A Systematic Review of the Status, Knowledge, and Research Gaps of Dugong in Southeast Asia

Supplemental Tables

Janmanee Panyawai[1] and Anchana Prathep[1, 2]

[1]Division of Biological Science, Faculty of Science, Prince of Songkla University, Hat Yai, Songkhla 90112, Thailand
[2]Excellence Center for Biodiversity of Peninsular Thailand, Faculty of Science,
Prince of Songkla University, Hat Yai, Songkhla 90112, Thailand
E-mail: anchana.p@psu.ac.th

Table S1. The latest report on dugong (*Dugong dugon*) in the coastal region and the summary of evidence types and sources contributing data of dugong numbers and distribution in Southeast Asia over the last 21 years, 2000 to June 2021

Countries	Regions	Coasts	Year(s)	Number of dugong(s)	Descriptions	Source(s)
Brunei Darussalam	Coast of Brunei	Brunei Bay	2002	--	Reported/documented	Marsh et al., 2002
			2007	--	Sighting	*Dugong & Seagrass Hub*, 2021
			2018	2 (1 mother–calf pair)	Sighting	*Dugong & Seagrass Hub*, 2021
Cambodia	Coast of Cambodia	Koh Kong	2007, 2008	Small sporadic group	Interview	Beasley & Davidson, 2007; Hines et al., 2008
		Kampot and Kep	2005	Small sporadic group	Interview	Perrin et al., 2005
			2007, 2008	Small sporadic group	Interview	Beasley & Davidson, 2007; Hines et al., 2008
			2018	1	Bycatch	Tubbs et al., 2019
		Koh Rong	2001	--	Interview	Beasley & Davidson, 2007
Indonesia	Bali	South Bali	2002	1-2	Sighting	Marsh et al., 2002
	Java	Banten	2002	1	Bycatch	Marsh et al., 2002
	Kalimantan	Central Kalimantan	--	--	Sighting	Marsh et al., 2002
		East Kalimantan	2000-2003, 2005, 2007	1	Sighting	Marsh et al., 2002; Kreb & Budiono, 2005; De Iongh et al., 2006, 2007
			2001-2007	--	Feeding trials	De Iongh et al., 2007
			2021	2-3	Estimated from feeding trails	Budiarsa et al., 2021
		South Kalimantan	1976	--	Anecdotal evidence	Allen et al., 1976
		West Kalimantan	--	--	Sighting	Marsh et al., 2002
	Maluku	Maluku	2001	--	Reported/documented	Marsh et al., 2002
		North Maluku	2011	1	Bycatch	Nontji et al., 2012
			2016	1	Carcass	Mamayu Utami et al., 2018
			NA-2016	2	Captive for tourism; released in 2016	Mamayu Utami et al., 2018
	Nusa Tenggara	East Nusa Tenggara	2004	1	Bycatch	UNEP/CMS, 2011
	Papua	Papua Province	--	--	Reported/documented	De Iongh, 1997; Marsh et al., 2002; UNEP/CMS, 2011
		West Papua	NA-2016	1	Intentionally captured and held captive for tourism	Mamayu Utami et al., 2018
	Sulawesi	Central Sulawesi	2001, 2002, 2009	1	Sighting	Moore, 2004; Moore et al., 2017
			2006-2015	1 calf	Held captive by fisher, purpose unknown; released in 2015	Moore et al., 2017
			NA-2015	1	Held captive for tourism; released in 2015	Moore et al., 2017
			2015	Small group	Sighting	Moore et al., 2017
			2015	2 calves	Stranded; released	Moore et al., 2017
			2016	1	Held captive by fisher, purpose unknown; released	Moore, 2004; Moore et al., 2017
			2019	2019	Held captive for research	Nurdin et al., 2019; Satyaningtijas et al., 2020
		North Sulawesi	2006	--	Feeding trials	McKenzie et al., 2006
			2014	--	Sighting	Moore et al., 2017
			2017	2	Sighting	Moore et al., 2017
		South Sulawesi	2011	1 calf	Stranded; held captive for tourism; released	Moore et al., 2017
			2016	--	Carcass sighting	Moore et al., 2017
			2017	6	Sighting	Moore et al., 2017
		Southeast Sulawesi	2002-2009	38	Interview	Cullen-Unsworth et al., 2018
			2010-2012	10	Interview	Cullen-Unsworth et al., 2018
	Sematra	Bangka Island	2007	1	Bycatch	Syafutra et al., 2018
			2007-2010	4	Bycatch	Nontji et al., 2012
			2017	4	Bycatch	Syafutra et al., 2018
			2017	1	Stranded; released	Syafutra et al., 2018
			2017	1	Stranded; died	Syafutra et al., 2018
		Bintan Island	2006	1	Dugong meat was sold in the local market	De Iongh et al., 2009

Countries	Regions	Coasts	Year(s)	Number of dugong(s)	Descriptions	Source(s)
Malaysia	East Malaysia	Sabah	2000	4	Sighting	Jaaman & Lah-Anyi, 2003
			2000, 2001	4	Aerial survey	Jaaman et al., 2001; Jaaman & Lah-Anyi, 2003
			2001	--	Specimens (dugong teeth; stored at Universiti Malaysia Sabah)	UNEP/CMS, 2011
			2001-2003	8	Bycatch	Rajamani & Marsh, 2010
			2001-2003	9	Carcass	Rajamani & Marsh, 2010
			2001-2003	4	Hunting	Rajamani & Marsh, 2010
			2006	Small sporadic group	Interview	Rajamani et al., 2006
		Sarawak	2000, 2001	14	Aerial survey	Jaaman et al., 2001; Jaaman & Lah-Anyi, 2003
			2007	5	Aerial survey	Bali et al., 2008
			2007	1	Carcass	Rajamani, 2009
			2008	2 (1 mother–calf pair)	Aerial survey	Bali et al., 2008
			2011	20 (4 mother–calf pairs)	Aerial survey	UNEP/CMS, 2011
	Peninsular Malaysia	Johor	2001-2010	21	Carcass	UNEP/CMS, 2011
			2004	≥ 2	Interview	Affendi et al., 2005
			2005	3-4	Aerial survey	Affendi et al., 2005
			2007	2 (mother–calf pair)	Sighting	Ooi et al., 2008
			2009	3	Boat survey	UNEP/CMS, 2011
		Kedah	2010, 2011	Small group	Interview	UNEP/CMS, 2011
		Terengganu	2005-2010	1	Carcass	UNEP/CMS, 2011
			2006	1	Sighting	UNEP/CMS, 2011
Myanmar	Andaman Sea	Mon, Yangon	2004-2007	4	Bycatch	Tun & Ilangakoon, 2007
		Mon, Tanintharyi	2005, 2007	--	Sighting	Tun & Ilangakoon, 2007; UNEP/CMS, 2011
	Rakhine coast	Rakhine	2001-2006	≥ 2/year	Bycatch	Ilangakoon & Tun, 2007; Tun & Ilangakoon, 2007
			2007	1	Bycatch	Tun & Ilangakoon, 2007
			2007	2-3	Sighting	Tun & Ilangakoon, 2007
Philippines	Luzon	Luzon coast	2002	Probably extinct	Reported/documented	Marsh et al., 2002
	Mindanao	Caraga	2002	--	Sighting	Marsh et al., 2002
		Soccsksargen	2002	--	Mention	Marsh et al., 2002
		Davao	2006	3-12	Underwater camera recording	Dagondon et al., 2006
			2015	--	Feeding trials	Mizuno et al., 2017
	Mimaropa	Palawan	1998-2000	30	Bycatch	UNEP/CMS, 2011
			2013	1	Bycatch	Poonian & Lopez, 2016
	Visayas	Visayas	2002	Probably extinct	Reported/documented	Marsh et al., 2002
Singapore	East Region	Southern coast of Pulau Tekong	2006	1	Carcass	National Library Board Singapore, 2009
Thailand	Andaman Sea	Ranong, Phang-nga, Krabi, Phuket, Trang, and Satun	1990-2019	210	Carcass	Poommouang et al., 2021
			2001	123-200	Estimated from aerial survey	Department of Marine and Coastal Resources (DMCR), 2018
			2017	191	Estimated from aerial survey	DMCR, 2018
	Gulf of Thailand	Rayong, Trat, Chanthaburi, Chonburi, Chumphon, Surat Thani, Nakornsrithammarat, and Pattani	1990-2019	8	Carcass	Poommouang et al., 2021
			2017	30	Estimated from aerial survey and interview	DMCR, 2018
Timor–Leste	Northern coast	The northern coast side of Timor–Leste (Atauro Island and Dili)	2008	--	Sighting	Timor–Leste, 2021
			2021	1	Sighting	Timor–Leste, 2021

Countries	Regions	Coasts	Year(s)	Number of dugong(s)	Descriptions	Source(s)
Vietnam	North Vietnam	Tonkin Gulf	1970s, 1997	--	Interview, specimen	UNEP/CMS, 2011
	South Vietnam	Con Dao	2000-2001	3	Carcass	Cox, 2002; UNEP/CMS, 2011
			2000-2003	73	Estimated from interview	Pham, 2003
			2000-2008	11 (1 mother–calf pair)	Sighting	Marsh et al., 2002; UNEP/CMS, 2011
			2000-2009	5-6	Interview	UNEP/CMS, 2011
		Phu Quoc	1997-2003	> 30	Carcass	Pham, 2003
			2002-2003	73	Estimated from interview	Pham, 2003
			2002-2008	58	Hunting	Pham, 2003; UNEP/CMS, 2011
			2002-2009	7	Bycatch	Pham, 2003; UNEP/CMS, 2011
			2003	--	Feeding trials	Pham, 2003
		Tho Chu	2000-2003	71	Estimated from interview	Pham, 2003
			2010	1	Sighting	UNEP/CMS, 2011

Literature Cited

Affendi, Y. A., Ooi, J., Phang, S. M., Azhar, H., Faedzul, R. R., & Rosmadi, F. (2005). *Dugongs in peril: The conservation and protection of dugongs in Johor, Malaysia*. The United Nations Development Program, Kuala Lumpur, Malaysia.

Allen, J. F., Lepes, M. M., Budairos, I. T., Sumitro, D., & Hammond, D. (1976). Some observations on the biology of the dugong (*Dugong dugon*) from the waters of South Sulawesi. *Aquatic Mammals*, *4*(2), 33-48.

Bali, J., Jaaman, S. A., Tisen, O. B., Landong, W. S., Zaini, M. K., Chin, W. Y., Bakir, K., & Saimin, S. (2008, May). Distribution and aerial sighting rate of marine wildlife in Sarawak waters. *The 7th IOC-WESTPAC International Scientific Symposium*, Kota Kinabalu, Malaysia.

Beasley, I., & Davidson, P. (2007). Conservation status of marine mammals in Cambodian waters, including seven new cetacean records of occurrence. *Aquatic Mammals*, *33*(3), 368-379. https://doi.org/10.1578/AM.33.3.2007.368

Budiarsa, A. A., De Iongh, H. H., Kustiawan, W., & van Bodegom, P. M. (2021). Dugong foraging behavior on tropical intertidal seagrass meadows: The influence of climatic drivers and anthropogenic disturbance. *Hydrobiologia*, *848*(2021), 4153-4166. https://doi.org/10.1007/s10750-021-04583-0

Cox, N. (2002). *Observations of the dugong* Dugong dugon *in Con Dao National Park, Vietnam, and recommendations for further research*. Sirenian International.

Cullen-Unsworth, L. C., Jones, B. L., Seary, R., Newman, R., & Unsworth, R. K. F. (2018). Reasons for seagrass optimism: Local ecological knowledge confirms presence of dugongs. *Marine Pollution Bulletin*, *134*, 118-122. https://doi.org/10.1016/j.marpolbul.2017.11.007

Dagondon, G. O., Uy, A. D., Fortich Bollozos, C. J., Lawas, B. D., & Donato, J. (2006, December). Dugongs community initiated dugong conservation in Cape San Agustin. *Proceedings of the 3rd International Symposium on SEASTAR2000 and Asian Bio-Logging Science (The 7th SEASTAR2000 Workshop)* (pp. 51-53), Bangkok, Thailand.

De Iongh, H. H. (1997). Current status of dugongs in Indonesia. In T., Tomascik, A. J. Mah, A. Nontji, & M. K. Moosa (Eds.), *The ecology of the Indonesian seas, Part II* (Canada and Periplus ed., pp. 1158-1166). Dalhousie University, Hong Kong.

De Iongh, H. H., Moraal, M., & Souffreau, C. (2006). Dugong survey of Derawan Island and Adang Bay, East Kalimantan, Indonesia [Electronic version]. *Sirenews*, *46*, 8-10.

De Iongh, H. H., Hutomo, M., Moraal, M., & Kiswara, W. (2009). *Indonesia scientific report: Part I. National Strategy and Action Plan for the Dugong in Indonesia*. Institute of Environmental Sciences Leiden.

De Iongh, H. H., Kiswara, A. W., Kustiawan, A. W., & Loth, A. P. E. (2007). A review of research on the interactions between dugongs (*Dugong dugon* Müller 1776) and intertidal seagrass beds in Indonesia. *Hydrobiologia*, *591*, 73-83. https://doi.org/10.1007/s10750-007-0785-4

Department of Marine and Coastal Resources (DMCR). (2018). *The status of Thai marine endangered animals*. DMCR, Ministry of Natural Resources and Environment, Thailand.

Dugong and seagrass hub. (2021). https://www.dugongseagrass.org

Hines, E., Adulyanukosol, K., Somany, P., Ath, L. S., Cox, N., Boonyanate, P., & Hoa, N. X. (2008). Conservation needs of the dugong *Dugong dugon* in Cambodia and Phu Quoc Island, Vietnam. *Oryx*, *42*(1), 113-121. https://doi.org/10.1017/S0030605308000094

Ilangakoon, A. D., & Tun, T. (2007). Rediscovering the dugong (*Dugong dugon*) in Myanmar and capacity building for research and conservation. *Raffles Bulletin of Zoology*, *55*(1), 195-199.

Jaaman, S. A., & Lah-Anyi, Y. U. (2003). Dugongs (*Dugong dugon* Müller, 1776) in East Malaysian waters. *ASEAN Review of Biodiversity and Environmental Conservation (ARBEC)*.

Jaaman, S. A., Lah-Anyi, Y. U., & Tashi, Y. (2001). Recent sightings of marine mammals and whale sharks in Sarawak. In E. L. Bennett & C. L. M. Chin (Eds.), *Hornbill: Volume 5. Proceedings of the Fifth Annual Workshop of the National Parks and Wildlife Division* (pp. 64-81). Sarawak Forestry Department.

Kreb, D., & Budiono. (2005). Cetacean diversity and habitat preferences in tropical waters of East Kalimantan, Indonesia. *Raffles Bulletin of Zoology*, *53*(1), 149-155.

Mamayu Utami, I. J., Soeprobowati, T. R., & Sugianto, D. N. (2018, August). An overview of marine mammals in Eastern Indonesia 2016: Implications for marine mammals research and conservation. *Proceedings of the 3rd International Conference on Energy, Environmental and Information System (ICENIS 2018)* (Article No. 04017), Semarang, Indonesia. https://doi.org/10.1051/e3sconf/20187304017

Marsh, H., Penrose, H., Eros, C., & Hughes, J. (2002). *Dugong status report and action plans for countries and territories: Early warning and assessment report series* (UNEP/DEWA/RS.02-1). United Nations Environment Programme.

McKenzie, L. J., Yoshida, R. L., Mellors, J. E., & Coles, R. G. (2006). S*eagrass-Watch monitoring report Indonesia*. Seagrass-Watch. 228 pp. www.seagrasswatch.org

Mizuno, K., Asada, A., Matsumoto, Y., Sugimoto, K., Fujii, T., Yamamuro, M., Fortes, M. D., Sarceda, M., & Jimenez, L. A. (2017). A simple and efficient method for making a high-resolution seagrass map and quantification of dugong feeding trail distribution: A field test at Mayo Bay, Philippines. *Ecological Informatics*, *38*, 89-94. https://doi.org/10.1016/j.ecoinf.2017.02.003

Moore, A. M. (2004). Coral reef survey & monitoring for management in Central Sulawesi, Indonesia: Laporan Kegiatan coral reef survey & monitoring for management in Central Sulawesi, Indonesia. In United Nations Environment Programme (Ed.), *Monitoring coral reefs for better management schemes: UNEP EAS/RCU Small Grants Fund Programme 2002-2003* (pp. 85-240). UNEP.

Moore, A. M., Ambo-Rappe, R., & Ali, Y. (2017). "The lost princess (putri duyung)" of the small islands: Dugongs around Sulawesi in the Anthropocene. *Frontiers in Marine Science*, *4*, Article 284. https://doi.org/10.3389/fmars.2017.00284

National Library Board Singapore. (2009). *Dugong*. Singapore Agency for Science, Technology and Research.

Nontji, A., Kuriandewa, T. E., & Hariyadi, E. (2012). *National review of dugong and seagrass: Indonesia*. GEF/UNEP Project on the Dugong and Seagrass Conservation.

Nurdin, M., Suprayogi, A., Satyaningtijas, A. S., & Darusman, H. S. (2019). Nutrition value, feed efficiency and species of seagrass as a feed of wild dugong (*Dugong dugon*) in Lingayan island, Tolitoli, Central Sulawesi. *Journal of the Indonesian Veterinary Research*, *3*(1), 36-41. https://doi.org/10.20956/jrvi.v3i1.5149

Ooi, J. L. S., Affedi, Y. A., & Phang, S. M. (2008). *PHASE II dugongs in peril: The conservation and protection of dugongs in Johor, Malaysia. Part I: Seagrass survey report July 2008*. Titan Chemical Corp. Bhd, Pasir Gudang, Malaysia.

Perrin, W. F., Reeves, R. R., Dolar, M. L. L., Jefferson, T. A., Wang, J. Y., & Estacion, J. (Eds.). (2005). *Report of the Second Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of South-East Asia*. UNEP/CMS Secretariat.

Pham, N. T. (2003, January). Dugong—The marine mammal remaining in Kien Giang Province and listed in the red data book of Viet Nam. *Proceeding of the Workshop on the Conservation of the Dugong and Seagrass Habitat in Viet Nam*, WWF Indochina.

Poommouang, A., Kriangwanich, W., Buddhachat, K., Brown, J. L., Piboon, P., Chomdej, S., Kampuansai, J., Mekchay, S., Kaewmong, P., Kittiwattanawong, K., & Nganvongpanit, K. (2021). Genetic diversity in a unique population of dugong (*Dugong dugon*) along the sea coasts of Thailand. *Scientific Reports*, *11*(1), 11624. https://doi.org/10.1038/s41598-021-90947-4

Poonian, C. N. S., & Lopez, D. D. (2016). Small-scale mariculture: A potentially significant threat to dugongs (*Dugong dugon*) through incidental entanglement. *Aquatic Mammals*, *42*(1), 56-59. https://doi.org/10.1578/AM.42.1.2016.56

Rajamani, L. (2009). *The conservation biology of the dugong (*Dugong dugon*) and its seagrass habitat in Sabah, Malaysia: A basis for conservation planning* (Doctoral dissertation). Universiti Malaysia Sabah, Kota Kinabalu, Malaysia. http://eprints.ums.edu.my/3707

Rajamani, L., & Marsh, H. (2010). Using parallel regional- and local-scale initiatives to inform conservation management of rare wildlife: A case study of the dugong *Dugong dugon* in Sabah, Malaysia. *Endangered Species Research*, *13*, 17-23. https://doi.org/10.3354/esr00310

Rajamani, L., Cabanbandr, A. S., & Rahmandr, R. A. (2006). Indigenous use and trade of dugong (*Dugong dugon*) in Sabah, Malaysia. *Ambio*, *35*(5), 266-268. https://doi.org/10.1579/05-S-093.1

Satyaningtijas, A. S., Suprayogi, A., Darusman, H. S., Nurdin, A., & Hanadhita, D. (2020). Relative white blood cell counts, heterophil to lymphocyte ratio, and discovery of blood parasites in wild dugong (*Dugong dugon*) at Lingayan Island, Toli-Toli, Indonesia. *Veterinary World*, *13*(9), 1849-1853. https://doi.org/10.14202/vetworld.2020.1849-1853

Syafutra, R., Adi, W., Iqbal, M., & Yustian, I. (2018). Short communication: *Dugong dugon* Müller, 1776 (Sirenia, Dugongidae) in Bangka Island, Indonesia. *Biodiversitas*, *19*(3), 773-780. https://doi.org/10.13057/biodiv/d190310

Timor–Leste. (2021). *Dugong and seagrass hub*. https://www.dugongseagrass.org/projects/seagrass-ecosystem-services-project/timor-leste

Tubbs, S. E., Bas, A. B., Cote, G., Jones, A. L., & Notman, G. (2019). Sighting and stranding reports of Irrawaddy dolphins (*Orcaella brevirostris*) and dugongs (*Dugong dugon*) in Kep and Kampot, Cambodia. *Aquatic Mammals*, *45*(5), 563-568. https://doi.org/10.1578/AM.45.5.2019.563

Tun, T., & Ilangakoon, A. D. (2007). *Assessment of dugong (*Dugong dugon*) occurrence and distribution in an extended area off the Rakhine coast of Western Myanmar*. Society for Marine Mammalogy.

United Nations Environment Programme/Convention on Migratory Species (UNEP/CMS). (2011). *Report of the UNEP/CMS Southeast Asia regional meeting on dugongs and workshop on developing standardised analysis protocols for dugong questionnaire survey project data for Southeast Asia region*. UNEP/CMS.

Table S2. The list and information of academic journal material in Southeast Asia (1993-June 2021) through the methodology in this review

No.	Topic	Authors	Location	Areas of study	Response variable(s)	Methods used	Highlight results
1	Stomach content analysis of a dugong (*Dugong dugon*) from South Sulawesi, Indonesia	Erftemeijer et al., 1993	Barang Lampo island, Indonesia	Biology	Digesta in the stomach	Stomach content analysis	The main contribution of the digesta in the dugong stomach is pioneering seagrass species (i.e., *Halophila, Halodule, Cymodocea*), 71.5%.
2	Observations on dugongs at Calauit Island, Busuanga, Palawan, Philippines	Aragones, 1994	Calauit Island, Busuanga, Palawan, Philippines	Ecology	Sighted location and number of dugong	Visual observation (top hill observation: a team of local observers by binocular)	(1) Most dugongs were found in small species' seagrass beds. They were seen feeding from late afternoon or dusk to early nighttime, or from late night to early morning. (2) The consumption rate is ~30.5 kg WW/individual/day.
3	Seagrass distribution and seasonal biomass changes in relation to dugong grazing in the Moluccas, East Indonesia	De Iongh et al., 1995	Maluku, Indonesia	Ecology	(1) Seagrass (species, % coverage, biomass, and total organic carbon [TOC]) (2) Sediment composition (3) Frequency of dugong grazing (the numbers of feeding tracks per quadrat, 20 × 20 m)	Permanence grid survey	(1) The grazed feeding tracks were restored after 5 months. (2) The dugongs prefer *Halodule uninervis*—low above-ground biomass with high levels of TOC. (3) TOC was highest in *H. uninervis*—below-ground part during the late wet season to the early dry season (Aug-Nov).
4	Can dugongs survive in Palau?	Marsh et al., 1995	Ngaremlengui, Philippines	Ecology	(1) Dugong abundance (individual/time) (2) Mortality and natural history (interview)	Aerial survey and interview	(1) The sighting rate of dugong was decreasing from 1978 to 1991. (2) Highly threatened: the illegal killing of dugongs occurs openly (meat), and jewelry from dugong ribs were sold illegally at local shops.
5	Observations on the behavior of the dugong (*Dugong dugon* Müller, 1776) from waters of the Lease Islands, eastern Indonesia	De Iongh et al., 1997	Lease Islands, Maluku, Indonesia	Ecology	(1) Dugong abundance (2) Dugong surface and submerged time (3) The response of dugongs to approaches by one or more swimmers or observers on a boat: (1) no apparent response (continued routine activity), (2) curiosity, or (3) avoidance (4) Feeding track density (5) Wave condition	Visual observation (top hill observation), SCUBA diving, and snorkeling transect	(1) These observations do not indicate regular feeding times and even during very rough seas, dugongs would still come to forage. (2) Most of the grazing trails were located in *Halophila ovalis* bed; greater depth (7-9 m). (3) Animals continued to feed when approached in a small boat. On one occasion, the approach of a large boat caused a fright response. The animal surfaced vertically a few meters from the boat, facing the boat. Most of the time, dugongs appeared to display curiosity towards divers.
6	Movement and home ranges of dugongs around the Lease Islands, East Indonesia	De Iongh et al., 1998	Lease Islands, Maluku, Indonesia	Ecology	(1) Travelling root (2) Type of visiting seagrass area	GPS tracking (tracking periods between 41 and 285 days)	(1) Mean home ranges covered 4.1 to 43.4 km^2 (1.6 to 127.9 km^2) which is overlapped with seagrass beds (*H. uninervis, H. ovalis, Clytra rotundata, Caulerpa serrulata, Syringodium isoetifolium*, and *Thalassia hemprichii*). (2) The repeated visit can be explained by the observed practice of cultivation grazing, resulting in distinct feeding plots.
7	Growth of seagrass *Halophila ovalis* at dugong trails compared to existing within-patch variation in a Thailand intertidal flat	Nakaoka & Aioi, 1999	Bae Na, Haad Chao Mai National Park, Trang, Thailand	Ecology	(1) Number of leaves, biomass, and morphology (length & width of leaves, internode length of rhizome) of *H. ovalis* at the center of *H. ovalis* patches, the edge of the patch, and the edge of grazing trails (2) Number of new leaves, rhizome branching frequency, and internode length within the above 3 treatments and in the edge of the artificial trail	Survey and experimental plot (rhizome marked by tagging wire around the second node from the growing apex for growth rate study)	(1) Growth and reproductive rates at the edge of seagrass patches were highest, while not a significant difference between the center of seagrass patches, dugong trails, and artificial trails. (2) The recovery rate of *H. ovalis* after grazed by dugong is lower than 20 days.
8	Dugongs in Trang Province, Thailand: Recommendations for conservation strategy	Hines et al., 2002	Trang, Thailand	Conservation	(1) The dugong status (review) (2) History and movements of dugongs information from local fishers	Review and interviews	The conservation strategy should develop under the consideration of recent dugong status, socioeconomic–historical background, community-based conservation and education, seagrass protection, and government policy.
9	Annual changes of urinary progesterone and estradiol-17β of the dugong in captivity	Wakai et al., 2002	Palawan, Philippines	Physiology	Urinary progesterone and estradiol-17β level	The double antibody RIA system using 125 I-labeled radioligands	The ovulatory cycle of the dugong is about 50 days.

No.	Topic	Authors	Location	Areas of study	Response variable(s)	Methods used	Highlight results
10	Impacts of dugong foraging on benthic animal communities in a Thailand seagrass bed	Nakaoka et al., 2002	Trang, Thailand	Ecology	Species composition, number and depth distribution of benthic organism in temporal changes at natural seagrass patch, surrounded dugong grazing trail seagrass patch, and within dugong trail	Core sampling	Taxa richness of the benthic animals was higher in intact *H. ovalis* vegetation compared to dugong trails. The density of epifauna and shallow infauna in *H. ovalis* beds was higher than dugong trails, while the deep infauna in *H. ovalis* beds were lower than dugong trails.
11	Dioxins/furans and polychlorinated biphenyls (PCBs) in dugongs from the Thailand coast	Kumar et al., 2003	Krabi and Phangna, Thailand	Biochemistry	Dioxins/furans and PCB concentration in dugong muscle tissues and seagrass in dugong stomach	Dioxins/furans and PCBs concentration analysis	Dioxins/furans and PCBs in dugong collected in 2001 had greater levels than samples collected in 1999.
12	Community perspectives and conservation needs for dugongs (*Dugong dugon*) along the Andaman coast of Thailand	Hines et al., 2005b	Andaman Sea, Thailand	Conservation	(1) Dugong sighting by local people (2) Local opinions about the importance of dugong and seagrass conservation (3) The influence of the dugong on the lives of villagers	Interview	(1) Dugong populations have declined in Thailand. (2) The largest threat to dugongs is an incidental catch in fishing nets. Other threats include seagrass habitat loss and the use of dugong parts for medicinal purposes. (3) An integrated management plan is needed urgently, with continued input of concerned scientists, to monitor and increase knowledge of dugong behavior and distribution.
13	Dugong (*Dugong dugon*) abundance along the Andaman coast of Thailand	Hines et al., 2005a	Andaman Sea, Thailand	Ecology	Dugong abundance (individual/time)	Aerial survey	In 2000-2001, the largest population was found in Trang; 31.5% were single dugongs. Higher numbers of dugong sightings and group sizes corresponded with higher tides until water turbidity impeded sightings after the highest spring tide.
14	Indigenous use and trade of dugong (*Dugong dugon*) in Sabah, Malaysia	Rajamani et al., 2006	Sabah, Malaysia	Socioecology	Dugong sighting, the information on dugong hunting, local use of dugong product, trade, conservation awareness, and conservation management suggestions	Interview and field survey	(1) The remaining dugong populations are decreasing in Sabah. (2) The traditional uses and anthropogenic threats to the remaining dugong populations in Sabah are due to various threats—namely, incidental catching and fish bombing, habitat loss as a result of land reclamation, and pollution from palm oil plantations and sedimentation. (3) An integrated management plan is needed.
15	Observations of dugong reproductive behavior in Trang Province, Thailand: Further evidence of intraspecific variation in dugong behavior	Adulyanukosol et al., 2007	Trang, Thailand	Ecology	Dugong reproductive behavior	Opportunistic visual observations and photographs during aerial surveys	The mating pattern was categorized by 5 stages: (1) *following:* male followed female; (2) *approaching and stimulating:* male approached and muzzled female; (3) *pairing:* both male and female swam in parallel, ventral to ventral, or dorsal to dorsal side; (4) *mounting:* male copulated with female; and (5) *separating:* male and female swam in different directions.
16	Capacity building and preliminary assessment on dugong (*Dugong dugon*) occurrence off the Rakhine coast of Myanmar	Tun & Ilangakoon, 2007	Rakhine, Myanmar	Ecology	Group discussions on dugong sighting frequency, distribution, and threats	Semi-structured interview (local capacity for dugong surveys using interview survey techniques)	Dugongs still inhabit waters off the Rakhine coast. This area has minimal direct hunting pressures, low rates of accidental bycatch, and no habitat degradation or fragmentation.
17	Concentrations of organotin compounds in tissues and organs of dugongs from Thai coastal waters	Harino et al., 2007	Andaman Sea, Thailand	Biochemistry	Length (cm), weight (kg), sex, and concentrations of butyltin (BT) and phenyltin (PT) compounds in dugong organ and tissue	Chemical analysis	(1) Concentrations of organotin (OT) compounds in dugongs collected from the Gulf of Thailand and Andaman Sea were not significantly different. (2) The concentrations of BTs and PTs in the livers of dugongs decreased between 1998 and 2002, suggesting a decrease in OT concentrations in the surrounding environment.
18	A review of research on the interactions between dugongs (*Dugong dugon* Müller 1776) and intertidal seagrass beds in Indonesia	De Iongh et al., 2007	Balikpapan Bay, Lease Islands, and Aru Islands, Indonesia	Ecology	(1) Dugong movements (in relation to those grazing sward) by GPS tagging (2) Dugong grazing factors	Previous work data analysis (an analysis of parameters explaining the temporal and spatial patterns of grazing in seagrass meadows)	(1) Dugong grazing is ruled by carbohydrate content in below-ground biomass. (2) The mechanisms of rotational grazing in restricted grazing swards are not yet well understood, and the maximization of carbohydrates does not fully explain this phenomenon.

No.	Topic	Authors	Location	Areas of study	Response variable(s)	Methods used	Highlight results
19	Rediscovering the dugong (*Dugong dugon*) in Myanmar and capacity building for research and conservation	Ilangakoon & Tun, 2007	Rakhine, Myanmar	Conservation	The information from local people and fishers about experience on dugong sighting, dugong occurrence, and reports of accidental bycatch and carcass	Semi-structured interview	(1) Dugongs still inhabit Myanmar waters along with healthy seagrass beds. (2) Dugong population in western Myanmar is less threatened by anthropogenic pressure, no direct hunting, low rate of accidental bycatch, and no habitat destruction.
20	Conservation needs of the dugong in Cambodia and Phu Quoc Island, Vietnam	Hines et al., 2008	Koh Kong, Kampot and Kep, Cambodia and Phu Quoc island, Vietnam	Conservation	Frequency of dugong sighting events	Aerial survey; interview	During 4 days of aerial surveys in Cambodia in 2004, researcher saw no dugongs. Interviewed villagers in Phu Quoc Island, Vietnam, in 2002 and learned that dugongs are regularly found and hunted, again for high profits.
21	The magnitude and sustainability of marine mammal bycatch in fisheries in East Malaysia	Jaaman et al., 2009	Sabah and Sarawak, Malaysia	Ecology	Marine mammal sightings and bycatch rate of each marine mammal species (or group)	Field survey; semistructured and informal interviews	(1) Gillnetters, trawlers, and fish stakes were reported to catch cetaceans and dugongs, while purse seiners caught only cetaceans. (2) Incidental catches of marine mammals are greatest in gillnets. (3) A dedicated monitoring and educational program, together with the establishment of Marine Protected Areas, is urgently needed to minimize the threat.
22	The Philippine marine mammal strandings from 1998 to 2009: Animals in the Philippines in peril?	Aragones et al., 2010	Philippines	Ecology	Frequency of stranding events between seasons across the years	Collection of data from government and nongovernment offices	Seven dugong stranding events were recorded during 2001 to 2009. High percentage of marine mammals might be linked to dynamite fishing (causing acoustic trauma), fisheries interactions, or biotoxins from harmful algal blooms coupled to their food web.
23	Using parallel regional and local-scale initiatives to inform conservation management of rare wildlife: A case study of the dugong in Sabah, Malaysia	Rajamani & Marsh, 2010	Sabah, Malaysia	Conservation	(1) Geopolitical scale; the distribution and abundance of the dugong (2) Local-scale, local knowledge of the distribution, and abundance of dugongs and ability to participate in monitoring at that scale	Aerial survey, interview surveys, and a monitoring program	Dugong populations in Sabah are small and clumped, and urgently require management intervention at local scales in the regionally important habitats identified by aerial surveys.
24	Modeling habitat and bycatch risk for dugongs in Sabah, Malaysia	Briscoe et al., 2014	Sabah and Sarawak, Malaysia	Ecology	(1) Dugong sighting and stranding events (2) Interview the local fishers about the sighting, stranding, and hunting of dugong (3) Environmental factors: seagrass distribution, nutrient concentration, salinity, turbidity, and water currents (4) Fishery effort (5) Fishery activity mapping	Field survey, interview, and modeling	An analysis identified several areas of high risk where dugong surveys were conducted and also identified high-risk areas in previously unsurveyed locations. Such methods can be used to direct field activities and data collection efforts and provide a robust template for existing sightings and fishing.
25	Aligning conservation and research priorities for proactive species and habitat management: The case of dugongs *Dugong dugon* in Johor, Malaysia	Ponnampalam et al., 2014	Johor, Malaysia	Conservation	Frequency of dugong sighting events	Aerial survey	The Johor islands may represent a significant congregation site for dugongs in Peninsular Malaysia, with as many as 20 dugongs recorded in a single day. Dugongs were found around Sibu, Tinggi, Besar, Rawa, and Seribuat Islands.
26	Small-scale mariculture: A potentially significant threat to dugongs (*Dugong dugon*) through incidental entanglement	Poonian & Lopez, 2016	Busuanga, Palawan, Philippines	Conservation	Bycatch dugong and frequency of stranding events	Information from government and nongovernment offices and local people	Several anecdotal reports that dugongs are threatened by incidental capture in small-scale fisheries and other static underwater structures could present a similar entanglement risk.
27	Using fisher knowledge, mapping population, habitat suitability, and risk for the conservation of dugongs in Johor Straits of Malaysia	Hashim et al., 2017	Johor, Malaysia	Conservation	(1) Dugong population information on the abundance and distribution of dugongs based on fisher surveys (location point) (2) Environmental predictor: seagrass biomass, distance from the shoreline, and water depth	Interview and species distribution model (MaxEnt)	The MaxEnt model output showed seagrass biomass as the highest contributing factor to the likelihood of dugong presence. The model also estimated 20 kg/m^2 of seagrass biomass, 3 km distance from the shoreline, and a water depth of 25 m as the optimum habitat condition for the dugong population.

No.	Topic	Authors	Location	Areas of study	Response variable(s)	Methods used	Highlight results
28	Elemental classification of the tusks of dugong (*Dugong dugon*) by HH-XRF analysis and comparison with other species	Nganvongpanit et al., 2017b	Thailand	Biochemistry	The elemental composition of dugong tusks and teeth of dugongs, dolphins, whales, elephants, and tigers	Handheld X-ray fluorescence analyzer (HH-XRF)	There was no significant difference in the elemental composition of male and female dugong tusks, whereas the overall accuracy for identifying habitat (Andaman Sea and Gulf of Thailand) was high (88.1%).
29	What the skull and scapular morphology of the dugong (*Dugong dugon*) can tell us: Sex, habitat, and body length?	Nganvongpanit et al., 2017a	Thailand	Biology	Sex, habitat, body length, external morphology, and morphometrics of the skull, scapular, and tusk of 81 dugong samples	Morphology and morphometric	(1) Multivariate linear regression show 100, 98.5, 96.15, and 91.30% accuracy rates for sexing using large tusks and the skull (caudal), coracoid process, and border tubercle, respectively. (2) Skull morphometrics could categorize dugong habitat (i.e., living in the Andaman Sea or Gulf of Thailand) with 100% accuracy. (3) The model ($Y = 54.214 + 1.650X + 0.110X^2$, where Y is the body length from the tip of the snout to the notch in the tail fluke and X is the condyle–premaxillary length, both in cm) could be used to estimate body length with the coefficient of determination (R^2) of 0.985.
30	Osteoarthritis in two marine mammals and 22 land mammals: Learning from skeletal remains	Nganvongpanit et al., 2017c	Thailand	Biology	Osteoarthritis (OA) (the degradation of articular cartilage and subchondral bone degradation) in dugongs, dolphins, and terrestrial mammal skeletons and the genetic relationship (cytochrome *b*) and OA occurrence among species	OA evaluation and joint observation by two experts	OA can occur in dugongs and dolphins, similar to terrestrial mammals, even though their natural habitat is the ocean that has the buoyant force. Moreover, gender did not influence OA occurrence in marine species.
31	A simple and efficient method for making a high-resolution seagrass map and quantification of dugong feeding trail distribution: A field test at Mayo Bay, Philippines	Mizuno et al., 2017	Mayo Bay, Midanao, Philippines	Ecology	Image of sample seagrass beds	(1) Snorkeling (2) Continuous image processing using PhotoScan	A new method of seagrass mapping and quantification of dugong trail distribution is proposed and tested. The method produces a clear and high-resolution image, but it needs skill for the divers, time, and effort.
32	Differences in vocalization patterns of dugongs between fine-scale habitats around Talibong Island, Thailand	Tanaka et al., 2017	Trang, Thailand	Ecology	(1) Dugong vocalization rate and power spectrum density (PSD) (2) Environmental factors: time period, current speed and direction, and water level (in feeding and vocal area)	Automatic underwater sound monitoring systems (AUS–OMS; AquaSound Inc., Kobe, Japan)	The vocalization pattern for dugongs differed between the feeding and vocal areas. In vocal areas, there is a higher vocalization rate and power spectrum density than in the feeding areas.
33	"The Lost Princess" (putri duyung) of the small islands: Dugongs around Sulawesi in the Anthropocene	Moore et al., 2017	Togean, Banggai, Spermonde, Taka Bonerate/ Selayar, and Tanakeke Islands, Sulawesi, Indonesia	Socioecology	The distribution, exploitation, and community perceptions of dugongs	The research collected, compiled, and evaluated data and information (mostly unpublished)	Sulawesi dugongs are now rare and under high threat. Many fishing communities consider dugong meat superior to beef and see it as a welcome change from fish, while certain body parts fetch a high price as do dugong tears.
34	Reasons for seagrass optimism: Local ecological knowledge confirms presence of dugongs	Cullen-Unsworth et al., 2018	Wakatobi Regency, Indonesia	Conservation	The knowledge of local people about dugong	Interview	Local ecological knowledge (LEK) helps to confirm dugong populations and supports associated resource management decisions.
35	Short Communication: *Dugong dugon* Müller, 1776 (Sirenia, Dugongidae) in Bangka Island, Indonesia	Syafutra et al., 2018	Pulau Bangka, Indonesia	Ecology	Frequency of dugong sighting and stranding events	Interview and the information from government and nongovernment offices, news, experts, and local people	Only 4 records of dugong were reported in Bangka Island in 1976, 2006, and 2007. Sixteen new records of dugong were collected in the eastern waters of Bangka Island. Most of the dugongs were found dead and entangled in gillnets. Kurau Village became the most important location for fishers to sell dead dugongs or dugong meat.

No.	Topic	Authors	Location	Areas of study	Response variable(s)	Methods used	Highlight results
36	Sighting and stranding reports of Irrawaddy dolphins (*Orcaella brevirostris*) and dugongs (*Dugong dugon*) in Kep and Kampot, Cambodia	Tubbs et al., 2019	Kep Archipelago, Cambodia	Ecology	Frequency of dugong sighting and stranding events	Field survey and the information from government and nongovernment offices	Unconfirmed fisher reports identifying the presence of small and sporadic dugong populations at both the Thai–Cambodian and Vietnamese–Cambodian border regions.
37	Age relationships with telomere length, body weight, and body length in wild dugong	Cherdsukjai et al., 2020	Thailand	Biology	The telomere length (rTL) (from the skin tissue) and the relationships between age by GLG (dentin growth layer groups) counts and body weight and length of dugong carcasses	(1) Molecular (2) GLG counts (3) Body morphometrics	(1) The physical maturity in dugongs occurs at 20 years of age. (2) The age estimated by GLGs was negatively correlated with rTL using the logistic formula with a rate of telomere attrition of approximately 0.036 rTL/y between the ages of 5 to 20 years. (3) The body weight and length were positively correlated with GLG-based age, with growth rates of ~8.8 kg/y for weight and ~3.58 cm/y for length, respectively.
38	Short Communication: Dugong (*Dugong dugon*) reproductive behaviour in Koh Libong, Thailand: Observations using drones	Infantes et al., 2020	Trang, Thailand	Biology	Image and video of dugong reproductive behavior	Aerial observation using drone	Drones were a cost-efficient tool to document dugong behavior and to provide video images.
39	Relative white blood cell counts, heterophil-to-lymphocyte ratio, and discovery of blood parasites in wild dugong (*Dugong dugon*) at Lingayan Island, Toli-Toli, Indonesia	Satyaningtijas et al., 2020	Lingayan Island, Indonesia	Biology	Number of white blood cell (WBC), the heterophil-to-lymphocyte (H/L) ratio, and parasites in wild dugong blood	Investigate the relative WBC counts and the H/L ratio to analyze the presence of blood parasites in wild dugongs	The relative WBC counts included heterophils (19.4%), lymphocytes (76.4%), and monocytes (3.6%); and the H/L ratio was 0.25. Intraerythrocytic parasites were identified and suspected to be Anaplasma and Babesia. The discovery of blood parasites could be one of the threatening factors for the dugong population.
40	Measuring the nonuse value of the dugong (*Dugong dugon*) in Thailand	Petcharat & Lee, 2020	Chatuchak, Bang Khae, Pathum Wan, Dusit, and Bang Kapi districts, Bangkok, Thailand	Socioecology	The nonuse value or the nonusers' willingness to pay for conserving the dugongs in Thailand from 300 residents in five selected districts of Bangkok	A face-to-face interview using the choice experiment method	(1) The average willingness to pay for the most preferred dugong conservation scheme (a marker buoy system, re-creating habitats, and slowing down the population decline) was 4,382 Thai Baht (122 USD) annually per household. (2) The respondents were not willing to pay for educating local fishers about the conservation of dugongs, though the development of the marker buoy system to identify dugong habitats was the most valued by the general public.
41	Classifying mermaids: Observations on local naming and classification of dugongs (*Dugong dugon*) among the Lio of Flores Island (Eastern Indonesia)	Gregory, 2020	Flores Island, Eastern Indonesia	Socioecology	The similarity and difference between folk and international biology about dugong	A face-to-face interview; myth	The Lio people of Flores Island describe dugongs as creatures that are half human and half fish—essentially like the European image of mermaids.
42	Development of an automatic detection method for dugong feeding sounds in an intertidal seagrass bed	Yamato et al., 2020	Trang, Thailand	Biology	Dugong feeding sounds (a series of broadband pulses)	Passive acoustic monitoring	(1) A new method to automatically detect the feeding sounds of dugongs from acoustic recording data. A morphological opening filter was applied to identify pulses and an autocorrelation coefficient threshold was used to extract the feeding sounds. Applying a threshold on water depth effectively reduced the false detection rate from 16.4 to 4.4%, and the correct detection rate increased from 72.2 to 76.8%. (2) The feeding sound of the dugong consists of a set of pulses with a constant interval.
43	Short Communication: Dugong's presence confirmation in Bintan Island based on local ecological knowledge	Idris et al., 2020	Bintan Island, Indonesia	Ecology	The dugong sighting frequency and locations, the type of fishing gear interfering with the dugong survival conditions, and the community habit of hunting and eating dugong	Interview (the rapid rural appraisal [RRA] method)	(1) The majority of respondents of Berakit (100%) and Kelong (78%) have often seen the presence of dugong in nature. (2) The threat to the survival of dugong on Bintan Island originates from the existence of fishing gear such as nets and fishing traps. Besides, at several locations, it is still in the habit of the communities to hunt dugong, and this is one of the biggest threats to dugong species conservation.

No.	Topic	Authors	Location	Areas of study	Response variable(s)	Methods used	Highlight results
44	Community leader perspectives on the utilization of seagrass ecosystem for marine tourism in Toli-Toli, Central Sulawesi, Indonesia	Sondita et al., 2020	Toli-Toli, Central Sulawesi, Indonesia	Conservation	Community leader perspectives about seagrass and dugong tourism of Seribu Island	A learning approach (field trip and workshop)	The village government can start planning sustainable tourism using the action plan developed in the workshop. The local business owner must be invited to participate actively in the process of local tourism development.
45	Pelvic bone morphometric analysis in the dugong (*Dugong dugon*)	Nganvongpanit et al., 2020	Phuket, Thailand	Biology	(1) 8 parameters: acetabular region width, anterior width, cranial width, ilium length, ischium length, narrow width, pelvic length, and posterior width (2) 5 indexes: anterior width/posterior width, body length/pelvic length, ilium length/ischium length, pelvic length/ilium length, and pelvic length/ischium length	Morphometric data encompassing 8 parameters and 5 indexes to analyze the morphology of the pelvic bones obtained from 88 specimens (45 dugongs)	(1) The pelvic bone is very useful in sex identification and body size estimation. (2) Three main findings: (1) the pelvic bone in mature male subjects is larger than it is in females, (2) a high rate of accuracy can be established for sex identification using morphometric data obtained from the pelvic bone, and (3) the pelvic bone has the highest degree of correlation with body length, followed by body weight and age.
46	Geospatial analyzing of straits shipping paths for the integration of air quality and marine wildlife conservation	Hadipour et al., 2021	Malacca Strait, Malaysia	Ecology	(1) Location point of dugong (2) Predictor: air pollutant of shipping emissions from moving vessels and maritime paths (distance from the maritime paths to the dugong home range)	Modeling—a relationship between air quality (modeled based on air pollutant of shipping emissions from moving vessels in the sea) and dugong habitat location (distance from the maritime paths to the dugong home range)	(1) This paper develops a GIS-based model to determine suitable locations for shipping paths within Malacca Strait by investigating the best air quality. (2) This research has successfully managed and developed a scientifically based method for understanding the relationship between wildlife habitat and marine transportation by analyzing successful and nonsuccessful present and future shipping.
47	Dugong foraging behavior on tropical intertidal seagrass meadows: The influence of climatic drivers and anthropogenic disturbance	Budiarsa et al., 2021	Bay of Balikpapan, East coast of Kalimantan, Indonesia	Ecology	(1) Number of grazing tracks in the intertidal zones (2) The dynamics of seagrass: biomass, the ratio of above-ground to below-ground biomass composition and distribution (7 intertidal seagrass meadows)	Field survey (monthly intervals over a year) for seasonal dugong tracks' distribution and species selectivity, and seagrass composition and distribution	(1) Seagrass features showed a significant relationship with wind speed, precipitation, desiccation time, the distance of the grazing sward to a residential area, and fishing activity. (2) The strong variation in the number of grazing trails throughout the year was significantly affected by seagrass biomass, location, and wind speed. (3) The grazing trial was found only in *Halodule pinifolia* patches. (4) The current estimated number of dugongs was 2 to 3 dugongs, which might indicate a slight reduction in the dugong herd's size compared to the population of 3 to 5 dugongs observed by De Iongh et al. (2007).
48	Genetic diversity in a unique population of dugong (*Dugong dugon*) along the sea coasts of Thailand	Poommouang et al., 2021	Thailand	Biology	The extracted DNA of 118 dugong skin samples	Measurement of inter-simple sequence repeat (ISSR) markers and mtDNA D-loop typing	(1) Only two genetic populations of dugongs exist in Thailand. (2) Dugongs from the Andaman Sea (Trang, Satun, and some areas of Krabi Province) exhibited greater diversity compared to Gulf of Thailand. Moreover, the dugong in this coast was genetically distinct, with a separate haplotype belonging to two clades found only in Thai waters that separated from other groups around 1.2 mya.
49	Automated classification of dugong calls and tonal noise by combining contour and MFCC features	Tanaka et al., 2021	Libong Island, Trang, Thailand	Biology	Tonal sounds, including both dugong calls and noise	The classification of tonal vocalizations and tonal noise	This study demonstrated an effective method to discriminate tonal noise from dugong calls by employing a supervised support vector machine (SVM).

Literature Cited

Adulyanukosol, K., Thongsukdee, S., Hara, T., Arai, N., & Tsuchiya, M. (2007). Observations of dugong reproductive behavior in Trang Province, Thailand: Further evidence of intraspecific variation in dugong behavior. *Marine Biology*, *151*(5), 1887-1891. https://doi.org/10.1007/s00227-007-0619-y

Aragones, L. V. (1994). Observations on dugongs at Calauit Island, Busuanga, Palawan, Philippines. *Wildlife Research*, *21*(6), 709-717. https://doi.org/10.1071/WR9940709

Aragones, L. V., Roque, M. A. A., Flores, M. B., Encomienda, R. P., Laule, G. E., Espinas, B. G., Diaz, G. C., Alesna, E. B., & Braun, R. C. (2010). The Philippine marine mammal strandings from 1998 to 2009: Animals in the Philippines in peril? *Aquatic Mammals*, *36*(3), 219-233. https://doi.org/10.1578/AM.36.3.2010.219

Briscoe, D., Hiatt, S., Lewison, R., & Hines, E. (2014). Modeling habitat and bycatch risk for dugongs in Sabah, Malaysia. *Endangered Species Research*, *24*(3), 237-247. https://doi.org/10.3354/esr00600

Budiarsa, A. A., De Iongh, H. H., Kustiawan, W., & van Bodegom, P. M. (2021). Dugong foraging behavior on tropical intertidal seagrass meadows: The influence of climatic drivers and anthropogenic disturbance. *Hydrobiologia*, *848*(2021), 4153-4166. https://doi.org/10.1007/s10750-021-04583-0

Cherdsukjai, P., Buddhachat, K., Brown, J., Kaewkool, M., Poommouang, A., Kaewmong, P., Kittiwattanawong, K., & Nganvongpanit, K. (2020). Age relationships with telomere length, body weight and body length in wild dugong (*Dugong dugon*). *PeerJ*, *8*, e10319. https://doi.org/10.7717/peerj.10319

Cullen-Unsworth, L. C., Jones, B. L., Seary, R., Newman, R., & Unsworth, R. K. F. (2018). Reasons for seagrass optimism: Local ecological knowledge confirms presence of dugongs. *Marine Pollution Bulletin*, *134*, 118-122. https://doi.org/10.1016/j.marpolbul.2017.11.00

De Iongh, H. H., Bierhuizen, B., & van Orden, B. (1997). Observations on the behaviour of the dugong (*Dugong dugon* Müller, 1776) from waters of the Lease Islands, eastern Indonesia. *Zoology*, *67*(1), 71-77. https://doi.org/10.1163/18759866-06701003

De Iongh, H. H., Langeveld, P., & van der Wal, M. (1998). Movement and home ranges of dugongs around the Lease Islands, East Indonesia. *Marine Ecology*, *19*(3), 179-193. https://doi.org/10.1111/j.1439-0485.1998.tb00461.x

De Iongh, H. H., Wenno, B. J., & Meelis, E. (1995). Seagrass distribution and seasonal biomass changes in relation to dugong grazing in the Moluccas, East Indonesia. *Aquatic Botany*, *50*, 1-19. https://doi.org/10.1016/0304-3770(94)00438-R

De Iongh, H. H., Kiswara, A. W., Kustiawan, A. W., & Loth, A. P. E. (2007). A review of research on the interactions between dugongs (*Dugong dugon* Müller 1776) and intertidal seagrass beds in Indonesia. *Hydrobiologia*, *591*, 73-83. https://doi.org/10.1007/s10750-007-0785-4

Erftemeijer, P. L. A., Djunarlin, & Moka, W. (1993). Stomach content analysis of a dugong (*Dugong dugon*) from South Sulawesi, Indonesia. *Australian Journal of Marine and Freshwater Research*, *44*(1), 229-233. https://doi.org/10.1071/MF9930229

Gregory, F. (2020). Classifying mermaids: Observations on local naming and classification of dugongs (*Dugong dugon*) among the Lio of Flores Island (Eastern Indonesia). *Journal of Ethnobiology*, *40*(1), 56-69. https://doi.org/10.2993/0278-0771-40.1.56

Hadipour, M., Naderi, M., Mokhtar, M., & Ern, L. K. (2021). Geospatial analyzing of straits shipping paths for the integration of air quality and marine wildlife conservation. *Journal of Wildlife and Biodiversity*, *5*(1), 63-80. https://doi.org/10.22120/jwb.2020.135939.1184

Harino, H., Ohji, M., Wattayakorn, G., Adulyanukosol, K., Arai, T., & Miyazaki, N. (2007). Concentrations of organotin compounds in tissues and organs of dugongs from Thai coastal waters. *Archives of Environmental Contamination and Toxicology*, *53*(3), 495-502. https://doi.org/10.1007/s00244-006-0254-5

Hashim, M., Ito, S., Numata, S., Hosaka, T., Hossain, M. S., Misbari, S., Yahya, N. N., & Ahmad, S. (2017). Using fisher knowledge, mapping population, habitat suitability and risk for the conservation of dugongs in Johor Straits of Malaysia. *Marine Policy*, *78*, 18-25. https://doi.org/10.1016/j.marpol.2017.01.002

Hines, E. M., Adulyanukosol, K., & Duffus, D. A. (2005a). Dugongs (*Dugong dugon*) abundance along the Andaman coast. *Marine Mammal Science*, *21*(3), 536-549. https://doi.org/10.1111/j.1748-7692.2005.tb01247.x

Hines, E., Duffus, D., & Dearden, P. (2002). Dugongs in Trang Province, Thailand: Recommendations for conservation strategy. In N. W. P. Munro, P. Dearden, T. B. Herman, & K. Beazley (Eds.), *Making ecosystem-based management work* (pp. 536-549). Science and Management of Protected Areas Association.

Hines, E., Adulyanukosol, K., Duffus, D., & Dearden, P. (2005b). Community perspectives and conservation needs for dugongs (*Dugong dugon*) along the Andaman coast of Thailand. *Environmental Management*, *36*(5), 654-664. https://doi.org/10.1007/s00267-003-0287-8

Hines, E., Adulyanukosol, K., Somany, P., Ath, L. S., Cox, N., Boonyanate, P., & Hoa, N. X. (2008). Conservation needs of the dugong *Dugong dugon* in Cambodia and Phu Quoc Island, Vietnam. *Oryx*, *42*(1), 113-121. https://doi.org/10.1017/S0030605308000094

Idris, F., Karlina, I., Herandarudewi, S. M. C., & Nugraha, A. H. (2020). Short communication: Dugong's presence confirmation in Bintan Island based on local ecological knowledge. *AACL Bioflux*, *13*(2), 651-656.

Ilangakoon, A. D., & Tun, T. (2007). Rediscovering the dugong (*Dugong dugon*) in Myanmar and capacity building for research and conservation. *Raffles Bulletin of Zoology*, *55*(1), 195-199.

Infantes, E., Cossa, D., Stankovic, M., Panyawai, J., Tuntiprapas, P., Daochai, C., & Prathep, A. (2020). Dugong (*Dugong dugon*) reproductive behaviour in Koh Libong, Thailand: Observations using drones. *Aquatic Mammals*, *46*(6), 603-608. https://doi.org/10.1578/AM.46.6.2020.603

Jaaman, S. A., Lah-Anyi, Y. U., & Pierce, G. J. (2009). The magnitude and sustainability of marine mammal bycatch in fisheries in East Malaysia. *Journal of the Marine Biological Association of the United Kingdom*, *89*(5), 907-920. https://doi.org/10.1017/S002531540800249X

Kumar, K. S., Yamamuro, M., Pitaksintorn, S., & Masunaga, S. (2003). Dioxins/furans and polychlorinated biphenyls (PCBs) in dugongs from the Thailand coast environmental contamination and toxicology. *Bulletin of Environmental Contamination and Toxicology*, *70*(2), 198-204. https://doi.org/10.1007/s00128-002-0177-4

Marsh, H., Rathbun, G., O'Shea, T. J., & Preen, A. R. (1995). Can dugongs survive in Palau? *Biological Conservation*, *72*(1), 85-89. https://doi.org/10.1016/0006-3207(94)00068-2

Mizuno, K., Asada, A., Matsumoto, Y., Sugimoto, K., Fujii, T., Yamamuro, M., Fortes, M. D., Sarceda, M., & Jimenez, L. A. (2017). A simple and efficient method for making a high-resolution seagrass map and quantification of dugong feeding trail distribution: A field test at Mayo Bay, Philippines. *Ecological Informatics*, *38*, 89-94. https://doi.org/10.1016/j.ecoinf.2017.02.003

Moore, A. M., Ambo-Rappe, R., & Ali, Y. (2017). "The lost princess (putri duyung)" of the small islands: Dugongs around Sulawesi in the Anthropocene. *Frontiers in Marine Science*, *4*, Article 284. https://doi.org/10.3389/fmars.2017.00284

Nakaoka, M., & Aioi, K. (1999). Growth of seagrass *Halophila ovalis* at dugong trails compared to existing within-patch variation in a Thailand intertidal flat. *Marine Ecology Progress Series*, *184*, 97-103. https://doi.org/10.3354/meps184097

Nakaoka, M., Mukai, H., & Chunhabundit, S. (2002). Impacts of dugong foraging on benthic animal communities in a Thailand seagrass bed. *Ecological Research*, *17*, 625-638. https://doi.org/10.1046/j.1440-1703.2002.00520.x

Nganvongpanit, K., Buddhachat, K., Kaewmong, P., Cherdsukjai, P., & Kittiwatanawong, K. (2017a). What the skull and scapular morphology of the dugong (*Dugong dugon*) can tell us: Sex, habitat and body length? *Scientific Reports*, *7*(1), 1964. https://doi.org/10.1038/s41598-017-01899-7

Nganvongpanit, K., Cherdsukjai, P., Boonsri, B., Buddhachat, K., Kaewmong, P., & Kittiwattanawong, K. (2020). Pelvic bone morphometric analysis in the dugong (*Dugong dugon*). *Scientific Reports*, *10*(1), 19350. https://doi.org/10.1038/s41598-020-76545-w

Nganvongpanit, K., Buddhachat, K., Piboon, P., Euppayo, T., Kaewmong, P., Cherdsukjai, P., Kittiwattanawong, K., & Thitaram, C. (2017b). Elemental classification of the tusks of dugong (*Dugong dugong*) by HH-XRF analysis and comparison with other species. *Scientific Reports*, *7*(1), 46167. https://doi.org/10.1038/srep46167

Nganvongpanit, K., Soponteerakul, R., Kaewkumpai, P., Punyapornwithaya, V., Buddhachat, K., Nomsiri, R., Kaewmong, P., Kittiwatanawong, K., Chawangwongsanukun, R., Angkawanish, T., Thitaram, C., & Mahakkanukrauh, P. (2017c). Osteoarthritis in two marine mammals and 22 land mammals: Learning from skeletal remains. *Journal of Anatomy*, *231*(1), 140-155. https://doi.org/10.1111/joa.12620

Petcharat, A., & Lee, Y. (2020). Measuring the nonuse value of the dugong (*Dugong dugon*) in Thailand. *Journal of Asia-Pacific Biodiversity*, *13*(1), 62-69. https://doi.org/10.1016/j.japb.2019.12.002

Ponnampalam, L. S., Izmal, J. H. F., Adulyanukosol, K., Ooi, J. L. S., & Reynolds, J. E. (2014). Aligning conservation and research priorities for proactive species and habitat management: The case of dugongs *Dugong dugon* in Johor, Malaysia. *Oryx*, *49*, 743-749. https://doi.org/10.1017/S0030605313001580

Poommouang, A., Kriangwanich, W., Buddhachat, K., Brown, J. L., Piboon, P., Chomdej, S., Kampuansai, J., Mekchay, S., Kaewmong, P., Kittiwattanawong, K., & Nganvongpanit, K. (2021). Genetic diversity in a unique population of dugong (*Dugong dugon*) along the sea coasts of Thailand. *Scientific Reports*, *11*(1), 11624. https://doi.org/10.1038/s41598-021-90947-4

Poonian, C. N. S., & Lopez, D. D. (2016). Small-scale mariculture: A potentially significant threat to dugongs (*Dugong dugon*) through incidental entanglement. *Aquatic Mammals*, *42*(1), 56-59. https://doi.org/10.1578/AM.42.1.2016.56

Rajamani, L., & Marsh, H. (2010). Using parallel regional- and local-scale initiatives to inform conservation management of rare wildlife: A case study of the dugong *Dugong dugon* in Sabah, Malaysia. *Endangered Species Research*, *13*, 17-23. https://doi.org/10.3354/esr00310

Rajamani, L., Cabanbandr, A. S., & Rahmandr, R. A. (2006). Indigenous use and trade of dugong (*Dugong dugon*) in Sabah, Malaysia. *Ambio*, *35*(5), 266-268. https://doi.org/10.1579/05-S-093.1

Satyaningtijas, A. S., Suprayogi, A., Darusman, H. S., Nurdin, A., & Hanadhita, D. (2020). Relative white blood cell counts, heterophil to lymphocyte ratio, and discovery of blood parasites in wild dugong (*Dugong dugon*) at Lingayan Island, Toli-Toli, Indonesia. *Veterinary World*, *13*(9), 1849-1853. https://doi.org/10.14202/vetworld.2020.1849-1853

Sondita, M. F. A., Sunuddin, A., Hestirianoto, T., Darmansyah, S., Kamal, M. M., Munib, A. A., Kurniawan, F., & Arkham, M. N. (2020, August). Community leader perspectives on the utilization of seagrass ecosystem for marine tourism in Toli-toli, Central Sulawesi, Indonesia. *The IOP Conference Series: Earth and Environmental Science International Symposium*, Bogor, Indonesia. https://doi.org/10.1088/1755-1315/420/1/012029

Syafutra, R., Adi, W., Iqbal, M., & Yustian, I. (2018). Short communication: *Dugong dugon* Müller, 1776 (Sirenia, Dugongidae) in Bangka Island, Indonesia. *Biodiversitas*, *19*(3), 773-780. https://doi.org/10.13057/biodiv/d190310

Tanaka, K., Ichikawa, K., Kittiwattanawong, K., Arai, N., & Mitamura, H. (2021). Automated classification of dugong calls and tonal noise by combining contour and MFCC features. *Acoustics Australia*, *49*(2), 385-394. https://doi.org/10.1007/s40857-021-00234-5

Tanaka, K., Ichikawa, K., Nishizawa, H., Kittiwattanawong, K., Arai, N., & Mitamura, H. (2017). Differences in vocalisation patterns of dugongs between fine-scale habitats around Talibong Island, Thailand. *Acoustics Australia*, *45*(2), 243-251. https://doi.org/10.1007/s40857-017-0094-7

Tubbs, S. E., Bas, A. B., Cote, G., Jones, A. L., & Notman, G. (2019). Sighting and stranding reports of Irrawaddy dolphins (*Orcaella brevirostris*) and dugongs (*Dugong dugon*) in Kep and Kampot, Cambodia. *Aquatic Mammals*, *45*(5), 563-568. https://doi.org/10.1578/AM.45.5.2019.563

Tun, T., & Ilangakoon, A. D. (2007). *Assessment of dugong (*Dugong dugon*) occurrence and distribution in an extended area off the Rakhine coast of Western Myanmar*. Society for Marine Mammalogy.

Wakai, Y., Hasegawa, K., Sakamoto, S., Asano, S., Watanabe, G., & Taya, K. (2002). Annual changes of urinary progesterone and estradiol-17β of the dugong (*Dugong dugon*) in captivity. *Zoological Science*, *19*(6), 679-682. https://doi.org/10.2108/zsj.19.679

Yamato, C., Ichikawa, K., Arai, N., Tanaka, K., Nishiyama, T., & Kittiwatanawong, K. (2020). Development of an automatic detection method for dugong feeding sounds in an intertidal seagrass bed. *Journal of Advanced Marine Science and Technology Society*, *26*(1), 1-9. https://doi.org/10.14928/amstec.26.1_1