. Between March 1997 and December 2004, they interviewed 1,186 fishermen, village headmen and/or knowledgeable villagers along the coastline. A total of 231 hunters caught dugongs and 49 hunted both dugongs and dolphins. The magnitude of dugong catches was similar throughout Sabah, but less in Sarawak. Harpoons or spears were the main hunting gear. An estimated 796 dugongs were reported to be taken annually with an average catch of 2.8 dugongs (95% CI = 2.47-3.21) hunter⁻¹. Most hunters had stopped hunting by the 1980s and only 32 (11%) said they still hunt dolphins or dugongs, at least occasionally or opportunistically during fishing trips at the time of those interviews. Such rates of dugong removal were almost certainly unsustainable (Jaaman et al. 2008; Johnson et al. 2023) and are likely to have contributed to the disappearance of dugongs from some locations (Marsh et al. 2002; Poomouang et al. 2021).

7.4.2 Fisheries interactions

While dugongs may no longer be hunted directly, incidental entanglement in nets or mariculture lines in nearshore waters is a serious but poorly documented threat that typically results in mortality due to drowning (Dolar et al. 2005; Rajamani et al. 2006; de longh et al. 2008; Jaaman et al. 2009; Marsh et al. 2011; Jaaman et al. 2017; Pilcher et al. 2017; Syafutra et al. 2018; Hines et al. 2020; Panyawai and Prathep 2022).

In Indonesia, a study on the exploitation of dugongs during 1979 and 1980 reported that 550 to 1,000 dugongs were caught each year using Taiwanese nets originally set for sharks in eight areas in the Moluccas (de longh and Wenno 1992). Today, most incidental entanglements are in gillnets (Syafutra et al. 2018) and/or fish weirs (Marsh et al. 2002). Individual animals are reportedly released back to the wild if alive (Mamamayu Utami et al. 2018) and consumed if dead (Syafutra et al. 2018).

Jaaman et al. (2009) conducted 753 interviews of fishers in the 16 districts along the coastline of Sabah between March 1997 and December 2004, and 358 interviews across 15 districts in Sarawak between November 1998 and October 2000. Incidental bycatch of dugongs was reported from all 16 districts in Sabah and the northern region of Sarawak by gillnets, trawlers and fish stakes. Jaaman et al. (2009) estimated that 479 dugongs (95% CI = 434-528) were by-caught every year in Sabah, 14

(95% CI = 2-30) in Sarawak and concluded that by-catch rates, particularly in gillnets, may be unsustainably high. However, no dugong catches were seen during their observer trips and there is clearly significant dissonance between these bycatch estimates and the estimates of abundance reported in Section 7.2.2, so these estimates may have been too high. Between 1996 and 2001, dugongs were the most recorded marine mammal stranded in East Malaysia (Jaaman et al. 2009).

In the Philippines, four of 119 dugong strandings (8%) were categorized as incidental entanglements. Seventy-seven percent (n=92) of those strandings were deceased dugongs but were not properly assessed for bycatch. All had good body condition and could be possible victims of entanglement or fisheries interactions (Aragones et al. 2017; L. Aragones, personal communication 2024).

7.4.3 Blast fishing

Destructive fishing techniques such as blast fishing are still used throughout much of Maritime Southeast Asia. Of the 119 dugong strandings Aragones et al. (2017) recorded, 10 individuals were assessed as victims of blasting. Two dugongs were still alive when stranded but eventually died.

7.4.4 Seagrass degradation

Dugong populations are threatened by declining seagrass habitats globally (Johnson et al. 2023). In densely populated coastal areas, a combination of mariculture waste, deforestation, siltation, incidental and destructive fishing, reclamation, development, dredging, and recreation degrade seagrass habitats (Marsh et al. 2002; Waycott et al. 2009). In the Philippines, major threats to dugongs include pollution due to coastal developments such as resorts in the Palawan islands (Hines 2012).

7.4.5 Vessel strikes

Collisions in boat channels or seagrass habitats can injure and/or kill dugongs (Plaimo et al. 2021; Meidina et al. 2023). However, the magnitude of this threat has not been quantified in Maritime Southeast Asia. There is some concern regarding a projected tourism increase in areas around Calauit Island due to the presence of dugongs (see section 7.2.4. Philippines). Dive centers in the Calamian Islands offer *dugong tours*, increasing vessel traffic in known dugong habitats and the potential for dugong-vessel interactions.

7.5 Conservation initiatives

7.5.1 International conventions

All dugong Range States in Maritime Southeast Asia are signatories to the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change (UNFCCC). Only the Philippines is a party to the Convention on the Conservation of Migratory Species of Wild Animals;

the Philippines and Timor-Leste are both signatories to the Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range (Dugong MOU). All Range States except Timor-Leste are Contracting Parties to Convention of International Trade in Endangered Species (CITES).

7.5.2 National laws

7.5.2.1 Indonesia

Sahri et al. (2020) and Nugraha et al. (2024) critically reviewed the legal framework and current institutional arrangements for the protection of marine mammals in Indonesia. Five international conventions, 28 Indonesian national regulations, and 16 provincial regulations on marine spatial planning were relevant, although some such as the membership of the International Whaling Commission apply only to cetaceans. Sahri et al. (2020) and Nugraha et al. (2024) identified three phases in the development of the legal framework regarding marine mammal governance: 1970s (species-centred approach), 1990s (site-based approach), and current (wider marine management approach). Despite these regulations, Sahri et al. (2020) conclude that the practical actions required by these regulations are still unclear and protection gaps exist, rendering conservation efforts less effective. Missing elements in conservation strategies developed to 2023 include a code of conduct for marine mammal watching tourism, standards for aquaria, and the legal basis for marine mammal stranding network and underwater noise pollution. Sahri et al. (2020) suggests establishing a mechanism for cross-institutional coordination for more effective marine mammal protection in Indonesia. Indonesia becoming a full member of the Convention on the Conservation of Migratory Species of Wild Animals would be an important step.

Dugongs are protected under *Article 33(3) of the 1945 Constitution*, which protects all species within the land and water resources of Indonesia (UNEP/CMS 2015). Dugongs are also protected through the *Conservation of Flora and Fauna Act No. 7 of 1999* under which they are listed as protected fauna. This legislation emphasizes the management of protected species through research and monitoring wild populations, the rehabilitation and protection of wild individuals and the protection of their habitats from threats.

The Ministry of Marine Affairs and Fisheries (MMAF) also protects dugongs and seagrass habitats through the management of six marine national parks: Thousand Islands, Karimunjawa, Bunaken, Wakatobi, Taka Bonerate and Cendrawasih Bay. In addition, local management of marine parks in Batu Angus, Aru Islands, Togian and Kupang Bay also protects dugongs and their seagrass habitats (Marsh et al. 2002). Management plans and the establishment of marine protected area (MPA) networks have also been drafted for Bali, Komodo, Alor, Kaimana, Raja Ampat and Derawan.

Strategies include spatial expansions of individual MPAs or linking numerous small MPAs into MPA networks (UNEP/CMS 2015).

With increasing reports of marine mammal strandings, the Indonesian government created a national Standard Operational Procedure (SOP) for assisting stranded marine mammals. The SOP was created by organizations including the MMAF, the Indonesia Institute of Science, Jakarta Animal Aid Network, YK-RASI, WWF Indonesia, Conservation International Indonesia, and APEX Environmental (UNEP/CMS 2015). This SOP outlines procedures for handling live or disoriented marine mammals, together with disposal and postmortem investigation of dead individuals. Conservation and Education campaigns have been conducted at various schools and fishing villages to improve knowledge on monitoring, conservation, policies, stranding procedures for marine mammals, and proper waste disposal and recycling (to reduce seagrass degradation).

de longh et al. (2009a, b) prepared a 'National Conservation Strategy and Action Plan for the Dugong in Indonesia' in partnership with the Centre for Oceanography in Jakarta. The Action Plan included a dugong database (de longh 2016). It is not known if this strategic plan was implemented. An action plan to conserve marine mammals for 2018–2022 was launched by the Indonesian government through enactment of MMAF Decree No.79/2018. Sahri et al. (2020) describe this plan as a comprehensive, structured, and detailed document that includes implementation and enforcement mechanisms: (i) research on ecological and socio-economic-cultural aspects, (ii) building a database and information system, (iii) reduction of the mortality rates from fishing and vessel strikes, (iv) identification and protection of critical habitats (e.g., migration corridors) as conservation areas, (v) regulation and modelling the potential economic value of marine mammal, (vi) capacity building and strategic partnership for registration of strandings, and (vii) regulation of the negative effects of noise and coastal development.

7.5.2.2 East Malaysia

Dugongs are protected from trade and hunting in Malaysia under the *Fisheries Act of 1985; Fisheries Regulations 1999; Wildlife Protection Ordinance 1998 (Sarawak); and Wildlife Conservation Enactment 1997 (Sabah)* (Marsh et al. 2002). In 2011, Malaysia prepared a 'National Plan of Action for Conservation and Management of Dugong', which was being updated as of 2020 (Dugong and Seagrass Hub no date (b)). An update was not available at the time of writing.

7.5.2.3 Brunei

Dugongs are listed under the protected species *Wildlife Act of 1978*, a law focused on the conservation and management of biodiversity (UNEP/CMS 2015). Dugongs are also protected from

hunting, disturbance, harassment, selling and disposal through the *Fisheries Order 2009 of the Department of Fisheries* (UNEP/CMS 2015).

7.5.2.4 Philippines

The dugong was the first marine mammal to be protected by Philippine laws (Marsh et al. 2002). The Department of Environment and Natural Resources (DENR) and the national government have enacted several laws to prohibit and penalize catching, selling, purchasing, possessing, transporting, and exporting dugongs (Perrin et al. 1996; Marsh et al. 2002). DENR *Administrative Order 55 and 48, Wildlife Act of the Philippines (Republic Act No. 9147), Department Administrative Order 2004-15, and Fisheries Code act 8550* (and its amended version *RA 10654*) protect dugongs in the Philippines, where they are included in the list of endangered, threatened, vulnerable, indeterminate, and insufficiently known species of wild birds, mammals, and reptiles (Marsh et al. 2002; UNEP/CMS 2015). Under these laws, any trade of dugongs is prohibited and penalized, except for research. Regulatory permits under *Administrative Order 96* and *Executive Order 247* are required to extract dugongs or their tissues for research. Additionally, dugongs situated in Marine Protected Areas throughout the Philippines are safeguarded from hunting through *Republic Act 7586*. There are also local resolutions in Palawan – a site that has the highest sightings of dugongs – by the Palawan Council for Sustainable Development (*03-216, 04-226, 10-413*) that identify dugongs as Critically Endangered and requiring protection (UNEP/CMS 2015).

Research to assess the current population status of dugongs, information dissemination to educate the public about dugongs and their conservation, and training to protect and aid entangled, captured or stranded dugongs have been enacted regionally through *Administrative Order 55*. Several agencies have participated in the conservation of dugongs: DENR, the Pawikan Conservation Project (PCP), Protected Areas and Wildlife Bureau (PAWB) (now the Biodiversity Management Bureau (BMB)), World Wildlife Fund (WWF) Philippines, Crocodile Farming Institute (CFI), Wildlife Refuge and Rescue Centre (WRRC) (now the Palawan Wildlife Rescue and Conservation Centre (PWRCC)), Palawan Marine Mammal Rescue Society (PMMRS), Mindanao Environment Forum (MEF), Siliman University, Southeast Asian Fisheries Development Center, and the University of the Philippines, Diliman (Marsh et al. 2002; UNEP/CMS 2015). The Philippine Marine Mammal Stranding Network Inc (PMMSN) and the Marine Mammal Research and Conservation Laboratory of the University of the Philippines, Institute of Environmental Science and Meteorology (UP IESM) through the *Bureau of Fisheries and Aquatic Resources (BFAR) Fisheries Office Order 313* (series of 2019) provide technical assistance for bycatch monitoring.

Researchers at UP IESM together with the Bureau of Biodiversity Monitoring of the Department of Environment and Natural Resources developed an 'Action Plan for Dugongs in the Philippines' in

2017. The resultant 'Conservation Action Plan for the Philippines (2020-2030)' is still awaiting formal approval by the DENR Secretary, but some key activities identified in the plan (e.g., conservation awareness programs and research) have already been initiated by local stakeholders in some areas.

Marine Wildlife Watch of the Philippines (MWWP) collaborates with DENR on dugong conservation activities and has conducted a few local dugong projects in the recent past (T. Aquino, personal communication 2024).

7.5.2.5 Timor-Leste

Dugongs are protected in Timor-Leste through the National Biodiversity and Strategy Action Plan (NBSAP) and the *Marine Protected Species Act* (Dugong and Seagrass Hub c). The NBSAP described the importance of seagrass beds as habitats for dugongs and other associated taxa like fish and invertebrates. Other laws or management plans that aim to conserve biodiversity in general are the National Strategic Development Plan of Timor-Leste (2011-2030), the National Adaptation Program of Action on Climate Change (December 2010), the National Action Program to Combat Land Degradation, and the *Biodiversity Decree Law* (Dugong and Seagrass Hub c). In addition to these nation-wide management plans and laws, dugongs are also protected within large MPAs (e.g., Nino Konis Santana National Park; da Silva 2021), or managed locally using traditional laws (e.g., *Tara Bandu*; Dugong and Seagrass Hub no date (c)).

7.5.3 Conservation status

The International Union for Conservation of Nature (IUCN) has listed the dugong as a Vulnerable species globally (Marsh and Sobotzick 2019). The dugong's conservation status in Maritime Southeast Asia is data deficient (Marsh et al. 2011). Nonetheless, the dugong is listed as Critically Endangered in the Philippines based on Section 2 (List of Threatened Wildlife and their Categories) of DENR Administrative Order No. 2004-15 (Aquino 2009; Molina 2023) and Endangered in East Timor under the Marine Protected Species Act (Dugong and Seagrass Hub no date (c)).

We found no information about the domestic status of the dugong in Indonesia, Malaysia, and Brunei.

7.6 Research and monitoring activities.

7.6.1 Institutions

Research on dugongs across Maritime Southeast Asia has focused on determining their distribution and relative abundance at key localities within each Range State, together with some limited research on their biology, ecology, behavior, and threats (Marsh et al. 2002; Hines 2012). These investigations have been conducted by a large number and variety of institutions including local and

international universities, government agencies and non-government organizations (NGOs), but have not been coordinated within or between Range States.

7.6.1.1 Indonesia

The following authors and institutions have contributed to dugong research (de longh et al. 1995a,b, 1997, 1998, 2007, 2008, 2009; Persoon et al. 1996; Marsh et al. 2002; Mangubhai et al. 2012; Lee and Nijiman 2015; Moore et al. 2017; Mamamayu Utami et al. 2018; Marimba et al. 2019; Latuamury et al. 2020; Satyaningtijas et al. 2020; Sirimorok and Asfriyanto 2020; Sondita et al. 2020; Syafutra et al. 2020; Budiarsa et al. 2021; Meidina et al. 2023; Plaimo et al. 2021):

- Indonesian Government: Ministry of Marine and Fisheries Affairs;
- Indonesian Universities: Diponegoro University, Institut Pertanian Bogor University, Mulawarman University, Pattimura University, Tribuana Kalabahi University, Universitas Bangko Belitung, Universitas Hasanuddin, University of Papua, University of Riau, Universitas Sriwijaya;
- International research organizations: California Academy of Sciences (USA), James Cook University (Australia), Leiden University (Netherlands), Oxford Brookes University (United Kingdom), Swansea University (United Kingdom), University of Rhode Island (USA);
- NGOs: Conservation International Indonesia, Coral Triangle Initiative, Flora and Fauna Bangka, IKI project, Indonesia Environmental and Conservation Education, Peasant School Network of Payo-Payo, Spirit of South Sumatra Conservation Society, Wildlife Reserves Singapore, WWF Indonesia, WWF Italy, and YAPEKA.

A 'National Conservation Strategy and Action Plan for the Dugong' in Indonesia was published in English in 2009 (de longh et al. 2009a, b) and later updated in Bahasa Indonesian.

7.6.1.2 East Malaysia and Brunei

Most research has been conducted by universities in East Malaysia as dugongs in the two countries are presumed to be part of the same population within Brunei Bay and surrounding areas (Section 7.2.3); Panyawai and Prathep 2022). Two universities, the Universiti Malaysia Sabah and the University of Aberdeen, United Kingdom have conducted dugong research in Brunei (Jaaman et al. 2008a, b).

The following institutions have contributed to research on dugongs and their habitats in East Malaysia and Brunei (Marsh et al. 2002; Rajamani et al. 2006; Jaaman et al. 2008a, b; Rajamani and Marsh 2010, 2015; Rajamani 2013; Briscoe et al. 2014; Teh et al. 2015).

- Government: Department of Fisheries (Sabah), Department of Wildlife (Sabah), Sabah Parks;

- Malaysian Universities: Universiti Malay, Universiti Malaya, Universiti Malaysia Sabah, Universiti Malaysia Sarawak, Universiti Putra Malaysia Terengganu, Universiti Sains Malaysia, Universiti Teknologi Malaysia;
- International research organization's: James Cook University (Australia), Marine and Coastal Resources Research Center (Thailand), San Diego State University San Francisco State University, Standford University, Tokyo Metropolitan University, University of Aberdeen and University of British Columbia;
- NGOs: Borne Divers and Sea Sports, Marine Research Foundation, WWF-Malaysia.

7.6.1.3 Philippines

The following institutions have contributed to dugong research (Aragones 1994; Marsh et al. 2002; Aragones et al. 2010; Hines 2012; Poonian and Lopez 2016; Mizuno et al. 2017; Abreo et al. 2018; de la Paz et al. 2021; Panyawai and Prathep 2022):

- Government: Department of Environment and Natural Resources;
- Philippine colleges and universities: Davao del Norte State College, Davao Oriental State College of Science and Technologym, Silliman University, University of the Philippines (Diliman and Los Banos).
- International universities: Prince of Songkhia University (Thailand), University of Tokyo (Japan);
- NGOs: Community Centered Conservation (C3); Conservation International, IKI project, Marine Wildlife Watch of the Philippines, WWF-Philippines, ZSL-Philippines.

7.6.1.4 Timor-Leste

The following institutions have contributed to dugong research (Dethmers et al. 2009; Panyawai and Prathep 2022; Johnson et al. 2023):

- Government: the Ministry of Agriculture and Fisheries (Timor-Leste);
- International research organizations: Atlantic Oceanographic and Meteorological Laboratory (USA), Center for Climate Change Information, Charles Darwin University (Australia), James Cook University (Australia), Meteorological, Climatological and Geophysical Agency (BMKG) Indonesia, Prince of Songkhia University (Thailand), Rosenstiel School of Marine Atmospheric Science (USA);
- NGOs: Arafura and Timor Seas Ecosystem Action (ATSEA) Program, C20, IKI project, Science Graphics.

7.6.2 Research methods used to date

Much of the research on dugongs in Maritime Southeast Asia has used four methods: (1) interviews and focus groups involving fishers, (2) catch and/or stranding reports (3) aerial surveys using occupied aircraft and (4) small scale unoccupied aerial vehicle (UAV), or drone, surveys. However, not all these methods have been used in every Range State. For example, aerial surveys have been conducted at a broad scale only in East Malaysia (Rajamani and Marsh 2010) and at a local scale in the Lease Islands in Indonesia (de longh et al. 1995a). Aragonés (1994) and Molina (2023) used land-based surveys in the inshore waters of the Calauit Island group in the Philippines. Research in Brunei, Philippines and Timor-Leste, has predominantly utilized interviews and reports of dugong sightings, catch and strandings (e.g., Jaaman et al. 2008a, b; Panyawai and Prathep 2022). These differences in survey methods and extent have precluded meaningful comparisons of dugong distribution and relative abundance across this region.

Jaya Ancol Oceanarium in Jakarta kept dugongs in captivity for many years from 1984 (Syah 2001). Some animals were used for research: trialling attachment for satellite transmitters (Marsh and Rathbun 1990); gut passage rate (Lanyon and Marsh 1995); blood parameters (Syah 2001); and water turnover (Lanyon et al. 2006). The Oceanarium no longer houses dugongs.

de longh et al. (1997, 1998 2008) studied the behavior of dugongs and tracked the movements of four animals for between 41- and 285-days using satellite transmitters. Home ranges varied between 4.1 km² and 43.4 km² (de longh et al. 1998). Each animal showed the individualistic patterns of movement that are characteristic of dugongs in other parts of their range (Deutsch et al. 2022). de longh (2005), de longh et al. (2007) and Budiarsa et al. (2021) studied the interactions between dugongs and intertidal seagrass habitats in Indonesia.

The 'Conservation of biodiversity, seagrass ecosystems and their services – safeguarding food security and resilience in vulnerable coastal communities in a changing climate' project (Seagrass Ecosystem Services project) is managed by the Secretariat of the Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range of the Convention on the Conservation of Migratory Species of Wild Animals (CMS Dugong MOU) and funded by the IKI project. This project aims to deliver site-specific assessments of seagrass health and threats, and to evaluate the ecosystem services seagrass provides. Project sites and areas of interest in Maritime Southeast Asia were northern Minahasa, Indonesia; Ulugan Bay, Palawan, Philippines; Green Island Bay and Roxas, Palawan, Philippines and Hera Bay, Timor-Leste. Site-specific community-participatory methodological tools for seagrass assessment were developed and modified and included the following approaches:

- Drop cameras: used to collect photo quadrats at mapping points, positioned using a restricted random sampling design.
- Field validation data: used to create maps within specific areas of interest.
- PlanetScope Dove imagery: used to create spatially explicit seagrass maps using field validation point data and machine learning.

For each site, a map package was made available on open-access Map Viewer and included: a survey spot check layer of field validation points; extent map of seagrass presence; a raster/polygon layer of interpolated seagrass abundance (% cover) and a polygon layer of seagrass communities (McKenzie et al. 2023). Some results from this work (McKenzie et al. 2023) are:

- Between January and June 2023, 2.42 km² of seagrass were mapped in Northern Minahasa, North Sulawesi Indonesia. Average abundance was 30.3 ± 1.2 % cover. Most communities were on fringing reefs. Nine seagrass species were recognized. The meadows were largely dominated by *Enhalus acaroides* and *Thalassia hemprichii*.
- Between October 2022 and April 2023, 3.33 km² of seagrass were mapped within Ulugan Bay, Palawan, Philippines. Average seagrass abundance was 23.0 ± 2.3 % with a mosaic of seven seagrass community types, predominantly in fringing reef habitats, dominated by *Enhalus acaroides* and *Thalassia hemprichii*.
- Between November 2022 and March 2023, 2.48 km² of seagrass was mapped Hera Bay, Timor Leste. Average seagrass abundance was estimated to be 36.9 ± 2.1 %. Most seagrasses occurred on fringing reefs dominated by *Enhalus acaroides* and *Thalassia hemprichii*.

The project successfully implemented a new collaborative approach to shallow-water seagrass mapping, which has been widely shared with local stakeholders and scientists. The approach has the capacity to contribute to the globally standardized seagrass assessment, which is required throughout much of the dugong's range.

The Coral Triangle Initiative (CTI), a multilateral partnership between Indonesia, Malaysia, Philippines, Timor-Leste, Papua New Guinea, and Solomon Islands aims to protect marine resources (including dugongs) within the biodiverse region. CTI has recently been using citizen science in dugong population monitoring in the Lease Islands (Coral Triangle Center 2023).

7.7 Regional summary

The coastal waters of Maritime Southeast Asia support numerous, fragmented dugong habitats, however, estimates of dugong populations and their status in the region remain data deficient (Marsh et al. 2011), despite the large number of institutions that have been involved in dugong conservation research in each county (Section 7.6.1). This is a situation that will be challenging to rectify for reasons of both governance and geography, along with funding prioritization.

As explained in Section 7.1.1, the length of coastline for each Range State, especially in Indonesia and the Philippines is vast, the shallow sea surrounding the islands is generally narrow, individual seagrass beds are small and fragmented, and without considerable information on the genetic structure of the dugong population it will be difficult to justify IUCN listings at the regional level (see guidelines prepared by IUCN Regional Applications Reference Group IUCN 2012). In addition, especially in Indonesia and the Philippines, there is a mismatch between the spatial scale of marine conservation, which has largely been organized at the local scale, and strategic planning for dugong conservation, generally organized at the national level (see Section 7.5.2). Coordinated governance at a regional level could be advantageous.

In Indonesia, the Ministry of Marine Affairs and Fisheries (MMAF) has six regional offices “Balai Pengelolaan Sumberdaya Pesisir dan Laut” (BPSPL, the Coastal and Marine Resource Management Offices), which manage several provinces within their geographical territories. These offices could perhaps organize regional action plans subsidiary to the national plan. Similarly in the Philippines, regional plans for each of the main island groups: Luzon, Visayas, and Mindanao could advance the conservation management of dugongs, preferably in coordination with other marine megafauna. Given that most populations at areas of importance (Table 7.3) are likely small, planning may receive more community support if it were organised for megafauna rather than dugongs *per se*. At the key location of Brunei Bay (Section 7.2.3), international coordination across the state government Sarawak and the federal territory of Labuan in East Malaysia and the country of Brunei would be highly desirable.

Once governance arrangements for the conservation of megafauna and their habitats are established at the appropriate spatial scale, it would be desirable to design and apply survey techniques suitable for to both: (1) the spatial scale of the distribution of dugongs and their seagrass habitats, and (2) local capacity in each Range State. For example, a sequence of: (1) fisher surveys to identify dugong areas of local importance and threats to dugongs (Pilcher et al. 2017) at the desired governance scale, (2) seasonal ‘hotspot surveys’ using small UAVs to provide baseline information on dugong distribution and abundance, (3) seagrass surveys using the Seagrass-Watch protocols being

applied in the IKI project, and (4) focus groups with local experts to identify threats to dugongs and other megafauna and their habitats could inform: (a) a review of the adequacy of existing 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.

Table 7.3. Summary of locations of importance to dugongs in Maritime Southeast Asia. The wider areas of dugong concentration in Indonesia (2010-2022) identified by Digdo et al. (2024) are outlined by boxes in Figure 7.1.

COUNTRY	MAJOR REGION	LOCATION
INDONESIA	Sumatra	Bangka Island, Bintan Island
	Eastern Kalimantan	Balikpapan Bay, Adang and Appia Bays Derawan Islands
	Central Sulawesi	Tolitoli
	North Sulawesi	Bunaken
	Lesser Sunda Islands	Eastern Lesser Sunda Islands and Timor Coast Area including 25 locations in the coastal areas of Sabu Islands, Rote Islands, Eastern Flores and Timor Island.
	West Papua	Kaimana in Raja Ampat Protected Areas MPA network and Bird's Head Seascape
	Moluccas Province	Lease Islands, Seram Island, Kei Islands, Buru, Halmahera, Tanimbar, Aru Islands
	Southwest Papua	Raja Ampat and Dampier Strait region
EAST MALAYSIA AND BRUNEI	Sarawak	Brunei Bay
	Sabah	Tun Mustapha Marine Park, north Sabah
	Brunei	
PHILIPPINES	Mindanao	Mayo and Pujada Bays, Sarangani Bay
	Visayas	Guimaras Island, Guimaras Strait, Iloilo, Panay Island, Negros Occidental
	Palawan	Calait Island, Busuanga Island, Busuanga-Coron area, Green Island Bay, Roxas
TIMOR-LESTE		East of Dili, West of Dili, Atauro Island, Roda Reef, TasiTolu

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7.9 References

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