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Ecological Insights and Conservation Perspectives on the Yellow-bellied Sea Snake *Hydrophis platurus* (Linnaeus, 1766) in Indian Waters

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Abstract
Marine snakes represent the unique adapted marine reptiles and form a distinctive component of reef and coastal ecosystems. Historically, the study of this group has been difficult because of the obstacles to collecting, managing, and retaining these creatures for field and lab-based research. The Yellow-bellied Sea snake, also known as Hydrophis platurus, is the most abundant hydrophiid snake on the planet and the only pelagic species. Out of seven, only three colour morphs are found in India. This review assembles all available species information (n=103) through various search engines and databases, ranging from 1936 to 2024. Since Yellow-bellied Sea snakes are frequently found along the coast, tracking their populations using passive telemetry and the mark-recapture approach would aid in assessing habitat utilization, site fidelity, fatalities through ongoing bycatch monitoring, and their ecological significance in aquatic ecosystems. Enhanced understanding of the ecology, population dynamics, diet, venom, bycatch composition, and pharmaceutical use of this species will fill information gaps in India. A thorough review of the Yellow-bellied Sea snake is intended in this paper, with particular attention paid to research gaps in the areas of ecology, behaviour pattern, reproduction, and the main threats posed by habitat degradation, including the destruction of mangrove forest habitat and coral reefs, as well as bycatch in trawls. It also seeks to identify specific areas where further research is needed, such as the impact of climate change on their distribution and abundance. Ultimately, this work aims to highlight the need for conservation efforts to protect this remarkable species and its habitat, emphasizing the importance of integrated approaches that involve local communities and stakeholders in the management and preservation of coastal ecosystems.
Keywords: *Squamata, Ophiology, Hydrophiinae, research gaps, telemetry, Human-snake conflict, bycatch, ecology.*

Introduction

Sea snakes are venomous creatures that have evolved distinctly from terrestrial snakes of the Elapidae family to thrive in marine habitats (Voris 1977; Heatwole 1999; Ineich and Laboute 2002). Further taxonomic classifications divided sea snakes into two subfamilies: oviparous sea kraits (Laticaudinae) and ovo-viviparous 'true sea snakes' (Hydrophinae; Lukoschek et al. 2007). They are primarily found in warm tropical and subtropical coastal seas (Tu 1988; Heatwole 1999; Wallach et al. 2014). Sea snakes occasionally travel into tidal river streams far from the tide line, whereas brackish water snakes can travel into the sea (Rasmussen et al. 2011; Murphy 2012). Sea snakes live in various environments, including mangrove swamps, coral reefs and lagoons, estuaries, and mud flats (Murphy et al. 2012). Water salinity has been shown to significantly impact the global distribution of marine snakes (Gasperetti 1988; Brischoux et al. 2012).

The true sea snakes (Elapidae: Hydrophiinae) are all venomous with front fangs and can be identified by their laterally compressed paddle-like or oar-shaped tail (Heatwole 1999). A total of 26 sea snake species in India are now identified (Vijayaraghavan 2005; Whitaker and Captain 2008; Adimallaiah 2014; Ganesh et al., 2019). True sea snakes (Hydrophiinae) exhibit various unique adaptations as a group of entirely aquatic and stenohaline animals (Brischoux and Shine, 2011). Like all reptiles, these snakes breathe through their mouths and have an extended cylindrical lung on the left side of their body for proper gas exchange. They have nasal valves that regulate the amount of air that enters the lungs, allowing them to stay below for one to two hours during a dive. Sea snakes have sophisticated vision systems and paddle-shaped tails to enable underwater habitat selection, foraging, and mating (Aubert and Shine 2008; Hart et al. 2012).

A recent study on true sea snakes revealed the presence of sensilla, which are unique sensing organs on the scales sensitive to light fluctuations in the surroundings (Zimmermann and Heatwole 1990; Crowe Riddell et al. 2016).

Sea snakes shed their skins more regularly than land snakes, approximately three to four months, primarily to eliminate fouling marine organisms such as algae, barnacles, and bryozoans (Mays and Nickerson 1968; Key et al. 1995). These snakes are caught as the bycatch in trawls, and it is assessed that roughly 50% of mortality is by suffocating or being smashed by the heaviness of the catch in the trawls (Ward 2000); Wassenberg et al. 2001; Milton et al. 2009). Sea snakes are frequently observed as bycatch in gill nets around the Indian coast (Lobo et al. 2005; Hatkar and Chinnasamy 2016; Hatkar and Chinnasamy 2020). Snakes in these waters appeared dangerously close to their top fatal level, implying that behavioural thermoregulation may be required to avoid death due to overheating (Dunson et al. 1971). They have a vital trophic impact on marine ecosystems (Voris 1972; Tu 1988; Brischoux and Lillywhite 2013). Given that these species consume a diverse spectrum of food, they serve as vital bio-indicators for functioning marine ecosystems. Sea snakes are generally exploited for their flesh, skin, and internal organs in various regions and are sometimes transported internationally by Heatwole (1997).

The Yellow-bellied Sea snake, or Pelagic snake, is the world's most abundant hydrophiid snake as well as the only pelagic species (Heatwole 1999; Hernández-Camacho et al. 2005; Brischoux and Lillywhite 2011; Sheehy et al. 2012; Quiñones et al. 2014). In northern Kerala, it is locally known as '*Manjakurishipambu*' (Manjakurishi=yellowish; pambu=snake) owing to its striking yellow and black colour (Palot and Radhakrishnan 2010).

Hydrophis platurus Linnaeus, 1766, earlier known as *Anguis platura*, is an Indo-Pacific elapid sea snake. In the 2017 edition of the IUCN Red List, it is classified as Least Concerned (Guinea et al. 2017). All sea snakes in India are protected under the Wildlife (Protection) Amendment Act 2022.

The species was previously classified in the monotypic genus *Pelamis*, but molecular investigations on its evolutionary links have led to its placement in the larger genus *Hydrophis* (Lu-koschek and Keogh 2006; Sanders et al. 2013). Previously named *Pelamis platura*, a hydrophine phylogeny revealed that *Pelamis* was placed within *Hydrophis*, requiring the transfer of *P. platurus* to *Hydrophis* Sanders et al. (2013). Rezaie-Atagholipour et al. (2016) verified the position within *Hydrophis*. In Bangladesh, this snake species is locally known as 'Rangila Samudric Shap' IUCN Bangladesh (2015). Locally in Malyalam it is called as Manjakkurussi paampu. Recently a new subspecies of sea snake, *Hydrophis platurus xanthos* was reported from Golfo Dulce, Costa Rica (Bessesen and Galbreath, 2017).
This venomous piscivore is usually associated with smooth-water drift lines near the ocean's surface. It opportunistically feeds on a range of small fish from an outstretched floating posture (Kropach, 1975). As a diurnal species, it does not seem to spend much time at the sea surface at night, preferring high ambient light, which might also signify a dependency on visual cues for predation (Rubinoff et al. 1986; Brischoux and Lillywhite 2011). Sea snake venom can cause skeletal muscle damage, leading to neuromuscular paralysis, myoglobinuria, or direct kidney damage Hawgood (1998).

Methodology

To conduct a comprehensive literature review on the yellow-bellied sea snake (*Hydrophis platurus*), we searched electronic databases, including Google Scholar, PubMed, Web of Science, and Scopus, Inaturalist. The search aimed to identify peer-reviewed articles, gray literature, and relevant scientific reports published from 1936 to 2024. Keywords used for the search included combinations of 'Yellow-bellied sea snake,' *Hydrophis platurus*, marine snake ecology, sea snake distribution, habitat, feeding behaviour, and conservation. We conducted searches in English, but also considered papers with English abstracts published in other languages, such as Spanish and French, given the specie's distribution range.

Studies were selected based on relevance to the biology, ecology, behaviour, and conservation of *H. platurus*. The inclusion criteria comprised original field studies, laboratory research, and review papers focused on the species or other marine snakes with relevant ecological information. Studies were excluded if they focused solely on unrelated taxa, did not report original data, or were purely descriptive without analytical depth. Additionally, we incorporated government reports, technical documents, and conference proceedings classified as grey literature, which provided insights into non-published research and field observations.

Data extraction involved recording key information from each selected study, including research objectives, geographic location, sample size, methods employed (e.g., telemetry, visual surveys, or stomach content analysis), and significant findings related to *H. platurus*. Where relevant, data on threats, habitat use, and conservation measures were also noted. Special attention was given to studies that addressed population trends, ecological impacts, and interactions with other marine organisms.

Information was synthesized through qualitative analysis, summarizing major themes such as geographic distribution, environmental preferences, foraging strategies, and known threats. When quantitative data were available, we used basic statistical tools to compare findings across studies (e.g., variation in population density across regions or diet composition). In cases of conflicting findings, we considered the context of each study (e.g., differing methodologies or local environmental conditions) to provide a balanced interpretation. The quality of each study was assessed based on criteria such as the sample size, the robustness of the methodology, and the potential for bias (e.g., publication bias, observer bias). Studies with stronger methodologies and larger sample sizes were given more weight in the review, while those with significant limitations were acknowledged but critically appraised to ensure an accurate representation of the literature.

Non-electronic sources, such as printed field guides, library archives, and interviews with marine biologists specializing in sea snakes, supplemented the non-electronic search. We also considered unpublished data shared by researchers and conservation organizations actively monitoring *H. platurus*. These additional sources provided valuable context and enriched the review with diverse perspectives.

Result

This study examined *Hydrophis platurus* from 103 sources, comprising n = 81 research articles, n = 14 books, n = 2 field guides, n = 1 PhD thesis and n = 3 web sources, n=2. Most of this literature comprises journal articles (42%) and books (19%), field guides (12.9%), web sources 9% and other relevant documents (8%) Figure 5). The analysis found that among the segments of these papers, (30.9%) discussed the distribution and habitat of these species, (10.6%) along the ranging coasts, bycatch and threats, and (9%), discussed the distribution of *H. platurus*. Among the bite casualty snake bites with 9.6%, behavioural pattern with (8.5%), seven per cent of the papers addressed the morphology and reproduction of the *H. platurus*, with food and feeding habits along with venom toxicity, food and feeding habits coming in second with 4.3%. Conversely, the areas that the authors looked into the least were colouration and population ecology researched disease at 2.1%, and predators along with cranial osteology at about 1.1%. The review found very little literature on the population genetic structure, movement ecology, and sexual dimorphism of this species. These studies significantly contribute to our deep knowledge about the species *H. platurus* (Figure 5).

The Yellow-bellied Sea snake (*H. platurus*) has seen a fluctuating trend in research publications, with the earliest studies appearing from 1936 to 1945. Indian contributions began in 1966-1975 but remained minimal. From 1976 to 1985, there was a peak in global publications, followed by sporadic studies from 1986 to 2005. From 2006 to 2015, Indian research increased, aligning with global efforts on marine snake ecology, conservation, and climate change impacts (Figure 4).

Geographical distribution and habitat

The Yellow-bellied Sea snake is classified as a 'passive surface drifter' and is found in the tropical regions of the Pacific and Indian Oceans between 18 and 20°C (Dunson and Ehlert 1971; Graham et al. 1971). It extends from the eastern African coastlines north to the Arabian Gulf, east through the Indian Ocean's Asian coast to the Pacific Ocean, and north to Japan, Bangladesh, as well as the eastern and western borders of Central America, the Galapagos Islands, Australia, and Vietnam (Reynolds et al. 1984; Heatwole 1999; Kharin 2006; Rasmussen et al. 2014; Sarker et al. 2017; De-Weerdt et al. 2021). Its reliance on freshwater to prevent water deficits during the dry season may explain its coastal distribution in Costa Rica. However, this remains debatable (Lillywhite et al. 2014) but later was confirmed by Bessesen et al. (2017).

Indian coast distribution

The Yellow-bellied Sea snake is found throughout coastal India and one of the Union territories except Lakshadweep (Table 1). These snakes are reported from Kerala, Goa, Odisha, Tamil Nadu, Gujarat, Andhra Pradesh, Maharashtra, and the Andaman Islands only (Ahamed1975, Murthy 1977; Kalairasan and Kanakasabai 1994; Lobo 2003; Lobo 2006; Tripathy 2006; Whitaker and Captain 2008; Palot and Radhakrishnan 2010; Palot 2015; Dabhi et al., 2019; Venkatraman et al. 2015; Patel and Vyas 2019; Waradkar per comm 2023; Patel et al. 2024).In India, sea snakes have been reported from Gujarat near Momai Temple on the Devbhoomi Dwarka coast (Maksud Chattra pers. Comm. 2022) and Magdalla Village, Surat District, in southern Gujarat Parmar (2018). In Kerala, the tidal waters of the Kallayi river in the Kozhikode district and the Kuppam river in the Kannur district Palot and Radhakrishnan (2010). This species has been spotted off the coast of Rangat, on Ross Island in the south Andamans, and on the southeast corner of Barren Island Kannanand Rajagopalan (2008). This snake species is found 100 meters into the deep sea, so it is rare to cite and study Jonnalagadda et al. (2018). It is relatively common throughout its range Sharma (2003).

Morphology

The body is small, robust, and firmly compressed laterally, covered with hexagonal or quadrangular scales, with minute tubercles in the lower rows in males (Murthy 2007). The thickest section of the body is the scale rows, ventrals divided mainly by a median longitudinal fissure or broken up and unclear; preanal somewhat expanded Murthy (2007). Males could weigh 114 grams, while females could weigh 154 gms Buzás et al. (2018). Eyesight is mediocre Murthy (2007). Yellow-bellied sea snakes, like many snakes, are sexually dimorphic in size, whereas females are slightly larger on average, and individuals can grow to a total length of at least 53.5 to 102 cm; tail length varies from 9.5 to12 cm Damotharan et al. (2010). The maximum length attained was 98 cm (Murthy 2007). The individual spotted in Kerala in the waters of the Kallayi river in Kozhikode district had a maximum length of 98 cm, and the other one found in the Kuppam river in Kannur district was only 29 cm Palot and Radhakrishnan (2010). According to Jonnalagadda et al. (2018), the heart of the Yellow-bellied sea serpent is situated in the pericardial sac between the 28^{th} and 35^{th} ribs in an oblique orientation. At birth, the minimum snout-vent length measures approximately 22 cm, and sexual maturity is attained at 62.5 cm and 50 cm for females and males, respectively (Marsh et al. 1993). *Hydrophis platurus xanthos*, is diagnosed by a notably smaller body size (Bessesen and Galbreath, 2017).

Cranial osteology

As per museum specimens *H. platurus*, the premaxilla is a single median bone, wider than its length, with a postero-dorsal process extending dorsally to connect with the nasal (Mondal et al. 2023). The septomaxilla forms the floor of the internal nares, with a short rectangular edge. The nasals, forming a pear-shaped structure, are longer and the suture between them is less distinct (Mondal et al. 2023). The frontal bones are longer and wider, with a narrower anterior end than the middle and posterior regions (Mondal et al. 2023). The prefrontal lacks a middle constriction and features a wider postero-lateral process (Mondal et al. 2023). The parietal, forming most of the braincase, is longer and wider at the postorbital process, but the middle section remains narrow (Mondal et al.

2023). The maxilla is longer than the skull and contains five to six maxillary teeth (Mondal et al. 2023). The pterygoid, though shorter than in other species, holds 23 teeth, with a PTTL ratio of 83.5% (Mondal et al. 2023). The palatine bone has five-seven teeth, while the ectopterygoid connects to the pterygoid at the 12th tooth. The quadrate bone has a consistent width along its length (Mondal et al. 2023). The basisphenoid is a flat hexagonal plate with a feeble medial keel (Mondal et al. 2023). The mandible is 1.3 times the skull length, with a compound bone at the maxilla's anterior-most end, upwardly directed at the juncture to the dentine, and the postero-lateral end of the dentine is longer and slanting (Mondal et al. 2023). The dentary bone ratio to mandibular length is 0.51, with 15-17 rows of teeth (Mondal et al. 2023). The retroarticular process is longer, and the skull height and width are relatively smaller than other species (Mondal et al. 2023).

Colouration

The pelagic sea snake has up to seven colour variants, the most prevalent being black above with yellow or brown beneath, with a distinct yellow line dividing the two hues (Murthy 2007). Three colour forms are found across the Indian coastline (Daniel 2002). The head is black, with a yellow upper lip, and the body is black above and brown below, with a yellow stripe or black ventral stripe, wavy or broken into spots (Daniel 2002). The other subspecies of yellow sea snake, *Hydrophis platurus xanthos* has nearly uniform yellow colouration, contrasting with the black and yellow stripe and tail spots or bands typical of the species (Bessesen and Galbreath, 2017).

Scalation

The Yellow-bellied Sea snake's head is long, narrow, and distinct from its rather slender neck; nostrils superior, nasals in contact with one another; two (occasionally three) anterior temporals and two - four posterior temporals; one or two pre- and two or three post-oculars; six-eight supralabials, fourth and fifth below the eye, usually separated from it by suboculars; and nine to thirteen lower labials (Murthy 2007). Yellow-bellied sea snake scales are made up of non-overlapping polygonal knobs featuring flattened outer surfaces and presumed filamentous sensillae (Lillywhite and Menon 2019). This characteristic may keep the skin moist when the dorsal body protrudes above water while foraging on calm marine slicks (Lillywhite and Menon 2019).

Population ecology

Over a year, Kropach (1975) identified 961 specimens of this species in the Bay of Panama, Eastern Tropical Pacific. During the period, none were recaptured. One was recovered in the Bay of Panama about a year later, while three were retrieved off the coast of Mexico. Although no report on population counts about the species exists, it is considered stable. Due to its pelagic habits, the Yellow-bellied sea snake is a widespread species rarely encountered as a bycatch. It isn't easy to distinguish from other species due to its distinct habits and appearance Marsh et al. (1993). In this study, accessible genetic markers from multiple species of sea snakes of the genus *Hydrophis* from the waters of the Gulf of Oman and the Persian Gulf were compared to populations from other locations of the Indian Ocean; they were comparable to conspecific populations from India and Australia (Yousefkhani et al. 2023).

Food and feeding habits

They are an essential component of the marine environment because they have a significant role in the food chain, feeding primarily on fishes such as Yellowfin surgeonfish (*Acanthurus xanthopterus*), Blackback silverside (*Melanorhinus cyanellus*), *Hypsoblennius* sp., three-banded butterflyfish (*Chaetodon humeralis*), *Kyphosus* sp., *Lutjanus* sp. and cephalopods that seek refuge beneath the stationary snake that resembles drifting wood (Brischoux and Lillywhite, 2013). This serpent hunts by approaching its target stealthily or remaining immobile at the water's surface and attacking fish that come to cover beneath it (Cogger 2000). It can ambush tiny fish behind its head by swimming in the backward direction and making a quick sideways swipe to capture any fish that gets too nearby (Cogger 2000). They swallow the fish from head to tail Daniel (2002). As a result, they only forage to a depth of roughly two meters (Kropach 1975).

Behavioural pattern

Yellow-bellied sea snake's lower and upper thermal tolerances are 11.7°C to 36°C, respectively (Graham 1971). They cease feeding around 16°C - 18°C when rapidly cooled, yet it has a robust solid tolerance to cold temperatures and can endure −5°C for an hour (Graham 1971). Yellow-bellied sea snakes do not acclimate to 17°C after ten days of exposure and cannot survive in the water this cold for extended periods (Graham 1971). These snakes spend a lot of time at the surface, and their black backs are not permanently entirely submerged; this may be a benefit for basking at cooler water temperatures, but when the temperature of the water is near 31°C, the heat gain from solar radiation may be enough to kill them (Dunson and Ehlert 1971). Activity such as the sea slicks are knotting, and feeding is common in this snake (Daniel 2002). Other activities like mating have not been observed to benefit from large aggregations (Kropach 1975).

Dunson and Robinson (1976) reported that Yellow-bellied Sea snakes are dehydrated in seawater (0.4% body mass per day) based on laboratory studies of water and sodium fluxes in this species. They confirmed fresh water consumption when supplied to dehydrated snakes (Dunson and Robinson, 1976).

Yellow-bellied sea snakes used knotting most commonly after shedding. While the new skin was still relatively elastic, the snakes, particularly juvenile sub-adult individuals, underwent convulsions, twisting, and knot-tying movements (Pickwell, 1971). One sequence commonly followed another for many minutes at a time; the habit continued for a minimum of two to three days with declining frequency. Adults who recently shed were less likely to engage in this action (Pickwell 1971). Generally, it floats near the surface among the flotsam and floating seaweed in tropical or subtropical regions of the Pacific and northern Indian Oceans Damotharan et al. 2010. When restricted, it is pretty inoffensive (Damotharan et al. 2010). Bessesen and González, 2022 stated distinct crepuscular peaks with consistent surfacing throughout the night, with feeding being more prevalent at night. Surface behaviours fluctuate over the photoperiodic cycle.

Adaptations

Sanders et al. (2012) state that among *H. platurus's* adaptations to aquatic life are a smaller ventral scale, a laterally flattened body, a paddle tail that facilitates swimming, valved nostrils, a palatine seal that keeps out saltwater, and cutaneous gas exchange that prolongs dive times. This species' skin may absorb up to 33 percent of the oxygen it consumes while diving and swimming on the surface (Graham 1974). Furthermore, it was previously believed that sea snakes' distinctive salt duct in their lower jaw drew salts out of the nearby seas (Dunson and Ehlert 1971). The Yellow-bellied Sea snake's heart was three-chambered, with the atria separated and the ventricular space partially divided (Jonnalagadda et al. 2018).

Reproduction

Little information is available on this snake's reproductive biology, with estimates of its gestation duration ranging from 4.5 to eight months (Kropach 1973). Brood size varies between two to eight eggs (Pickwell et al. 1980). Cogger, 1959 discovered beached specimens in Australia with completely developed foetuses in June and July and deduced that neonates are born in the middle of winter. In Panama, however, young ones in the population and gravid females bearing differently developing foetuses have been found all year in Mexico, and South Africa, implying that parturition is not restricted to a single season (Kropach 1973; Kropach 1975). Pickwell (1971) proposed that *H. platurus* had a peak time of birth in Mexico throughout late fall and early winter. Females give birth to live young in tidal pools, according to Ditmars (1936).

Threats

Death from entanglement in fishing nets when captured as bycatch by trawlers is the main or direct threat to the continued existence of marine snakes in India, in fact, the fishermen murder those that survive (Ganesh et al. 2019). In 2015, there was a mass death of sea snakes in the Gulf of Oman due to an oil spill. In 19 Yellow- bellied sea snakes, oil was found on 93.3% of the eyes and snouts, 15.4% of the respiratory tracts, 38.5% of the mouth, 33.3% of the oesophagus, and 16.7% of the stomachs (Yaghmour et al. 2022). The degradation of mangrove forest habitats and the deterioration of adjacent ecosystems, such as coral reefs, pose an indirect hazard Ganesh et al. 2019.

Predators

Most native marine predators, including predatory fish and sharks, avoid this serpent as its bright colouration indicates that it is intensely venomous and possibly toxic to consume (Cogger 2000). *Pelamis* portions were given to predatory marine fish, who declined to consume them, and those who were deceived into consuming the flesh regurgitated it shortly after. Both predators (a leopard seal and a pufferfish) regurgitated the serpent soon after eating. Several aquatic invertebrates, such as a barnacle that only develops on sea snakes, suffocate yellow-bellied sea snakes (Cogger 2000). If the infection is severe, the drag it causes can impair the snake's effectiveness. The serpent can eliminate these creatures by knotting and shedding its skin. Nematodes (roundworms) and cestodes (tapeworms are instances of endoparasites (Cogger 2000).

Bycatch

This species is rarely caught as bycatch. The species was trapped on a fishing net and died near Kundli, Gujarat Patel et al. (2022). Bycatch has been reported from Marve beach in Maharashtra, Tamil Nadu, and Andhra Pradesh (Damotharan et al.2010; Jonnalagadda et al. 2018; Waradkar Siddharth. Pers. Comm. 2023). Two specimens were collected during bycatch studies in Bangladesh (Sarkar et al. 2017). One specimen was caught during trawling from the Chennai coast in January from 2009 to 2013 Venkatraman et al. (2015). Only eight specimens were captured in Thailand from 1967 to 1972 Anthony (1974).

Disease

A female Yellow-bellied Sea snake that was discovered on the beach and kept in the Waikiki Aquarium was determined to have fungal dermatoses, despite the fact that the condition in sea snakes is frequently undetectable (Reavill et al. 2004). Epibionts such as shrimps and crabs are found to be associated with this species in Costa Rica (Pfaller et al. 2012).

Venom toxicity

Based on a study conducted in Central America, Lomonte et al. (2014) documented the envenomation and management of Yellow-bellied Sea snake bites. Even though the Yellow-bellied Sea snake is a common species with fatal venom, a complete analysis of its ingredients is still lacking, possibly due to its poor medical significance (Wang et al. 1976). Individuals of this species are potentially lethal, with a subcutaneous LD50 of 0.067mg/kg and a yield per bite of 1.0-4.0 mg (Jonnalagadda et al. 2018). There have been no reported deaths from attacks in Australian waters (Williams et al. 2007).

Bite casualty

Human envenomation by the Yellow-bellied Sea snake is few. It has been proposed that H. platurus poses little threat to most humans due to its small mouth and low venom yield, despite Kinghom (1956) stating that death had been recorded in India and Taylor (1953) referring to a seventeenth-century report implying the bite was extremely toxic (Ernst 1992). Kropach (1972) recorded six undetectable Yellow-bellied Sea snake bites in the Caribbean Sea. Senanayake et al. (2005) reported a snake bite incident from Sri Lanka to a seven-year-old child caused by a Yellow-bellied Sea snake. Other than a three-centimeter straight scratch trail, no localized or systemic consequences were noted throughout the one-and-a-half-day hospitalization. A bite casualty case from *H. platurus* to adult fishermen in Sri Lanka was reported (Karunaratne and Panabokke 1972). The patient later experienced intense pain, hyperkalemia, and renal failure, these symptoms persisted for 24 days before the patient passed away. An individual got bit by an *H. platurus* on 22 January 1993 near Costa Rica (Solórzano 1995). The snake's right fang pierced the dorsal surface of the left hand, near and slightly anterior to the proximal portion of the first metacarpal (Solórzano 1995). Lamar quickly applied oral suction to the wound and proceeded sporadically for 15 minutes. The bite site became mildly oedematous and discoloured, and one centimetre around the site stayed highly sensitive to touch for 36 hours (Solórzano 1995). The bite site experienced pressure-induced discomfort until a few days, and the wound recovered quickly and without medical attention (Solórzano 1995).

Conclusion

Sea snakes act as ecosystem intermediaries, predators, and prey to various, predators, and marine fauna. Hence, studying and maintaining sea snakes is a vital means of monitoring the health of coastal ecosystems. There are few viable conservation techniques for sea snakes in India. Yet, stringent compliance with Indian fishery regulations in several coastal states may assist in mitigating some of the threats to sea snakes. Improved understanding of the ecology, population dynamics, diet, venom and bycatch composition, and therapeutic use, threat, and reproduction of this species will fill information gaps currently in India. The primary goals of any future work would be to undertake comparative studies on sea snake ecology and long-term monitoring and identify existing conservation issues in various states. Monitoring Yellow-bellied Sea snake populations with the mark-recapture approach and GPS loggers would help test for habitat utilization and site fidelity, conservation status (mortality assessment) and understanding their ecological significance in marine ecosystems. Initiating a long-term bycatch monitoring effort to collect baseline data on sea snake species abundance is recommended. The most crucial part of conservation efforts is the analysis of high biodiversity areas and the distribution of threatened species.

Figure 1. A Yellow-bellied Sea snake at Costa Rica (Photo credits: Flaxington)

Figure 2. A Yellow-bellied Sea snake collected in the Gulf of Oman off Fujairah

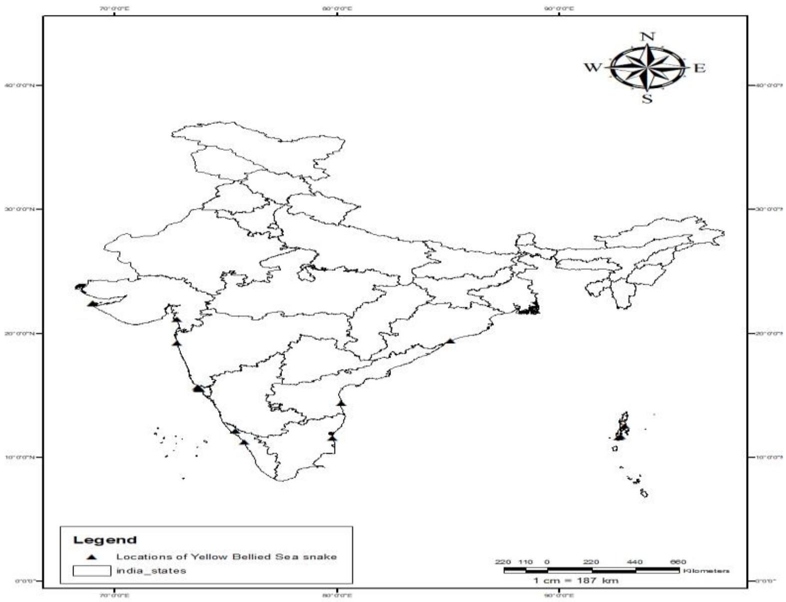

Figure 2. Map of Distribution records of Yellow-bellied Sea snake in Indi

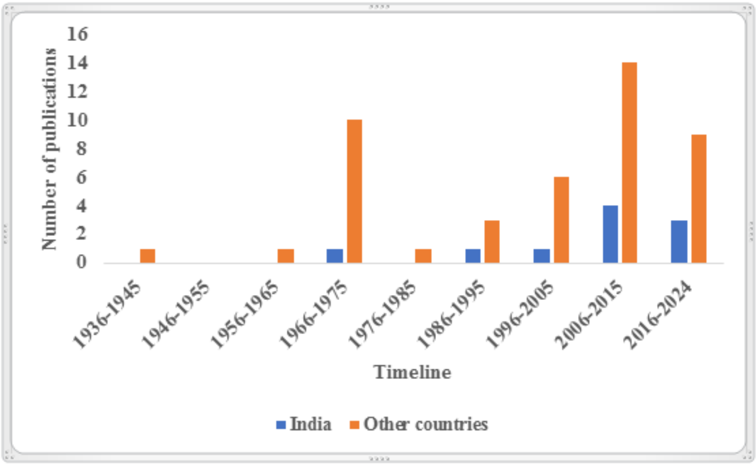

Figure 3. Literature published with mentions of *Hydrophis platurus* (Linnaeus, 1766)

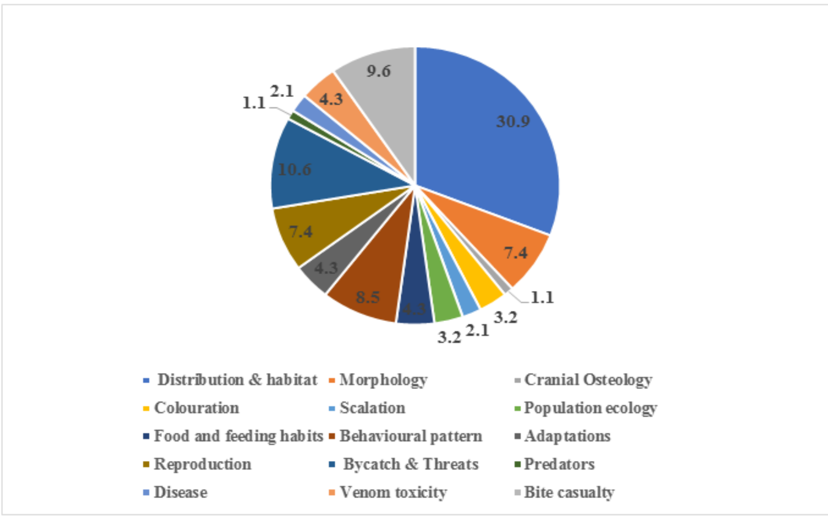

Figure 4. Proportions of different areas of study from past research papers on *Hydrophis* platurus (Linnaeus, 1766)

Table 1: Details of the geographic distribution of Yellow-Bellied Sea Snake *Hydrophis platurus* from the Indian coastline

SN	Species	Latitude	Longitude	Status of Individual	State	References
1	*Hydrophis platurus*	18.9547913	72.809547	In-situ sighting; live	Maharashtra	Pradip Padate pers comm.
2	*Hydrophis platurus*	19.19755	72.79670	Dead specimen	Maharashtra	Waradkar Siddharth pers. Comm. 2023
3	*Hydrophis platurus*	14.34130	80.16436	ZSI Specimen; dead; specimen source undocumented	Andhra Pradesh	Jonnalagadda et al. (2018)
4	*Hydrophis platurus*	21.14161	72.75822	ZSI Specimen; dead; specimen source undocumented	Gujarat	Parmar (2018)
5	*Hydrophis platurus*	11.23361	75.79180	In-situ sighting; live	Kerala	Palot et al. (2010)
6	*Hydrophis platurus*	12.09994	75.41930	Entangled in Fishing Nets and Found Alive	Kerala	Palot et al. (2010).
7	*Hydrophis platurus*	12.50705	92.92125	Not mentioned	Andaman Island	Kannan and Rajagopalan (2008).
8	*Hydrophis platurus*	11.56930	92.65994	Not mentioned	Andaman Island	Kannan and Rajagopalan (2008).
9	*Hydrophis platurus*	11.67580	92.76241	Not mentioned	Andaman Island	Kannan and Rajagopalan (2008).
10	*Hydrophis platurus*	22.42295	68.99435	Live	Gujarat	Motawal M. pers. Comm. Wildlife Trust of India
11	*Hydrophis platurus*	20.570449	72.89534	In situ sighting; Dead	Gujarat	Patel, et al., 2024
12	*Hydrophis platurus*	22.39800	68.98866	Live	Gujarat	Maksud Chattra pers. Comm. 2022
13	*Hydrophis platurus*	22.43025	68.99859	Live	Gujarat	Hamid Kadar pers. Comm. 2022
14	*Hydrophis platurus*	11.51832	79.77139	Not mentioned	Tamil Nadu	Damotharan et al. (2010)
15	*Hydrophis platurus*	15.51795	73.76262	Dead	Goa	Lobo (2003)
16	*Hydrophis platurus*	19.39530	85.08939	Not mentioned (just mentioned washed ashore)	Odisha	Tripathy (2006)
17	*Hydrophis platurus*	15.48264	73.80734	Dead	Goa	Lobo (2003)
18	*Hydrophis platurus*	15.55547	73.75138	Dead	Goa	Lobo (2003)
19	*Hydrophis platurus*	15.62709	73.72774	Dead	Goa	Lobo (2003)

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Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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