

First report on the entanglement of Yellow Sea Snake *Hydrophis spiralis* (Shaw, 1802) in plastic debris in the Northwestern Bay of Bengal

Pratyush Das^{1, 2, 3, *}, Pratap Kumar Mohanty², Krishnan Silambarasan^{1, *}, Sujit Kumar Pattnayak¹, Gunamaya Patra³, Digambar Swain³, Annada Bhusan Kar¹, Rebecca Jade Nicholls⁴

Abstract

A common cause of unnatural death in marine organisms is entanglement in derelict fishing gear and other marine debris. Such incidents involving marine birds, mammals, turtles and fish are regularly reported. However, few documented cases of entangled sea snakes (Hydrophiinae) exist. This report details the findings of a dead yellow sea snake (*Hydrophis spiralis*) in the northwestern Bay of Bengal. The sea snake was found with a section of fishing net mesh constricting its neck, causing damage to the underlying tissue and exposing the muscle. The twine was located anterior to the stomach, and necropsy revealed no food in the stomach or intestines. This is the first recorded case of sea snake mortality due to marine debris entanglement or entrapment in Indian waters.

Keywords

Bay of Bengal; India; *Hydrophis spiralis*; Marine plastic debris; Trawling; Entanglement

¹ Fishery Survey of India, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, Visakhapatnam, India

² Department of Marine Sciences, Berhampur University, Odisha, India

³ Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, New Delhi – 110001

⁴ Thomson Environmental Consultants, Compass House, Surrey Research Park, Guildford, GU2 7AG, United Kingdom

*Correspondence: pratyush.das@fsi.gov.in, silambuplankton@hotmail.com (P. Das; K. Silambarasan)

Received: 29 November 2024; revised: 28 April 2025; accepted: 19 May 2025

Globally, the amount of plastics and other anthropogenic debris is increasing rapidly in the world's oceans (Eriksen et al., 2014; Claro et al., 2019). This increase is largely attributed to fishing activities (Ribic et al., 1997; Gregory, 2009; Ryan et al., 2009), river runoffs (Lebreton et al., 2017; Ryan, 2018), and shipping activities (Čulin and Bielić, 2016; Thushari and Senevirathna, 2020). Additionally, many recreational activities, such as tourism, boating, and swimming, generate plastic debris that is either discarded directly into the sea or reaches the sea through waterways (Rees and Pond, 1995; Van Cauwenberghe et al., 2013). From areas of accumulation, anthropogenic debris is transported in large quantities to oceanic waters by convergent currents (Davison and Asch, 2011; Choy and Drazen, 2013; Lusher et al., 2013).

The United Nations Environment Programme (UNEP) and the European Commission have adopted the widely accepted definition of marine debris as “any persistent, manufactured or processed solid material discarded, disposed

or abandoned in the marine and coastal environment” and have labelled the issue as “an escalating environmental problem” (Werner et al., 2016). A major constituent of marine debris is plastic, which is considered hazardous waste and adversely impacts marine organisms worldwide (Rochman et al., 2014). This issue is becoming increasingly alarming and poses a significant threat to the health of marine ecosystems (Derraik, 2002).

The growing use of plastics worldwide due to their advantageous characteristics, such as strength, durability, light weight, portability, and affordability, has led to an increase in their disposal into the environment (Laist, 1987). Consequently, the environmental impacts of plastics, particularly in marine ecosystems, continue to worsen, necessitating urgent global action to mitigate this escalating problem.

The increasing presence of anthropogenic debris in marine environments has resulted in a growing number of documented cases of marine species ingesting or becoming entangled in marine debris. The first comprehensive list of impacted species was compiled by Laist (1997), who reported that a total of 267 species had been affected by

plastic debris. Among these, 135 species, including sea turtles, marine mammals, and seabirds, were found to have become fatally entangled in marine debris. However, it is challenging to determine whether these animals died due to entanglement while the gear was still in use or after it had been discarded. The problem of lost fishing gear, often referred to as “ghost fishing”, appears to be increasing, which coincides with the shift towards more durable, non-biodegradable gear (Carr and Harris, 1997). A review by Kühn and Van Franeker (2020) provides further evidence of this trend, finding that 914 species have been affected by marine debris. Their review only included cases where discarded debris caused harm, excluding incidents involving active fishing gear. Of these 914 species, 354 were affected by entanglement, including marine birds, turtles, fish, invertebrates and even two species of sea snakes – *Hydrophis elegans* and *Hydrophis major*.

In this context, entanglement refers to the snagging, wrapping, or trapping of marine animals’ body parts in abandoned fishing gear, leading to unintended injuries or fatalities (Wallace, 1985). Sea snakes are particularly vulnerable to bycatch in trawl fisheries. As air-breathing, venomous animals, they are at risk of drowning or being killed by the crew when caught as bycatch (Heatwole, 1997; Milton, 2001; Udyawer et al., 2016). These threats collectively emphasise the significant impact that discarded and lost fishing gear has on marine biodiversity. In addition to entanglement and by-catch, marine debris, especially plastics, is a growing threat to sea snakes such as *Hydrophis spiralis*, leading to entrapment, restricted movement and suffocation (Law et al., 2020). Moreover, sea snakes may accidentally ingest plastics while foraging, causing internal damage or blockages (Wilcox et al., 2018). The accumu-

lation of marine debris also affects prey availability, degrades ecosystem health, and increases the vulnerability of sea snakes (Gall and Thompson, 2015). The present study aims to report the first documented case of a dead sea snake found entangled in fishing gear in Indian waters. Further, this study highlights the impact of ghost fishing on marine biodiversity, emphasising the need for sustainable fishing practices, improved management of discarded gear, and increased awareness to mitigate risks to vulnerable marine species.

The sea snake was observed during a routine fishing operation by a 34 m Fish trawl operated by MFV Matsya Shikari owned by the Fishery Survey of India (Ministry of Fisheries, Animal Husbandry and Dairying, Government of India) on 19th November 2020 in the Northwestern Bay of Bengal (Lat. 19°09.2’N/Long. 84°56.1’E, Figure 1). The entangled sea snake was found dead upon collection and was transported to a shore laboratory for further examination.

According to the International Union for Conservation of Nature (IUCN) Red List, *Hydrophis spiralis* is currently classified as Least Concern (LC), based on its wide distribution and the absence of major threats causing significant population decline. However, even species listed as Least Concern may still be impacted by-catch in fisheries, habitat degradation, and marine pollution, including plastic debris and ghost nets (Elfes et al., 2010). Emphasising its conservation status highlights the urgency of addressing the growing threats. The snake exhibited a yellowish dorsal side and whitish underbelly, with black bands encircling the body that fused dorsally and narrowed laterally. It had seven maxillary teeth behind the fangs, a rostral tip that was pointed and protruding downwards, smooth, and overlapping body scales, and two supralabial scales. Based

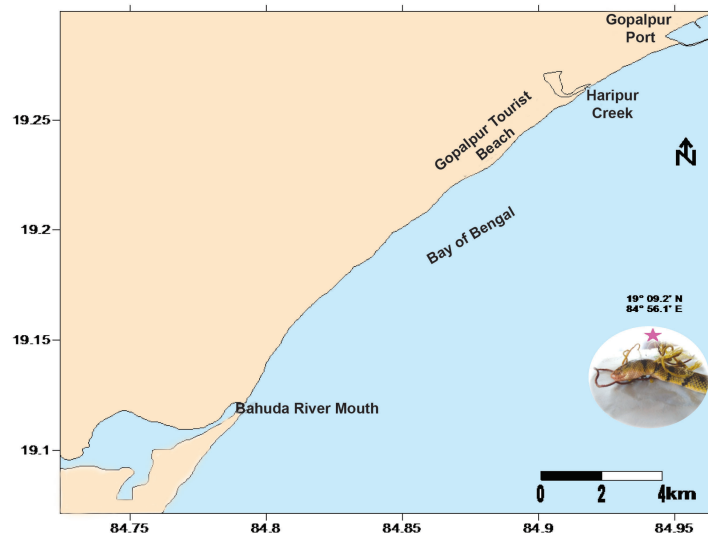


Figure 1. Map of the northwestern Bay of Bengal, India, showing where *Hydrophis spiralis* was found on 19th November 2020 (Lat. 19°09.2’N/ Long. 84°56.1’E).



Figure 2. The entire *Hydrophis spiralis* has entanglement, and the length of the snout-vent is 152 cm.



Figure 3. *Hydrophis spiralis* head with entanglement removed, with a 1.4 cm wooden spike pinned in the wound.

on these characteristics, the individual was identified as *Hydrophis spiralis*, using the identification keys provided by Karthikeyan and Balasubramanian (2007) and Rezaie-Atagholipour et al. (2016).

The specimen was a male, with a snout-vent length of 152 cm and a weight of 850 grams (Figure 2). The snake was entangled in a piece of fishing net, with a 30 cm long and 2 mm thick fishing twine cutting into its skin. During the removal of the fishing twine, it was observed that the internal diameter of the constricting mesh was smaller than the diameter of the snake. This constriction had caused significant skin abrasion, resulting in extensive keratinisation of the epidermis. The affected area consisted of four epidermal layers: a highly keratinised temporary layer, a corneal

layer, an intermediary zone, and a basal layer (Kardong, 2015). The injury had damaged the tissue, exposing the underlying muscle. The fishing twine was positioned anterior to the stomach, and a necropsy revealed that the stomach and intestines were empty, suggesting that the constriction may have impeded food passage. Additionally, a thin wooden spike, measuring 1.4 cm, was found embedded in the muscle at the wound site during the removal of the twine (Figure 3).

Several studies on various aspects of marine sea snakes have been carried out in different regions of Indian waters, including Gujarat (Chandrasekar et al., 2018), Goa (Lobo et al., 2004; Lobo et al., 2005; Padate, 2009), Kerala (Palot and Radhakrishnan, 2010), Odisha (Murthy and

Rao, 1988), and Tamil Nadu (Murthy, 1977; Lobo, 2006; Karthikeyan and Balasubramanian, 2007; Karthikeyan et al., 2008; Muthukumaran et al., 2015). However, this study represents the first record of a sea snake (*Hydrophis spiralis*) entangled in derelict fishing gear in Indian waters. Similar incidents involving terrestrial and semi-aquatic snakes being entangled in mesh netting and other plastic debris have been reported elsewhere (Udyawer et al., 2013).

The origin of the fishing net involved in the entanglement remains unknown. Based on the appearance of the twine and knots (Figure 2), it is likely that the net was indeed a type of fishing net. It is also unclear whether the net was active, passive, or abandoned at the time of entanglement. As evidenced by the lack of deterioration of the sea snake specimen, it is likely that it died not long before being caught in the trawl by MFV *Matsya Shikari*. This suggests that the snake may have died due to either starvation, caused by the constricting net, or drowning in the trawl. *Hydrophis spiralis* is known to inhabit sandy and muddy bottoms in up to depths of 50 metres, and its diet consists of burrowing animals (Sherratt et al., 2018). It is unlikely that a sea snake would become entangled in a piece of net freely floating in the water current. Instead, the snake could have become ensnared during hunting or another instinct-driven manoeuvre, if the net was lying on the seabed or caught amongst rocks. It is possible that in its efforts to escape, the net tightened around the snake's body, leading to the wound observed. Alternatively, the snake could have become entangled in an active trawl or passive gillnet, which later ruptured, leaving behind the smaller piece of net in which the snake was found. Another possibility is that the snake, after becoming caught in a fishing net, was cut free by a fisherman but not entirely released from the section of the mesh in which it was caught.

Although sea snakes are noted as being "gentle, inoffensive creatures reluctant to bite, unless provoked" (Guinea, 1994; Heatwole and Cogger, 1994; Toriba, 1994; Warrell, 1994; Chandrasekar et al., 2018; Fuehrer et al., 2020; Udyawer et al., 2021), when caught in a net, the sea snake is most likely to be trapped in the head region, while trying to escape and needs to be physically removed (Manupriya, 2019). This can result in the sea snakes becoming injured and stressed, and therefore more likely to attack. This means the fishermen are the most at-risk population for sea snake bites when trying to remove them from their nets (Fuehrer et al., 2020; Udyawer et al., 2021). In various locations, fishermen have developed techniques for the safe management of sea snakes, be this to remove the sea snakes from bycatch or when targeting them for their skin, organs and meat (Herre, 1942; Dunson, 1975; Udyawer et al., 2016). In India, marine snakes are conserved under the Schedule IV of Indian Wildlife (Protection) Act, 1972 (Padate et al., 2009; Ganesh et al., 2019) and fisher-

men can learn how to handle sea snakes to remove them safely, cutting the line if required (Reid and Lim, 1957) and throw them back into the sea, although some fishermen will kill the sea snakes to reduce the risk of injury to themselves (Milton, 2001; Udyawer et al., 2016; Ganesh, 2019; Manupriya, 2019). In the case discussed here, there were no injuries, except those caused by the entanglement and subsequent starvation.

Plastic ingestion and entanglement deleteriously affect marine food webs. In particular, when sea snakes and other marine organisms ingest plastic debris, the material accumulates in their tissues. Predators that feed on contaminated prey may subsequently ingest plastics themselves, a phenomenon known as trophic transfer (Farrell and Nelson, 2013). Furthermore, plastics and associated toxins can accumulate and biomagnify across multi-trophic levels, affecting the health, survival and reproductive success of many marine wild species. This hurts marine ecosystems by altering the predator-prey relationships (Wright et al., 2013). Ultimately, such biomagnifying transfer destabilises the food web structure, leading to cascading effects that threaten the overall resilience and productivity of marine environments.

A final factor it is important to consider that if the sea snake had not been caught by the MFV *Matsya Shikari*, its weakened state from exhaustion and lack of food would have made it an easy target for predators. If consumed by a predator, the plastic twine around the snake's neck could have posed a significant threat to the predator, further emphasising the broader impacts of marine debris on the food web and marine ecosystem health.

The present study reports the first documented case of a sea snake (*Hydrophis spiralis*) found dead due to entanglement in derelict fishing gear in Indian waters. The incident highlights the severe threats posed by discarded and lost fishing gear to marine wildlife, including sea snakes, which are particularly vulnerable as bycatch in fisheries. The entanglement not only caused physical injuries to the snake but likely led to starvation and eventually death. This case underscores the urgent need for better management of abandoned fishing gear and the implementation of mitigation measures such as gear markings to identify lost equipment, ghost net retrieval programs, and fishers' awareness training to minimise by-catch and entanglement incidents. Proper training for fishermen on the safe handling and release of bycatch, along with conservation measures to protect sea snakes, which are safeguarded under the Indian wildlife laws, is crucial. Additionally, reducing marine pollution and promoting sustainable fishing practices are essential steps to mitigate the negative impacts of ghost nets and support the conservation of marine biodiversity.

Acknowledgements

The authors express their special thanks and gratitude to Shri Jatindra Nath Swain, Union Secretary, Department of

Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, Dr Ruth Barnich, Thomson Environmental Consultants, United Kingdom, and also to the Director General, Fishery Survey of India, Mumbai for consistent support, advice and encouragement. The authors also express their sincere gratitude to the anonymous reviewers for their constructive comments and valuable suggestions that helped improve the manuscript.

Declaration of interest

None declared.

References

- Carr, A., Harris, J., 1997. *Ghost-fishing gear: have fishing practices during the past few years reduced the impact?* [In:] Coe, J.M., Rogers, A.B. (eds.), *Marine Debris. Sources, Impacts and Solutions*. Springer-Verlag, New York, 141–151.
- Chandrasekar, K., Balakrishnan, S., Arun, G., Satyanarayana, Ch., Venkataraman, K., 2018. *New observation of Intertwined Annulated Sea Snake Hydrophis cyanocinctus (Reptilia: Elaphidae: Hydrophiinae) from Pirotan Island, Gulf of Katchchh*. Indian J. Marine Sci. 47 (12), 2465–2468.
- Choy, C. A., Drazen, J. C., 2013. *Plastic for dinner? Observations of frequent debris ingestion by pelagic predatory fishes from the central North Pacific*. Marine Ecol. Progress Ser. 485, 155–163.
- Claro, F., Fossi, M.C., Ioakeimidis, C., Baini, M., Lusher, A.L., Mcfee, W., Mcintosh, R.R., Pelamatti, T., Sorce, M., Galgani, F., Hardesty, B.D., 2019. *Tools and constrains in monitoring interactions between marine litter and megafauna: insights from case studies around the world*. Marine Pollut. Bull. 141, 147–160.
- Čulin, J., Bielić T., 2016. *Plastic Pollution from Ships*. Pomorskizbornik 51, 57–66.
- Davison, P., Asch, R. G., 2011. *Plastic ingestion by mesopelagic fishes in the North Pacific Subtropical Gyre*. Marine Ecol. Progress Ser. 432, 173–180.
- Derraik, J. G. B., 2002. *The pollution of the marine environment by plastic debris: a review*. Marine Pollut. Bull. 44, 842–852.
- Dunson, W.A., 1975. *Sea snakes of tropical Queensland between 18 and 20 degrees South latitude*. [In:] Dunison W.A. (ed.), *The Biology of Sea Snakes*. Univ. Park Press Baltimore, 151–162.
- Elfes, C., Livingstone, S. R., Lane, A., Guillot, C., Lukoschek, V., Sanders, K., Courtney, A., Gatus, J., Carpenter, K., 2010. *Hydrophis spiralis*. The IUCN Red List of Threatened Species 2010: e.T176738A7297563.
- Eriksen, M., Lebreton, L. C.M., Carson, H. S., Thiel, M., Moore, C. J., Borerro, J. C., Galgani, F., Ryan, P. G., Reisser, J., 2014. *Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea*. PLoS One 1–15. <https://doi.org/10.1371/journal.pone.0111913>
- Farrell, P., Nelson, K., 2013. *Trophic level transfer of microplastic: Mytilus edulis (L.) to Carcinus maenas (L.)*. Environ. Pollut. 177, 1–3. <https://doi.org/10.1016/j.envpol.2013.01.046>
- Fuehrer, J., Kong, E., Murphy-Lavoie H., 2020. *Sea Snake Toxicity*. StatPearls. Treasure Island (FL), StatPearls Publ., <https://www.ncbi.nlm.nih.gov/books/NBK532973/> (Accessed: Jan. 2020)
- Gall, S. C., Thompson, R. C., 2015. *The impact of debris on marine life*. Marine Pollut. Bull. 92(1–2), 170–179.
- Ganesh, S. R., Nandhini, T., Samuel, V. D., Sreeraj, C. R., Abhilash, K. R., Purvaja, R., Ramesh, R., 2019. *Marine snakes of Indian coasts: historical resume, systematic checklist, toxinology, status, and identification key*. J. Threatened Taxa 11(1), 13132–13150. <https://doi.org/10.11609/jott.3981.11.1.13132-13150>
- Gregory, M. R., 2009. *Environmental implications of plastic debris in marine settings-entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions*. Philosoph. Transact. Royal Soc. B, 364, 2013–2025.
- Guinea, M. L., 1994. *Sea snakes of Fiji and Niue*. [In:] P. Gopalakrishnakone (ed.), *Sea snake toxinology*, Singapore Univ. Press, 212–233.
- Heatwole, H., 1997. *Marine snakes: are they a sustainable resource?* Wildlife Soc. Bull., 766–772.
- Heatwole, H., Cogger, H., 1994. *Sea snakes of Australia*. [In:] Gopalakrishnakone, P. (ed.) *Sea snake toxinology*, Singapore Univ. Press, 167–205.
- Herre, A.W.C.T., 1942. *Notes on Philippine Sea snakes*. Copeia, 7–9.
- Kardong, K., 2015. *Vertebrates: Comparative Anatomy, Function, Evolution*, 7th edn.
- Karthikeyan, R., Balasubramanian, T., 2007. *Species diversity of Sea Snake (Hydrophiidae) distributed in the Coramandal Coast (East Coast of India)*. Int. J. Zool. Res. 3(3), 107–131.
- Karthikeyan, R., Vijayalakshmi, S., Balasubramanian, T., 2008. *Feeding and parturition of female annulated sea snake Hydrophis cyanocinctus in captivity*. Current Sci. 94 (5), 660–664.
- Kühn, S., Van Franeker, J.A., 2020. *Quantitative overview of marine debris ingested by marine megafauna*. Marine Pollut. Bull. 151, 110858.
- Laist, D. W., 1987. *Overview of biological effects of lost and discarded plastic debris in the marine environment*. Marine Pollut. Bull. 18, 319–326.
- Laist, D. W., 1997. *Impacts of Marine Debris: Entanglement of Marine Life in Marine Debris Including a Comprehensive List of Species with Entanglement and Ingestion Records*. [In:] Coe, J. M. et al. (eds.), *Marine Debris*, Springer-Verlag, New York, 99–139.

- https://doi.org/10.1007/978-1-4613-8486-1_10
- Law, K. L., Starr, N., Siegler, T. R., Jambeck, J. R., Mallos, N. J., Leonard, G. H., 2020. *The United States' contribution of plastic waste to land and ocean*. Sci. Advances 6(44), eabd0288.
- Lebreton, L.C.M., Vanderzwet, J., Damsteeg, J.W., Slat, B., Andrady, A., Reisser, J., 2017. *River plastic emissions to the world's ocean*. Nat. Communicat. 8, 1–10.
- Lobo, A. S., 2006. *Sea snakes of the Gulf of Mannar Marine National Park. The species and their conservation*. Tech. rep., Rufford Foundation (submitted).
- Lobo, A. S., Vasudevan, K., Pandav, B., 2005. *Trophic ecology of *Lapemiscurtus* (Hydrophiinae) along the western coast of India*. Copeia 2005(3), 637–641.
- Lobo, A., Pandav, B., Vasudevan, K., 2004. *Weight-length relationships in two species of marine snakes along the coast of Goa, Western India*. Hamadryad 29, 89–93.
- Lusher, A. L., Mchugh, M., Thompson, R. C., 2013. *Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel*. Marine Pollut. Bull. 67, 94–99.
- Manupriya, 2019. *Threatened and undocumented sea snakes of India*. <https://india.mongabay.com/2019/03/threatened-and-undocumented-sea-snakes-of-india/>
- Milton, D.A., 2001. *Assessing the susceptibility to fishing of populations of rare trawl bycatch: sea snakes caught by Australia's Northern Prawn Fishery*. Biol. Conserv. 101(3), 281–290.
- Murthy, T. S. N., 1977. *On sea snakes occurring in Madras waters*. J. Marine Biol. Assoc. India 19, 68–72.
- Murthy, T. S. N., Rao, K. R., 1988. *Snake of the Chilka lake, Orissa, India*. The Snake 20, 67–73.
- Muthukumar, M., Rao, A. B. V., Alexander, R., 2015. *Threats of passive fishing activities on sea snakes, *Enhydrinascistosa* (Daudin, 1803) of Pudu cherry coast, India*. Int. J. Pure Appl. Zool. 3 (1), 53–58.
- Padate, V. P., Baragi, L. V., Rionker, C. U. 2009. *Biological aspects of sea snakes caught incidentally by commercial trawlers off Goa, west coast of India*. J. Threatened Taxa 1(12), 609–616.
- Palot, M. J., Radhakrishnan, C. 2010. *First record of Yellow-bellied Sea Snake *Pelamisplaturus* (Linnaeus, 1766) (Reptilia: Hydrophiidae) from a riverine tract in northern Kerala, India*. J. Threatened Taxa 2(9), 1175–1176.
- Rees, G., Pond, K., 1995. *Marine litter monitoring programmes – a review of methods with special reference to national surveys*. Marine Pollut. Bull. 30, 103–108. [https://doi.org/10.1016/0025-326X\(94\)00192-C](https://doi.org/10.1016/0025-326X(94)00192-C)
- Reid, H.A., Lim, K.J., 1957. *Sea-snake Bite*. British Med. J. 2(5056), p. 1266.
- Rezaie-Atagholipour, M., Ghezellou, P., Hesni, M. A., Dakhteh, S.M.H., Ahmadian, H., Vidal, N., 2016. *Sea snakes (Elapidae, Hydrophiinae) in their westernmost extent: an updated and illustrated checklist and key to the species in the Persian Gulf and Gulf of Oman*. Zoo Keys 622, 129–164. <https://doi.org/10.3897/zookeys.622.9939>
- Ribic, C.A., Johnson, S.W., Cole, C.A., 1997. *Distribution, type, accumulation, and source of marine debris in the United States, 1989–1993*. [In:] Coe, J., Rogers, D. (eds.), *Marine Debris: Sources, Impacts, and Solutions*. Springer-Verlag, New York, 35–47.
- Rochman, C. M., Lewison, R. L., Eriksen, M., Allen, H., Cook, A. M., Teh, S. J., 2014. *Polybrominated diphenyl ethers (PBDEs) in fish tissue may be an indicator of plastic contamination in marine habitats*. Sci. Total Environ. 476–477, 622–633.
- Ryan, P.G., 2018. *Entanglement of birds in plastics and other synthetic materials*. Marine Pollut. Bull. 135, 159–164.
- Ryan, P.G., Moore, C.J., Vanfraneker, J.A., Moloney, C.L., 2009. *Monitoring the abundance of plastic debris in the marine environment*. Philosoph. Transac. Royal Soc. B 364, 1999–2012.
- Sherratt, E., Rasmussen, A.R. And Sanders, K.L., 2018. *Trophic specialization drives morphological evolution in sea snakes*. Royal Soc. Open Sci. 5(3), 172141.
- Thushari, G. G. N., Senevirathna, J. D. M., 2020. *Plastic pollution in the marine environment*. Heliyon 6(8), e04709. <https://doi.org/10.1016/j.heliyon.2020.e04709>
- Toriba, M., 1994. *Sea snakes of Japan*. [In:] Gopalakrishnakone, P. (ed.), *Sea snake toxinology*, Singapore Univ. Press, 206–211.
- Udyawer, V., Goiran, C., Shine, R., 2021. *Peaceful coexistence between people and deadly wildlife: Why are recreational users of the ocean so rarely bitten by sea snakes?* People and Nature.
- Udyawer, V., Read, M. A., Hamann, M., Simpfendorfer, C.A., Heupel, M.R., 2013. *First record of sea snake (*Hydrophis elegans*, Hydrophiinae) entrapped in marine debris*. Marine Pollut. Bull. 73(1), 336–8. <https://doi.org/10.1016/j.marpolbul.2013.06.023>
- Udyawer, V., Read, M., Hamann, M., Heupel, M.R., Simpfendorfer, C.A., 2016. *Importance of shallow tidal habitats as refugia from trawl fishing for sea snakes*. J. Herpetology 50(4), 527–533.
- Van Cauwenberghe, L., Vanreusel, A., Mees, J., Janssen, C. R., 2013. *Microplastic pollution in deep-sea sediments*. Environ. Pollut. 182, 495–499. <https://doi.org/10.1016/j.envpol.2013.08.013>
- Wallace, N., 1985. *Debris entanglement in the marine environment: A review*. Proc. Workshop on the Fate and Impact of Marine Debris, 259–277.
- NOAA Technical Memorandum, NMFS, SWFC 54.
- Warrel, D.A., 1994. *Sea snake bites in the Asia-Pacific region*. [In:] Gopalakrishnakone, P. (ed.), *Sea snake toxinology*, Singapore Univ. Press, 1–36.
- Werner, S., Budziak, A., Van Franeker, J.A., Galgani, F., Hanke, G., Maes, T., Matiddi, M., Nilsson, P., Oosterbaan, L., Priestland, E., Thompson, R., 2016. *Harm caused by*

marine litter. MSFD GES TG Marine Litter – Thematic Rep. No. EUR 28317. European Union.

<https://doi.org/10.2788/690366>

Wilcox, C., Van Sebille, E., Hardesty, B. D., 2018. *Marine debris modeling: How the movement of debris connects ocean plastics to ecological impacts*. Front. Ecol. Envi-

ron. 16(3), 145–152.

Wright, S. L., Thompson, R. C., Galloway, T. S., 2013. *The physical impacts of microplastics on marine organisms: a review*. Environ. Pollut. 178, 483–492.

<https://doi.org/10.1016/j.envpol.2013.02.031>