

Chapter 8: EAST ASIA

Helene Marsh¹, David Blair¹, Toshio Kasuya², Songhai Li³, Mingli Lin³, Len McKenzie⁴, Hiroyuki Ozawa⁵, Yoshihito Wakai⁶, Linda Wong⁷, Hideki Yoshikawa⁸.

¹ College of Science and Engineering, James Cook University, Townsville, Queensland, Australia.

² 5-30-32-3, Nagayama, Tama, Tokyo, 206-0025 Japan.

³ Marine Mammal and Marine Bioacoustics Laboratory, Institute of Deep-sea Science and Engineering, Chinese Academy of Sciences.

⁴ Centre for Tropical Water and Aquatic Research TropWATER, Cairns, Queensland, Australia.

⁵ Okinawa Prefecture Environment Science Centre 720 Kyoduka, Urasoe-City, Okinawa, Japan 901-2111.

⁶ Toba Aquarium, 3-3-6 Toba, Mie, 517-8517, Japan.

⁷ China Biodiversity Conservation and Green Development Foundation, Chengming Building, Xizhimen, Beijing.

⁸ Save the Dugong Campaign Centre. 301 Chiyoda Building #1 in Nakama Office. 2-21 Tukudohatiman, Shinjuku, Tokyo, 162-0815 Japan.

Correspondence to: Helene Marsh helene.marsh@jcu.edu.au.

Suggested citation: Marsh, H., Blair, D., Kasuya, T., Li, S., Lin, M., McKenzie, L., Ozawa, H., Wakai, Y., Wong, L. and Yoshikawa, H. (2024). East Asia. In 'A global Assessment of Dugong Status and Conservation Needs'. Marsh, H., Blair, D., McKenzie, L. and Schramm, L. (eds.). Bonn: United Nations Environment Programme. Chapter 8. [Page range]. [URL].

Disclaimer: This document is a draft and has not yet been reviewed by the Secretariat. Review and revision of the content will be undertaken by the Secretariat, the DTG and UNEP prior to final publication. The designations employed and the presentation of material on the maps within do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Regional Findings

East Asia: China and Japan

- Dugongs are in critically low numbers in the coastal waters of China (Vietnamese-Chinese 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.
- IUCN 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 Chinese waters 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 megafauna in the Nansei Islands region more generically.

8.1 Regional Setting

8.1.1 Geographic overview

This chapter considers the status of the dugong along the ~ 12,025 km coast of East Asia, north of the Vietnamese-Chinese border (21.53° N, 108.06° E) to the northern border of the Fujian Province (27.17° N, 120.43° E), the coastal islands of Hainan and Taiwan in China (Figure 8.1) and the offshore Nansei Islands (also known as Ryuku Islands, Southwest Islands, Nansei-Shoto, Ryukyu-ko or Ryukyu Arc) in Japan (Figure 8.2). The Nansei Islands form an almost 1,300 km long arc between Kyushu and the island of Yonaguni about 150 km northeast of Taiwan, China. Within the Nansei Islands, the northern limit of the dugong's historical distribution was probably around the Amami Island group (Carter et al. 1946; Nishiwaki et al. 1979).

This region is the northern boundary of the dugong's range in the Pacific Ocean and is part of the Tropical Indo-Pacific seagrass bioregion (Short et al. 2007). Estimates of the area of seagrass in the region are variable, but all indicate that extensive seagrass meadows are unlikely to occur. The estimated seagrass area with moderate to high confidence for southern China is 158 km², with around 26 km² occurring along the mainland; most (~ 16 km²) in Guangdong province (Huang et al. 2006; Zheng et al. 2013; Jiang et al. 2020), 9 km² for Guangxi Zhuang Autonomous Region (hereafter referred to as Guangxi) and the least in Hong Kong 0.1 km² (Fong 1999; Kwok et al. 2005).

Approximately 64 km² of seagrass meadows occur in the sheltered bays and nearshore habitats surrounding Hainan Island (Huang et al. 2006; Zheng et al. 2013; Jiang et al. 2017). However, the largest area of seagrass (68 km²) occurs in the waters surrounding Taiwan (Sudo et al. 2021). Sudo et al. (2021) estimated, based on scientific papers and reports for the period 2000–2020, approximately 24 km² of seagrass meadows for the Nansei (Ryukyu) Islands in Japan.

There is consensus that the extant dugong population in East Asia is extremely small. In 2019, the International Union for the Conservation of Nature (IUCN) classified the Nansei 'subpopulation'¹ as Critically Endangered (Brownell et al. 2019). The Chinese 'subpopulation' has not yet been assessed by the IUCN. Brownell et al. (2019) concluded that the dugong was extinct in Taiwanese waters, noting that there is some doubt as to whether they ever supported a viable population (see Section 8.2.1 below). Lin et al. (2022a), claimed that the dugong was functionally extinct in China and suggested that its regional status there should be reassessed as 'Critically Endangered (possibly extinct)'. However, the IUCN (2012) requirements for assessment as Extinct have not been fulfilled as discussed in Section 8.5.2.1.

¹ IUCN uses the term 'subpopulation' in the assessment of a regional population. The term 'subpopulation' is used here with reference to IUCN documentation only.

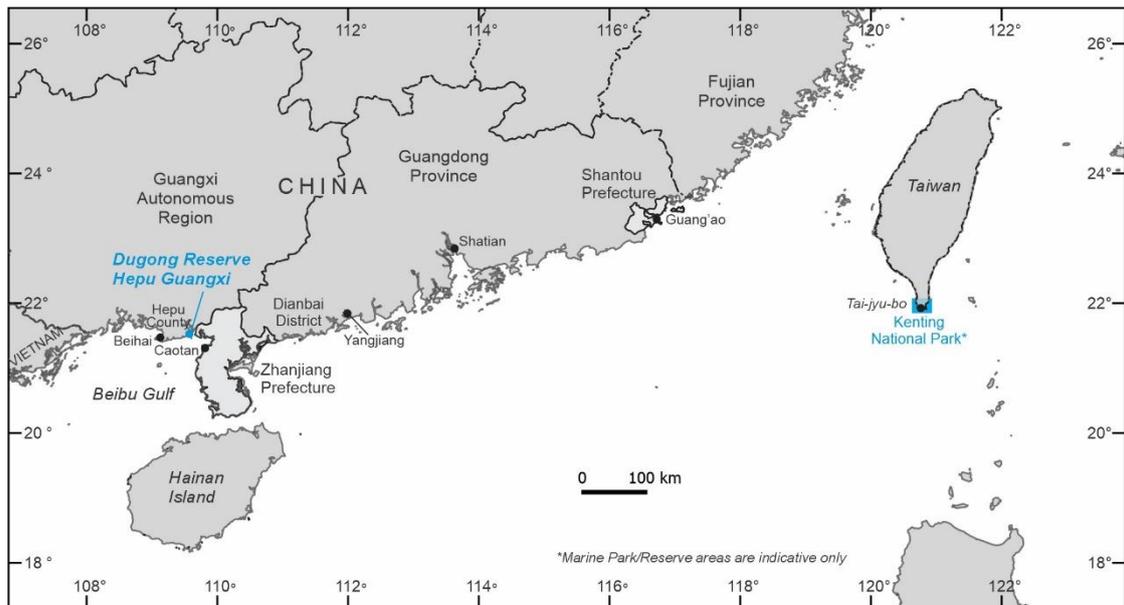


Figure 8.1. Geographic context of the historic range of the dugong in China showing placenames mentioned in the text. Kenting National Park is shown in blue. Figure created by Adella Edwards; reproduced with permission.

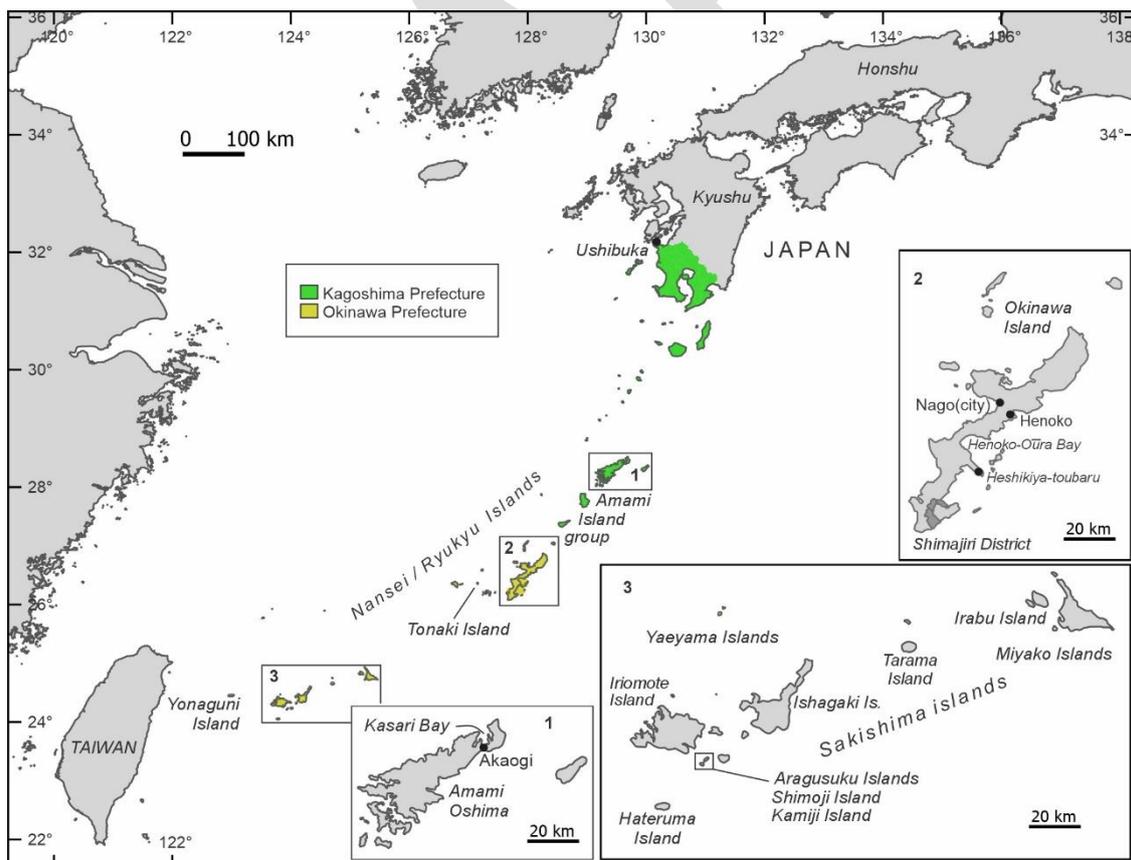


Figure 8.2. Geographic context of the dugong's range in Japan showing placenames mentioned in the text. Insets: (1) Amami Oshima; (2) Okinawa Islands; and (3) Sakishima Islands. Figure created by Adella Edwards; reproduced with permission.

8.1.2 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. China (officially the People's Republic of China) is a major economy, a G20 country, the third largest country in the world by area, and the world's second most populous nation. It has the world's second largest GDP (United Nations Department of Economic and Social Affairs [UNDESA] 2023) and a High Human Development Index (HDI) of 0.768 (ranked 79) (United Nations Development Programme [UNDP] 2022). China has a population of 1.426 billion people (UNDESA 2022). 1623 million people live within 50 km of the coast in the dugong's historic range in China; 81 million within 10 km of the coast in this region (Chapter 1, Figure 1.x).

Table 8.1. Human Development Index (HDI) status rank and Gross Domestic Product (GDP) per capita rank of the dugong Range States in East Asia. Consistent with the remainder of this chapter, the countries in this table are ordered west to east starting with China. 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
China	High	79	72
Japan	Very High	19	33

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)

China is divided into over 30 administrative regions; including six provinces in the dugong's historic range: Fujian, Guangdong, Hainan, Hong Kong, Macao and Taiwan, and one autonomous region: Guangxi.

Japan is a G7 country with the world's fourth largest GDP and a Very High HDI of 0.925 (ranked 19) (UNDP 2022). Approximately 1.48 million people live within 10km of the coastline in the dugong's historic range in Japan (Chapter 1, Figure 1.x).

The Nansei Islands have an ethnically distinctive indigenous population and language, and the differences between this region and the rest of Japan continue to play a significant role in the relationship between the people of Okinawa and the Japanese central government (Palz 2023). Historically, the Ryukyu Kingdom ruled the islands, however, the monarchy was abolished in 1879, resulting in the formation of Okinawa Prefecture. The 27-year American occupation of Okinawa after World War II further maintained the region's distinction from the main Japanese islands (Welch et al.

2010). The northern half of the Nansei Islands, including Amami Island, is in Kagoshima Prefecture; the southern half of the Nansei Islands is under the administration of Okinawa Prefecture (Figure 8.2).

8.1.3 Genetics of dugong sub-populations

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

There have been no genetic studies specifically focussing on dugongs from this region. The only data comes from Okinawa, southern Japan. Blair et al. (2014) reported two sequences from this population that represent two haplotypes within the northeastern haplogroup (Chapter 1, Figure 1.x). One of the haplotypes was similar to a sequence from Palawan in the Philippines, about 2,000 km distant. The mitochondrial haplotype extracted from the whole-genome data reported by Tian et al. (2023) differed slightly from the other two, representing a third Okinawan haplotype (data not shown). It is interesting that each of three dugongs sampled from Okinawa should have a different haplotype (at least three different female individuals). This suggests greater past diversity and perhaps a rapid decline in recent times (within a dugong's typical life span).

The Okinawan population has been regarded as distinct, with little opportunity to exchange genes with other populations (Kayanne et al. 2022). Certainly, analyses based on the whole-genome data from a single Okinawan dugong (Tian et al. 2023) place it far from Australian dugongs.

Tian et al. (2023) inferred demographic parameters from the Okinawan genome. This had features reflecting long-term and continuing population decline, extensive inbreeding, and reduction in heterozygosity. All of these are likely to be observed in a Critically Endangered population.

- Genetic data is extremely limited from the East Asian region. Three mitochondrial haplotypes place dugongs from Okinawa within the northeastern haplogroup.
- Data from a whole-genome study indicate demographic parameters consistent with a Critically Endangered population.

8.2 Distribution, abundance and trends in range states

8.2.1 China

8.2.1.1 Fujian, Guangdong, Guangxi, Hainan, Hong Kong and Macao

Hines (2012) reports that Allen (1938) claimed that the earliest report of a dugong in Chinese waters was made by Dutch explorers travelling between Nanyang and Guangzhou in the mid-seventeenth century.

Lin et al. (2022a) reviewed all available historical data covering the past distribution of dugongs in Chinese waters from the twentieth century onwards. The following is a summary of these records, supplemented by information compiled by the China Biodiversity Conservation and Green Development Foundation (CBCGDF) (J. Zhou, L. Wong, S. Ma, Y. Xu, personal communication 2023):

- 42 records from Guangxi: several field observations for the Beibu Gulf in 1935 (Hines 2012); and 41 observations from Beihai:
 - Hunting: 11 records of 244 dugongs 1955-1984 (Shou 1958, Wang and Sun 1986, Wang et al. 2007); these records include 28 animals captured for research in 1976, all of which died;
 - Bycatch: six records of six animals 1996-2000 (Wang et al. 2007; Zhou et al. 2003);
 - Strandings: eight records of 11 dugongs 1978-2000; (Wang and Sun 1986; Wang et al. 2007); and
 - Field observations/surveys: 16 records of 37 dugongs 1935-2004 (Hines 2012; Wang et al. 2007).
- Four records for Guangdong Province between 1972–1999 (two strandings (Wang and Sun 1986); and two bycatch (Zhou et al. 2003)); and
- 11 observations from Hainan Province: seven hunting records of a total of 30 dugongs between 1954-1986 (Wang and Sun 1986; Wang et al. 2007); two records of bycatch (each of one dugong in 1983 and 1986; Wang et al. 2007; Zhou et al. 2003); one field sighting in 2000 (Zhou et al. 2003) and one stranded dugong in 2008 (Wang et al. 2010), likely the last dugong recorded in Chinese nearshore waters. In 1976, a total of 28 live dugongs were captured with assistance from the Fisheries Bureau of the Guangxi, the Fisheries Bureau of Hepu County, and the Marine Combat Brigade of Shatian Commune, and transported to ponds for scientific research on the artificial breeding of dugongs (Gu 1980). Unfortunately, all died.

Although several vessel surveys for dugongs in Chinese waters were conducted between 1962 and 2004 (Wang and Sun 1986; Zhou et al. 2003; Wang et al. 2007), there are no verified field observations or serial surveys after 2000. Thus, any conclusions about population size must be tentative. Wang and Sun (1986) concluded that dugongs: (1) were mostly found along the coast of Guangxi and western Guangdong, rarely along the coasts of Dianbai and Yangjiang Counties, Guangdong; (2) were found only on the west coast in the waters of Hainan Island; (3) were not found off the southeast coast of Guangdong, and (4) that the northern limit of their distribution was southern Taiwan.

Lin et al. (2022a) conducted a large-scale interview survey of 788 marine resource users across Guangxi, Guangdong, Hainan and Fujian in 2019. Twelve percent of respondents (n=91) recognized a

picture of a dugong, but only 5% (n=37) reported past sightings with a mean last-sighting date in the late 1990s. Only three respondents reported sightings since 2014 (previous five years) including one sighting near the dugong reserve in Caotan, western Zhanjiang Prefecture (western Guangdong), and two sightings in the Guang'ao Port Area of Shantou Prefecture (eastern Guangdong), an area with no historical dugong records.

In their report to SEAMAM III, Zhao et al. (2015) concluded that 'dugongs have been extirpated from Chinese waters for years'. Lin et al. (2022a) acknowledged the possibility that a few surviving dugongs in Chinese coastal waters might have been undetected by the respondents to their surveys but concluded that: (1) dugongs were likely functionally extinct in China; and (2) recovery is unlikely with the continuing deterioration of coastal ecosystems. They concluded that hunting, combined with the degradation of seagrass meadows and accidental entanglement, contributed to the rapid collapse of China's dugong population, and recommended that the status of the dugong in Chinese waters be formally assessed.

8.2.1.2 Taiwan

Brownell et al. (2019) concluded that dugongs no longer occur off Taiwan, with the last recorded strandings in 1986. The last sightings from the southern tip of Taiwan (now Kenting National Park) were in the 1950s and 1960s (Zhou 2004). Wang et al. (2015) claimed that previous reports of the presence of dugongs in Taiwanese waters could be traced back to a single confirmed specimen that was reportedly captured near the village of Tai-jyu-bo (21.94° N, 120.75° E) in 1931 or 1932. This specimen was first reported by Hirasaka (1932), who included photographs of the skull. The Kuroshio Current travels from Luzon Island in the Philippines north along the eastern coast of Taiwan where the continental shelf is narrow and seagrass habitat was not reported by Liu (2013) or Sudo et al. (2021). Hirasaka (1932) also stated that a young male and an adult male were reportedly captured around 1931/2 but no specimens were examined. Thus, these records may be extralimital rather than evidence of a past population.

- If the dugong still exists in Chinese water, its numbers must be extremely low and the population is unlikely to recover.

8.2.2 Japan

Dugong bones have been found in more than 100 archaeological sites throughout the Nansei Islands (Welch et al. 2010), indicating that dugongs were hunted there from as early as 6,000 years ago (Early Jōmon period). Welch et al. (2010) report that 'these sites are distributed across the archipelago: five sites in the Amami Islands Group, 86 sites in the Okinawa Island Group, eight sites in

the Miyako Island Group, and 12 sites in the Yaeyama Island Group'. In addition, bones have been found at two sites on mainland Japan: one on Kyushu and one on Honshu (Figure 8.2).

The most northern, confirmed, modern records of the dugong are considered to be extralimital. In September 2002, an adult dugong was taken in fishing gear, off Ushibuka (32° N, 130° E), Kyushu, Japan (Yamamuro et al. 2004). Another was captured in a set net off the west coast of Kyushu in October 2002. A few days after, another was stranded nearby (Ogura et al. 2005).

During the time of the Ryukyu Kingdom (1429–1879) 'the people of Shimoji and Kamiiji (the two islands that make up Aragusuku Island (Figure 2.2)) were exclusively allowed to hunt' (Welch et al. 2010). Dugongs were hunted with nets and the meat was used to pay taxes to the Kingdom between 1637 and 1879 (Ohama 1971). After the Ryukyu Dynasty was integrated into Japan in 1879, dugongs began to be harvested commercially. Harvest statistics from 1894–1916 showed that 327 dugongs were caught during this period near the Yaeyama, Miyako, and Okinawa Island Groups (Uni 2003). There are no data from 1916 until after World War II, when dugongs were killed incidentally in association with dynamite (blast) fishing until 1972, even though the practice was prohibited after 1948 (Uni 2003; Shirakihara et al. 2007; Kayenne et al. 2022).

Kayenne et al. (2022, Supplementary Material Table 1) summarised data on known dugong mortalities reported in local newspaper articles from 1960–2020 as follows: (1) near Amami and Miyako Islands and the Yaeyama Island Group, four dugongs were reported as hunted for sale in 1960, 1965 and 1967; (2) in 1987, a dead dugong was found in the Yaeyama Island Group; (3) from 1979–2004, a local newspaper reported that 14 dugongs including six calves were found dead on Okinawa Island: seven were caught in gill or fixed nets (another four were released alive or kept in an aquarium) and seven dead animals were found stranded; (4) a pregnant female was caught in a fixed net in 1995. Bycatch continued until at least 2000 but Kayenne et al. (2022) found no records of bycatch deaths since then.

Dugongs were believed to have been eliminated from the waters of several islands e.g., the Miyako Island Group by 1965 and around the Yaeyama Island Group by 1967 (Kasuya et al. 2000), but there have been occasional sightings in the Yaeyama Island Group since that time. Since the 1970s, confirmed sightings and specimens of dugongs have mainly been from the waters around Okinawa Island, where survey effort has been concentrated. There have also been occasional sightings outside the Okinawa region (Brownell et al. 2019; Kayenne et al. 2022).

Since 1997, aerial surveys for dugongs have been conducted largely in response to concerns over the impacts of the military base to be constructed in Henoko-Ōura Bay on Okinawa. In 1998–99, only ten dugongs were observed during transect aerial surveys around Miyako, Okinawa and Yaeyama Island

Groups: all were sighted during the 837 km flown in 1998; no dugongs were observed around Iriomote, Ishigaki, Tarama and the Miyako Islands in the 310 km flown in 1999 (Shirakihara et al. 2007). In 1999, an airline helicopter sighted six dugongs along the east coast of Okinawa Island (Dugong Network Okinawa, 2000). Defence Agency surveys covered dugong habitats around Okinawa Island once a month from 2007–2009, and four times a year since 2009. Up to five dugongs were sighted in a single survey in 2003 (Brownell et al. 2019). From 2007, a maximum of three dugongs (each individually recognizable) had been sighted in a single survey (Brownell et al. 2019). One of these animals died in March 2019 from a stingray barb, presumably while bottom feeding (Japanese Ministry of the Environment 2019); the other known individuals have not been seen in recent years.

There have been occasional dugong sightings outside the Okinawan region. Ogura et al. (2005) reported four sightings from Kasari Bay, Amami-Oshima from the early 2000s, presumably including a dugong reported from Akaogi in Kasari Bay, Amami-Oshima in September 2002. Other incidental sightings have been reported from Tarama Island (Miyako Island Group) from June 2013; Iriomote Island (Yaeyama Island Group) from 2013 to 2014 (Natural Park Foundation 2019); and Tonaki Island, 58 km southwest of Okinawa from July 2017 (Okinawa Prefectural Government 2019); Hateruma Island (Yaeyama Island Group) from August 2018 (Natural Park Foundation 2019).

The dugong population of the Nansei Islands has been under serious threat of local extinction since the 1990s (Uchida 1994; Kasuya and Brownell 2001). A scientifically valid estimate of its size is not available, but numbers are certainly very low (Brownell et al. 2019; Kasuya and Hosokawa 2021; Kayenne et al. 2022). Brownell et al. (2019) estimated the population to be < 10 animals.

Even though the population of dugongs in the region is likely to be extremely small, recent reports of sounds, feeding and photographs of feeding trails at three locations around Okinawa and six locations in the Sakishima Islands indicate that dugongs are not yet extinct there (Figure 8.2 inset 3, Japanese Ministry of the Environment 2019, 2020, 2021, 2022, 2023a,b; Okinawa Prefectural Government 2019, 2020, 2021, 2022, 2023; Palz 2023). Dugong faeces have been confirmed by DNA testing of stools found in two locations: (1) about 2km south of the military base construction site in Henoko-Ōura Bay on Okinawa Island in 2022; and (2) around Irapu Island (in the Sakishima Islands where dugong feeding trails have also been seen; Figure 8.2 inset 3; Okinawa Prefectural Government 2023).

- The number of dugongs in Japanese waters is almost certainly extremely small but the species still persists in the Nansei Islands region.

8.3 Cultural values

8.3.1 China

Historically China was a largely inland, agrarian society (He et al. 2014) in contrast to the maritime society of the Nansei Islands in Japan. We found no academic account of the dugong's values in Chinese culture. Linda Wong (personal communication 2023) advised that historical records described dugongs as 'mermaids' unique to the South China Sea, and that there are legends of dugong tears turning into pearls and using dugong fat for long-lasting burning. The stories narrated in Ren Fang's *Shuyiji* ('Ancient tales of strange matters'), which dates from the Southern Song period (1127-1279) recount tales of immortals, deities, strange beasts and spirits, including a man named Zha Dao who encountered a fish during his maritime journey (Fang 1647) described as: 'A woman appeared on the sea, wearing a red gown and with dishevelled hair.' It is uncertain whether this account refers to a dugong.

8.3.2 Japan

Welch et al. (2010) consulted more than 400 sources in their comprehensive research on the dugong in Okinawa's maritime culture. These sources include evidence of dugong bones found in more than 100 archaeological sites throughout the Ryukyu Islands. These deposits are evidence of dugong consumption but the importance and meaning to the people utilising them is unclear. Nonetheless, the Heshikiya-Toubaru Site on the eastern side of central Okinawa includes dugong bone artefacts that were probably used for personal adornments including hairpins, rings, and bracelets in the Late to Final Jōmon periods, plus 'butterfly' shaped ornaments that may have been used as amulets (Welch et al. 2010; Palz 2023).

Until the Gusuku period (12th–15th century), arrow heads were made of dugong and cow bones, presumably because metal had to be imported from mainland Japan (Welch et al. 2010; Palz 2023). During this time, local lords (*aji*) began to use dice made from dugong bones for playing games. In the Ryukyu Kingdom (1429-1879), dugong meat was a precious resource and if caught, dugongs had to be offered to the king. Dugong meat was not only considered delicious, but it was also alleged to possess medicinal qualities; consuming the meat promised everlasting youth and longevity (*furō chōju* 不老長寿) and assisted women in childbirth and subsequent recovery (Welch et al. 2010; Palz 2023).

The dugong still features in the songs and legends of the people of the Nansei Islands (Welch et al. 2010; Ikeda and Mukai 2012, Palz 2023). Dugong skulls can still be seen atop stone walls at some of the 'sacred groves' (Yaeyaman Utaki) on Aragusuku Islands (Welch et al. 2010; T. Kasuya and H. Marsh, personal communication 2023; Palz 2023).

Toba Aquarium has held dugongs in captivity since the 1970s and the sole remaining animal, 'Serena', has resided at the Aquarium for more than 30 years (Marsh et al. 2022). Serena is the symbol of the aquarium and attracts large numbers of Japanese visitors each year.

Palz (2023) studied the role of the dugong in the environmental activism response to the proposed construction of the Futenma Replacement Facility in Henoko-Ōura Bay, Okinawa, by the Japanese government for the US military (see references in Palz for details of the activism). Palz concluded that the dugong had become a symbol of the protest against the new base; a symbol of resistance that directly influenced the collective human experience of the construction site due to its status as a Critically Endangered species, a Japanese Natural Monument (see Section 8.5.2.2), and an animal with cultural meaning for the people of Okinawa.



Figure 8.3. Activists using the dugong as a symbol of their protest against the construction of the Futenma Replacement Facility in Henoko-Ōura Bay. The occasion was a meeting between the Prime Minister of Japan and the Nago Mayor at the Nago Civic Hall in Nago City, Okinawa Prefecture on May 4, 2010. Taro Hosokawa photograph; reproduced with permission.

8.4 Threatening processes

Historically East Asia probably supported hundreds, rather than thousands, of dugongs because of the relatively small areas of seagrass habitat compared with locations such as Australia or the Arabian Gulf. This would have limited the level of sustainable dugong hunting for food, as evidenced by the histories of dugong exploitation in the region outlined in Section 8.2. In recent years, especially in China, major pressures have likely come from the loss of seagrass resulting from human

development in coastal areas and incidental capture in fishing nets. Climate change is likely to exacerbate this already precarious situation.

The current threats to dugongs in the region are listed below:

8.4.1 Threats to dugong survivorship

- Incidental capture in fishing gear (e.g., gillnets and seine nets),
- Entanglement in marine debris,
- Hunting and direct fishing: historically legal, currently illegal,
- Vessel strikes,
- Extreme natural events (e.g., storm surges and tsunamis),
- Possible demographic stochasticity due to the extremely low population size (Kayanne et al. 2022).

8.4.2 Threats to dugong fecundity due to habitat loss, fragmentation and modification

- Habitat damage caused by human settlements in the coastal zone and associated riverine systems, infrastructure developments (including the Futenma Military Base Replacement Facility on Okinawa, Japan), shipping, trawling, destructive fishing,
- Degradation of seagrass habitat, including from untreated sewage disposal, coastal dredging and reclamation, inshore commercial trawling, declining water quality due to land clearing and resultant erosion,
- Extreme weather and climate change impacts on seagrass communities (e.g., extreme tropical storms, marine heatwaves,)
- Chemical pollution (e.g., oil spills and heavy metal loads).

8.5 Conservation initiatives

8.5.1 International conventions

Both China and Japan are parties to the Ramsar Convention, Convention on Biological Diversity, Convention on International Trade in Endangered Species (CITES), and the United Nations Framework Convention on Climate Change. None of these treaties provides any real protection for the dugongs in East Asian waters. Both China and Japan are listed as non-party states to the Convention on Migratory Species (CMS). Neither country is a signatory to the associated Dugong Memorandum of Understanding (Dugong MOU).

8.5.2 National Laws

8.5.2.1 China

Li et al. (2023) list 16 pieces of legislation and regulation relevant for marine megafauna conservation in China's coastal ecosystems. Dugongs were given Class I protected species status in 1988, with a ban on hunting (National People's Congress of the People's Republic of China 2022).

Lin et al. (2022a) claimed that the dugong is functionally extinct in China. The IUCN (2012) considers 'A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.' Thus Lin et al. (2022a)'s assessment has no formal status as the IUCN requirements for extinction have not been fulfilled.

8.5.2.2 Japan

There is some uncertainty as to whether the dugong was nominated as a natural monument before World War II under Japanese domestic law. Nonetheless, the dugong was so designated in January 1955 under the *1954 Okinawa Law for the Protection of Cultural Properties*. After the U.S. returned Okinawa to Japan in 1972, the government placed the dugong on their list of Natural Monuments (Welch et al. 2010). This designation may have been for biodiversity conservation rather than cultural reasons although this is uncertain.

Kasuya and Miyazaki (1997) informally classified the population in Okinawan waters using the IUCN Red List criteria as Critically Endangered. This informal assessment was subsequently confirmed by Shirakihara et al. (2007). The Japanese Ministry of Environment designated the Japanese dugong as Critically Endangered in their 2007 Red Data Book (Ministry of the Environment 2014) and have not altered the status since (Kayanne et al. 2022). In 2019, the IUCN formally classified the Nansei 'subpopulation' of the dugong as Critically Endangered under criteria C and D1, on the basis of its very small population size, and evidence of past and continuing observed decline (Brownell et al. 2019).

Okinawa dugongs have also been protected by the *Fisheries Resources Protection Act* since 1993 (Kasuya et al. 2000) and by the *Wildlife Protection and Hunting Management Law* since 2003 (Mammal Society of Japan 2023).

As Brownell et al. (2019) point out, the current legislation and associated protections restrict direct killing but do not regulate incidental kills or habitat alteration, which are today's most serious threatening processes. Although each fisher must be licensed to operate legally in the small-type set

net and gillnet fisheries, a license holder is entitled to fish across a wide area. The Ministry of Environment and the Fisheries Agency have made independent efforts to develop techniques to detect a dugong entering a net and safely release a dugong from a net (T. Hosokawa, personal communication 2019). However, the efficacy of such techniques is impossible to determine because dugong numbers are low, making the capture of a dugong in a net a rare (but very serious) event.

8.5.3 Other conservation initiatives

8.5.3.1 China

A dugong reserve in Hepu, Guangxi, was established in 1986 and given national reserve status in 1992. However, sightings in China were already rare by then, indicating that this action was too late to be effective (Lin et al. 2022b).

8.5.3.2 Japan

There are several nationally managed 'Marine Protected Zones' (MPZs) in the Nansei Islands, which are regulated by Japan's Ministry of Environment. Conservation targets there focus mainly on coral reefs, and there is a lack of dedicated areas for seagrass protection (Komatsu and Aoki 2020).

Many MPZs are small in size, and several are designated as *Ordinary Zones*, where regulation is lenient (Takahashi and Kimura 2004). Regulation can sometimes be restrictive for local economies and incompatible for social contexts of the communities surrounding the MPZs (Kakuma 2007). The Natural Park Law (1957) in Japan does not restrict fishing gear in MPZs, nor does it regulate habitat degradation (Ikeda and Mukai 2012). This reduces the efficacy of the protected area, especially in the case of dugong conservation.

There are also numerous community based MPZs in the Nansei Islands. These are sometimes operated by local dive shops (Shah et al. 2019) or fisheries agencies, such as the Yaeyama Fishery Cooperative, which began resource management in the late 1990s and has since established four MPZs (Komatsu and Aoki 2020). Many of these community led MPZs focus on enhancing fishery resources, often by targeting protection of certain species for economic benefit (Shah et al. 2019).

These areas are important for facilitating community participation from local fishers and other stakeholders associated with the marine environment. Cox et al. (2010) found that community led MPZs are better at encouraging local participation and compliance, and often have longer lasting effects than nationally managed Marine Protected Areas.

8.6 Research and monitoring initiatives

In China, the China Biodiversity Conservation and Green Development Foundation (CBCGDF) has become a partner of the CMS (Convention on the Conservation of Migratory Species of Wild Animals 2016), and its Dugong Task Force is in the process of implementing a three-year work strategy.

With support from the Dugong MOU Secretariat and the US Marine Mammal commission, the IUCN Sirenia Specialist Group (2019) developed a Japanese dugong research plan to guide future research and monitoring by the Japanese Government, Okinawa Prefecture and NGOs. This plan outlines multiple approaches to determine if any dugongs remain in Japanese waters because the numbers are so low that any single approach is unlikely to be sufficient. The initiatives include: (1) fisher surveys; (2) a smartphone app to encourage the reporting of sightings; (3) using eDNA to confirm the presence of dugongs; (4) passive acoustic observations of dugong, (5) raising public awareness through a mapping dugongs project; and (6) investigating the status of seagrass meadows in the Nansei Islands Region. In the event of dugongs being detected, the plan envisaged a workshop with key stakeholders to design conservation initiatives. To date, this workshop has not been held, despite the evidence that dugongs are not yet extinct in this region (Section 8.2.2). Nonetheless, some of these suggestions have been implemented resulting in evidence that dugongs are not extinct in the islands (Section 8.2.2).

8.7 Regional summary

Dugong populations in East Asia are in a critical condition. It is extremely unlikely that dugongs will recover in this region given: (1) the extremely poor prospects of natural immigration into the area, (2) captive breeding programmes, or (3) the translocation of dugongs into the region from elsewhere.

It is likely that all marine megafauna in Chinese coastal waters are impacted by similar threats to varying degrees. Given the few, if any, remaining dugongs, interventions designed to protect coastal marine megafauna more generically may be more successful than dugong-specific interventions. As Li et al. (2023) point out, although megafauna profoundly affect the functioning of coastal ecosystems, they are often neglected in the conservation schemes. China has recently developed an Ecological Conservation Redline strategy, which includes protecting 30% of coastal waters and 35% of coastlines (He et al. 2018), suggesting that the time is right for a coordinated approach to marine megafauna conservation as a core component of this initiative.

The imperilled situation of the dugong in Japan has been recognized both internationally and nationally by its Critically Endangered status as explained above. Numbers are certainly very low,

and recovery will be a formidable challenge. Much of the recent and considerable interest in dugong conservation in Japan has been driven by its status as the symbol of opposition to the proposed transfer of the Futenma US Marine Corps Air Station to Henoko-Ōura Bay (see Section 8.2 and Figures 8.2, 8.3). The military base is now under construction. As Brownell et al. (2019) point out, ‘the current legislation and associated protection only restrict direct killing and do not regulate incidental kills or habitat alteration, both of which threaten the continued existence of dugongs in Okinawan waters’. Nonetheless, the Okinawan public considers the remaining dugong population in the waters of the Nansei Islands to be very important. Palz (2023) concludes this view has not diminished since the construction started. This influence could be harnessed to transfer attention to the dugongs that might still be living in the waters of the Nansei region and their habitats.

8.8 Acknowledgments

This work was funded by the United Nations Environment Programme’s Convention on Migratory Species and its associated Dugong Memorandum of Understanding with in-kind contributions from the corresponding authors and James Cook University.

8.9 References

- Allen, G.M. (1938). *The mammals of China and Mongolia*. New York: American Museum of natural History.
- Blair, D., McMahon, A., McDonald, B., Tikel, D., Waycott, M. and Marsh, H. (2014). Pleistocene sea level fluctuations and the phylogeography of the Dugong in Australian waters. *Marine Mammal Science* 30(1), 104-121. <http://dx.doi.org/10.1111/mms.12022>.
- Brownell Jr., R.L., Kasuya, T. and Marsh, H. (2019). *Dugong dugon (Nansei subpopulation)*. The IUCN Red List of Threatened Species. e.T157011948A157011982.
- Carter T.D., Hill, J.E. and Tate, G.H. (1946). *Mammals of the Pacific World*. New York, New York: The Macmillan Company.
- Convention on the Conservation of Migratory Species of Wild Animals (2016). CMS Signs First Partnership Agreement with Chinese NGO, 9 November. <https://www.cms.int/en/news/cms-signs-first-partnership-agreement-chinese-ngo>. Accessed 2 March 2024.
- Cox, M., Arnold, G. and Villamayor Tomas, S. (2010). A review of design principles for community-based natural resource management. *Ecology and Society* 15(4), 38. <https://www.ecologyandsociety.org/vol15/iss4/art38/>.
- Dugong Network Okinawa. (2000). *For the protection of Dugong offshore Okinawa*. Okinawa, Japan: Dugong Network Okinawa.
- Fang, R. (1646). *Shu yi ji; 述異記 說郛*. 卷六六. China: s.n. (In Chinese).

- Fong, T.C. (1999). Conservation and management of Hong Kong seagrasses. *Asian Marine Biology* 16, 109-121.
- Gu, J. (1980). Capture and domestication of dugongs. *Journal of Wildlife Science* 1(1), 38-41.
- He, Q., Bertness, M.D., Bruno, J.F., Li, B., Chen, G., Coverdale, T.C., Altieri, A.H., Bai, J., Sun, T., Pennings, S.C., Liu, J., Ehrlich, P.R. and Cui, B. (2014). Economic development and coastal ecosystem change in China. *Scientific Reports* 4(1), 5995. <https://doi.org/10.1038/srep05995>.
- He, P., Gao, J., Zhang, W., Rao, S., Zou, C., Du, J. and Liu, W. (2018). China integrating conservation areas into red lines for stricter and unified management. *Land Use Policy* 71(1), 245-248. <https://doi.org/10.1016/j.landusepol.2017.11.057>.
- Hines, E.M. (2012). Dugongs in Asia. In *Sirenian Conservation: Issues and Strategies in Developing Countries*. Hines, E.M., Reynolds III, J.E., Aragones, L.V., Mignucci-Giannoni A.A. and Marmontel, M. (eds). Gainesville, Florida: University Press of Florida. Chapter 7. 58-76.
- Hirasaka, K. (1932). The occurrence of dugong in Formosa. *Memoirs of the Faculty of Science and Agriculture, Taihoku Imperial University* 3(1), 1-4.
- Huang, X., Huang, L., Li, Y., Xu, Z., Fong, C. W., Huang, D., Han, Q., Huang, H., Tan, Y. and Liu, S. (2006). Main seagrass beds and threats to their habitats in the coastal sea of South China. *Chinese Science Bulletin* 51(2), 136-142. <https://doi.org/10.1007/s11434-006-9136-5>.
- Ikeda, K. and Mukai, H. (2012). Dugongs in Japan. In *Sirenian Conservation: Issues and Strategies in Developing Countries*. Hines, E.M., Reynolds III, J.E., Aragones, L.V., Mignucci-Giannoni A.A. and Marmontel, M. (eds.). Gainesville, Florida: University Press of Florida. Chapter 8. 77-83.
- IUCN (2012). *IUCN Red List Categories and Criteria. Version 3.1. Second Edition*. Gland, Switzerland, and Cambridge, UK: IUCN.
- Japanese Ministry of the Environment (2014). *Red Data Book 2014, Threatened Wildlife of Japan. Volume 1, Mammalia*. Tokyo, Japan: GYOSEI Corporation. 32-33.
- Japanese Ministry of the Environment (2019). *Jyugon to chiikishakai tono kyosei suishin Heisei 30 nendo kekka gaiyo* [Project for promoting coexistence between dugongs and local communities: A summary of the project results in Japanese Fiscal Year Heisei 30 (2018)]. (In Japanese).
- Japanese Ministry of the Environment (2020). *Jyugon to chiikishakai tono kyosei suishin Heisei 30 nendo kekka gaiyo* [Project for promoting coexistence between dugongs and local communities: A summary of the project results in Japanese Fiscal Year Reiwa 1 (2019)]. (In Japanese).
- Japanese Ministry of the Environment (2021). *Jyugon to chiikishakai tono kyosei suishin Heisei 30 nendo kekka gaiyo* [Project for promoting coexistence between dugongs and local communities: A summary of the project results in Japanese Fiscal Year Reiwa 2 (2020)]. (In Japanese).
- Japanese Ministry of the Environment (2022). *Jyugon to chiikishakai tono kyosei suishin Heisei 30 nendo kekka gaiyo* [Project for promoting coexistence between dugongs and local communities: A summary of the project results in Japanese Fiscal Year Reiwa 3 (2021)]. (In Japanese).
- Japanese Ministry of the Environment. (2023). *Jyugon to chiikishakai tono kyosei suishin Reiwa 4 nendo kekka gaiyo* [Project for promoting coexistence between dugongs and local communities: A summary of the project results in Japanese Fiscal Year Reiwa 4 (2022)]. (In Japanese).
- Jiang, Z., Liu, S., Zhang, J., Zhao, C., Wu, Y., Yu, S., Zhang, X., Huang, C., Huang, X. and Kumar, M. (2017). Newly discovered seagrass beds and their potential for blue carbon in the coastal seas of Hainan Island, South China Sea. *Marine Pollution Bulletin* 125(1), 513-521. <http://dx.doi.org/10.1016/j.marpolbul.2017.07.066>.

- Jiang, Z., Cui, L., Liu, S., Zhao, C., Wu, Y., Chen, Q., Yu, S., Li, J., He, J., Fang, Y., Ranvilage, C.I. and Huang, X. (2020). Historical changes in seagrass beds in a rapidly urbanizing area of Guangdong Province: Implications for conservation and management. *Global Ecology and Conservation* 22, e01035. <https://doi.org/10.1016/j.gecco.2020.e01035>.
- Kakuma, S. (2007). Diversity and multifunctionality of marine protected areas (MPAs) in coral reef areas. *Journal of the Coral Reef Society of Japan* 8(2), 91-108. <https://doi.org/10.3755/jcrs.8.91>.
- Kasuya, T. and Brownell, R.L. (2001). *Conservation status and future prospects of dugongs in Japanese waters*. Unpublished report.
- Kasuya, T. and Hosokawa, T. (2021). Okinawa no jyugon [Okinawa dugongs]. In *Jyugon to manatii: kaigyurui no seitai to hozen*. Tokyo, Japan: Tokyo University Press. 397-434. (In Japanese).
- Kasuya, T., Shirakihara, M. and Kawamichi, T. (2000). Background information appended to a resolution of Japanese Society of Mammalogists in 2000 requesting protection of dugongs in Okinawa.
- Kayanne, H., Hara, T., Arai, N., Yamano, H. and Matsuda, H. (2022). Trajectory to local extinction of an isolated dugong population near Okinawa Island. *Scientific Reports* 12(1), 6151. <https://doi.org/10.1038/s41598-022-09992-2>.
- Komatsu, T. and Aoki, N. (2020). Japanese-type MPAs and self-organised MPAs by local communities in Japan. In *Evolution of Marine Coastal Ecosystems Under the Pressure of Global Changes*. Ceccaldi, H.J., Henocque, Y., Komatsu, T., Prouzet, P., Sautour, B. and Yoshida, J. (eds.). Cham: Springer. 457-477.
- Kwok, W.P., Yang, J.K., Tong, P.Y. and Lam, C. (2005). Distribution of seagrasses in Hong Kong. *Hong Kong Biodiversity: Agriculture, Fisheries and Conservation Department Newsletter (漁農自然護理署風水林的植物調查)* 8, 12-14.
- Li, X., Wang, H., McCauley, D.J., Altierl, A.H., Silliman, B.R., Lefcheck, J.S., Wu, J., Li, B. and He, Q. (2023). A wide megafauna gap undermines China's expanding coastal ecosystem conservation. *Science Advances* 9(32). <https://10.1126/sciadv.adg3800>.
- Lin, M., Turvey, S.T., Han, C., Huang, X., Mazaris, A.D., Liu, M., Ma, H., Yang, Z., Tang, X. and Li, S. (2022a). Functional extinction of dugongs in China. *Royal Society Open Science* 9(8). <https://doi.org/10.1098/rsos.211994>.
- Lin, M., Turvey, S.T., Liu, M., Ma, H. and Li, S. (2022b). Lessons from extinctions of dugong populations. *Science* 378(6616), 148. <https://doi.org/10.1126/science.ade9750>.
- Liu, J.Y. (2013). Status of marine biodiversity in the China seas. *PLoS ONE* 8(1), e50719. <https://doi.org/10.1371/journal.pone.0050719>.
- Mammal Society of Japan (2023). *Guidelines for the Procedure of Obtaining Mammal Specimens as Approved by the Mammal Society of Japan (2023 Revision)*. https://www.mammalogy.jp/guideline2023_English.html. Accessed 2 March 2024.
- National People's Congress of the People's Republic of China (2022). Wildlife Protection Law of the People's Republic of China, 31 December. <http://www.npc.gov.cn/npc/c30834/202212/77cc070369d94dd09270fb9c0f52cbd0.shtml>. Accessed 3 August 2023.
- Natural Park Foundation (2019). *Report on commissioned work to promote symbiosis between dugong and local communities*. Japan: Natural Park Foundation.

- Nishiwaki, N., Kasuya, T., Miyazaki, N., Tobayama, T. and Kataoka, T. (1979). Present distribution of the dugong in the world. *Scientific Reports of the Whales Research Institute* 31, 33-141.
- Ogura, G., Hirayama, T., Sudo, K., Otaishi, N., Mukai, H. and Kawashima, Y. (2005). Investigation of the northern limit of dugong habitat in the Tokara islands and Amami-Oshima in the Ryukyu Archipelago, Japan. *Wildlife Conservation of Japan* 9(2), 49-58. (In Japanese)
- Ohama, S. (1971). Taxes of the Yaeyama Islands (a poll tax in the Yaeyama Islands). Tokyo, Japan: San-ichi Syobou.
- Okinawa Prefectural Government (2019). *Heisei 30 nendo jyugon hogo taisaku jigyo houkokusho* [Report on Dugong Protection Project in Japanese Fiscal Year Heisei 29]. Okinawa, Japan: Okinawa Prefectural Government, Environmental Department, Nature Conservation Division. (In Japanese).
- Okinawa Prefectural Government (2022). *Reiwa 3 nendo jyugon hogo taisaku jigyo houkokusho* [Report on Dugong Protection Project in Japanese Fiscal Year Reiwa 3]. Okinawa, Japan: Okinawa Prefectural Government, Environmental Department, Nature Conservation Division. (In Japanese).
- Okinawa Prefectural Government (2023). *Reiwa 4 nendo jyugon hogo taisaku jigyo houkokusho* [Report on Dugong Protection Project in Japanese Fiscal Year Reiwa 4]. Okinawa, Japan: Okinawa Prefectural Government, Environmental Department, Nature Conservation Division. (In Japanese).
- Palz, M. (2023). *Searching for Zan: Human-Dugong Relations and Environmental Activism in Okinawa*. PhD Thesis submitted to the University of Oslo, Norway.
- Schiavina, M., Freire, S., Carioli, A. and MacManus, K. (2023). GHS-POP R2023A - GHS population grid multitemporal (1975-2030). European Commission, Joint Research Centre (JRC).
- Shah, P., Dissanayake, S.T., Fujita, Y. and Nunes, P.A. (2019). Impact of a local, coastal community based management regime when defining marine protected areas: Empirical results from a study in Okinawa, Japan. *PLoS ONE*, 14(3), e0213354. <https://doi.org/10.1371/journal.pone.0213354>.
- Shirakihara, M., Yoshida, H., Yokochi, H., Ogawa, H., Hosokawa, T., Higashi, N. and Kasuya, T. (2007). Current status and conservation needs of dugongs in southern Japan. *Marine Mammal Science* 23(3), 694-706. <https://doi.org/10.1111/j.1748-7692.2007.00123.x>.
- Short, F., Carruthers, T., Dennison, W. and Waycott, M. (2007). Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology* 350(1), 3-20. <https://doi.org/10.1016/j.jembe.2007.06.012>.
- Shou Z. (1958). The dugong found in Beibu Gulf, Guangdong. *Chinese Journal of Zoology* 2,146-152.
- Sirenia Specialist Group. (2019). *A Research Plan for the Japanese Dugong subpopulation*. Expert workshop. Toba Aquarium, 24-26 September 2019. Tokyo, Japan: Sirenia Specialist Group.
- Sudo, K., Quiros, T.E., Prathep, A., Luong, C.V., Lin, H-J., Bujang, J.S., Ooi, J.L., Fortes, M.D., Zakaria, M.H., Yaakub, S.M., Tan, Y.M., Huang, X. and Nakaoka, M. (2021). Distribution, temporal change, and conservation status of tropical seagrass beds in southeast Asia: 2000–2020. *Frontiers in Marine Science* 8(1). <https://doi.org/10.3389/fmars.2021.637722>.
- Takahashi, K. and Kimura, T. (2004). Legal systems. In *Coral Reefs of Japan*. Japanese Coral Reef Society (ed.). Japan: Ministry of the Environment.
- Tian, R., Zhang, Y., Kang, H., Zhang, F., Jin, Z., Wang, H., Zhang, P., Zhou, X., Lanyon, J.M., Sneath, H.L., Woolford, L., Fan, G., Li, S. and Seim, I. (2023). Sirenian genomes illuminate the evolution of fully aquatic species within the Mammalian superorder Afrotheria. *bioRxiv*. <https://doi.org/10.1101/2023.09.01.555811>. (Preprint).

Uchida, S. (1994). The dugong. In *Database of Japanese Rare Wild Aquatic Organisms*. Odate, S. (ed.). Tokyo: Fisheries Agency and Japanese Association for Conservation of Aquatic Resources. 569-583.

Uni, K. (2003). Harvest report of dugong (*Dugong dugon*) in Okinawa Prefecture. *Bulletin of Nago Museum* 11, 1-14.

United Nations, Department of Economic and Social Affairs, Population Division (2022). *World Population Prospects 2022*, online edition. <https://population.un.org/wpp/>. Accessed 18 August 2023

United Nations Department of Economic and Social Affairs, Statistics Division (2023). *Country Profile (China)*. <https://unstats.un.org/unsd/snaama/CountryProfile>. Accessed 18 August 2023.

Wang, P. and Sun, J. (1986). The distribution of the dugong of the coast of China. *Acta Theriologica Sinica* 6(3), 175-181.

Wang, P., Han, J., Ma, Z. and Wang, N. (2007). Survey on the resources status of dugong in Hainan Province, China. *Acta Theriologica Sinica* 27(1), 68-73.

Wang, L., Xing, Z., Wang, J., Liang, W., Hong, M. and Shi, H. (2010). The recovered carcass of a dugong (*Dugong dugon*) in Yelin Bay of Wenchang City, Hainan Province and its cause of death. *Acta Theriologica Sinica*, 30(3), 354-356.

Wang, J., Yang, S.C. and Kan, C.Y. (2015). *SEAMAM III Report-Taiwan*. Report of the Third Southeast Asian Marine Mammal Symposium (SEAMAM III). Bonn, Germany: UNEP/CMS Secretariat.

Welch, D.J., Rokkum, A., Jefferson, T.A., Higa, N. and McNeill, J.R. (2010). An anthropological study of the significance of the dugong in Okinawa culture. Unpublished report prepared for US Marine Corps. Washington, D.C., USA: US Marine Corps.

Yamamuro, M., Aketa, K. and Uchida, S. (2004). Carbon and nitrogen isotope ratios of the tissues and gut contents of a dugong from the temperate coast of Japan. *Mammal Study* 29(2), 179-183.

Zheng, F., Qiu, G., Fan, H. and Zhang, W. (2013). Diversity, distribution and conservation of Chinese seagrass species. *Biodiversity Science* 21(5), 517-526.

Zhao, K., Hung, S.K. and Zhu, Q. (2015). *SEAMAM III Report-Taiwan*. Report of the Third Southeast Asian Marine Mammal Symposium (SEAMAM III). Bonn, Germany: UNEP/CMS Secretariat.

Zhou, K. (2004). *Fauna sinica mammalia (vol. 9) Cetacea: Carnivora: Phocoidea Sirenia*. Beijing, China: Science Press.

Zhou, K., Xu, X. and Tang, J. (2003). Survey of the status of the dugong in the Beibu Gulf, China, with remarks on the Indian humpbacked dolphin (*Sousa plumbea*). *Acta Theriologica Sinica* 23(1), 21-26.