REPORT ON

ENHANCING SEA TURTLE NESTING SURVIVAL

DATABASE STUDY ON THE EFFECTIVENESS OF EX-SITU CONSERVATION

IN THE COLOMBO DISTRICT OF SRI LANKA

By The Pearl Protectors

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THE PEARL PROTECTORS

The Pearl Protectors is a volunteer-based and non-profit marine conservation organization in Sri Lanka. Established in 2018, The Pearl Protectors seek to mitigate the impacts of anthropogenic activities on the marine environment, reduce plastic pollution and promote sustainable practices through youth engagement, volunteerism, awareness and advocacy.

Projects undertaken by The Pearl Protectors over the years entail launching of the 'Pearl Protector Approved' Accredited Standardization Certificate to promote a plastic-free dining culture; the annual construction of a Christmas tree out of discarded plastic bottles to highlight single-use plastic pollution; school education programs; eco-brick workshops; coastal cleanups including the Nurdle Free Lanka Initiative; Cleaner Seabed's for Sri Lanka Underwater cleaning expedition; World Oceans Day through Art competition; and social media campaigns to inspire action towards protecting the marine environment.

The purpose of this report is to highlight the impact through the conservation efforts undertaken during the sea turtle nesting season of 2024 by the volunteers of The Pearl Protectors through patrolling the shorelines of Colombo district. The report also analyzes the nesting data collected to determine effective practices of conservation and way forward.

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Summary

The 2024 Turtle Patrol initiative by The Pearl Protectors aimed to safeguard sea turtles across Dehiwala, Mount Lavinia, and Wellawatte beaches. Volunteers patrolled nightly for 79 days, identifying nesting sites, deterring poaching, and relocating eggs with support from the Sri Lanka Coast Guard. Objectives included conserving 18,000 turtle eggs and raising awareness about sea turtle conservation. Volunteers, organized into 27 teams, underwent comprehensive training and documented their findings using standardized google forms. Additionally, awareness programs were conducted for coastal communities, fishermen, and residents of fishing villages. This initiative exemplified a collaborative effort to safeguard sea turtles and their nesting sites, emphasizing the critical role of volunteer patrolling, data gathering, and community engagement in sea turtle conservation efforts.

Introduction

Sea turtles, among the world's most iconic and endangered species, face numerous threats to their survival. Only about one in 1,000 turtles survive to reach maturity, with hatchlings vulnerable to a multitude of threats. Dehydration poses a significant risk as hatchlings must navigate from their nest to the ocean, with any delay increasing their susceptibility to desiccation. Moreover, predators such as birds, crabs, and other animals await to further diminish their chances of survival (Bennett , 2018) . In addition to these natural threats, sea turtles also face human-induced dangers, including poachers who target them for their eggs, shells, and hunting for turtle meat further exacerbating population decline.

In the coastal regions of Sri Lanka, where five out of seven marine turtle species thrive including the Olive Ridley Turtle (*Lepidochelys olivacea*), Leatherback Turtle (*Dermochelys coriacea*), Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*), and the Loggerhead Turtle (*Caretta caretta*) conservation efforts are imperative (Rajakaruna et al., 2009). Recognizing the urgency of protecting these species, The Pearl Protectors initiative organized volunteer patrols and implemented artificial nesting strategies in three key locations in Sri Lanka - Dehiwala North, Dehiwala South, Mount Lavinia and initially Wellawatte, during the sea turtle nesting season of 2024.

Relocating turtle eggs to artificial nests presents a promising strategy to enhance hatching success and mitigate natural threats such as predation and environmental fluctuations as well as human-induced threats. However, the efficacy of this method remains to be thoroughly evaluated in the context of Sri Lanka's unique coastal ecosystems. Additionally, the impacts of urbanization, weather patterns, lunar phases, and tidal cycles on nesting behaviors and survival rates necessitate detailed investigation.

This report aims to analyze the common nesting locations within the three key locations and the influence of environmental factors such as lunar phases, and tidal cycle on nesting success.

Through comprehensive data analysis and evaluation, this report aims to provide insights into the effectiveness of volunteer-led patrolling. By understanding the complex interplay between

environmental factors and conservation efforts, the study aims to inform evidence-based strategies for the protection of sea turtles in Sri Lanka and beyond.

Methodology

Duration and Frequency of Patrolling:

The sea turtle patrolling was conducted over a span of 79 days, commencing from January 8th and concluding on March 31st, 2024. Patrols were scheduled daily, with exceptions made for adverse weather conditions, such as heavy rainfall, which rendered patrolling impractical. Throughout the duration, a total of 130 volunteers actively participated in the patrolling efforts.

Volunteer Allocation and Training:

The volunteers were organized into 27 groups, with each group assigned to cover one of the three key locations: Dehiwala North, Dehiwala South, Mount Lavinia as well as Wellawatte, during the sea turtle nesting season of 2024. However, after one month of patrolling in Wellawatte, it was observed that there were fewer risks, less nesting activity, and fewer turtles compared to the other three locations. Consequently, the patrolling efforts in Wellawatte were discontinued, and all volunteers allocated to that area were reallocated to the other three key locations where there was higher nesting activity and a greater need for volunteers. To ensure efficiency effectiveness and safety each area was allocated with a minimum of four patrollers, overseen by designated group leaders. Prior to the commencement of the patrolling season, all volunteers underwent a comprehensive training, comprising three compulsory sessions. These sessions included completion of an online classroom module on Turtle Patrolling, participation in online meetings for discussion and training on the fundamental aspects of turtle patrolling and a practical training session conducted in-field (fig.11). Additionally, volunteers were integrated into a dedicated WhatsApp group to facilitate effective communication.

Awareness programs were also conducted to educate the communities living near the sea, including fishermen and those residing in fishing villages (fig.12). These programs aimed to raise awareness about the importance of sea turtle conservation, the threats faced by sea turtles, and the role of local communities in protecting these endangered species and their habitats.

Patrolling Procedure:

Patrols were initiated at 9:30 PM and extended until approximately 2 AM, although some patrols extended beyond this timeframe. Patrollers walked along the coastline, searching for signs of nesting activity, hatchlings, turtle tracks, and the presence of turtles themselves. Upon encountering nests, hatchlings, or turtles, precise locations were documented using Google Maps and shared on the dedicated WhatsApp group for documentation purposes.

Nest Extraction and Artificial Renesting:

In instances where nests were discovered, they were carefully extracted from their original locations and relocated to the nearest coast guard point within the designated areas. These relocated nests are placed within a net-fenced and separated turtle conservation area to protect the eggs and hatchlings from animals and other dangers (fig. 13). Each nest within this conservation area is marked with a board indicating the date of nesting, the number of eggs in the nest, the expected date of hatch, and the turtle species (fig.14). This process of artificial renesting was carried out with utmost care to ensure the safety and viability of the eggs (fig.15). Conversely, hatchlings found during patrols were collected and released into the ocean. When a nest or hatchlings are observed, the coast guard is immediately notified via phone call to come collect the nest. Until the coast guard arrives, the patrollers diligently protect the nest from poachers and any other potential threats, ensuring the safety of the eggs and hatchlings.

It's important to note that the assistance of coastguards during this process was crucial due to legal regulations in Sri Lanka. According to the Fauna and Flora Protection Ordinance (FFPO, 1938 amended in 1972), it is strictly prohibited for civilians to capture, kill, injure, or possess sea turtles or their eggs. Therefore, as patrollers were civilian volunteers, they did not have the authority to handle eggs, hatchlings, or turtles.

Data Collection and Documentation:

At the conclusion of each patrol, detailed records of the day's activities were recorded by each group using a standardized Google Form. These logs encompassed essential information such as the date and day of patrol, patrol location, team members, number of patrol rounds conducted,

types of situations encountered (e.g. turtle sightings, nesting activity, hatchling discoveries), as well as any observations or concerns documented during the patrol.

Results

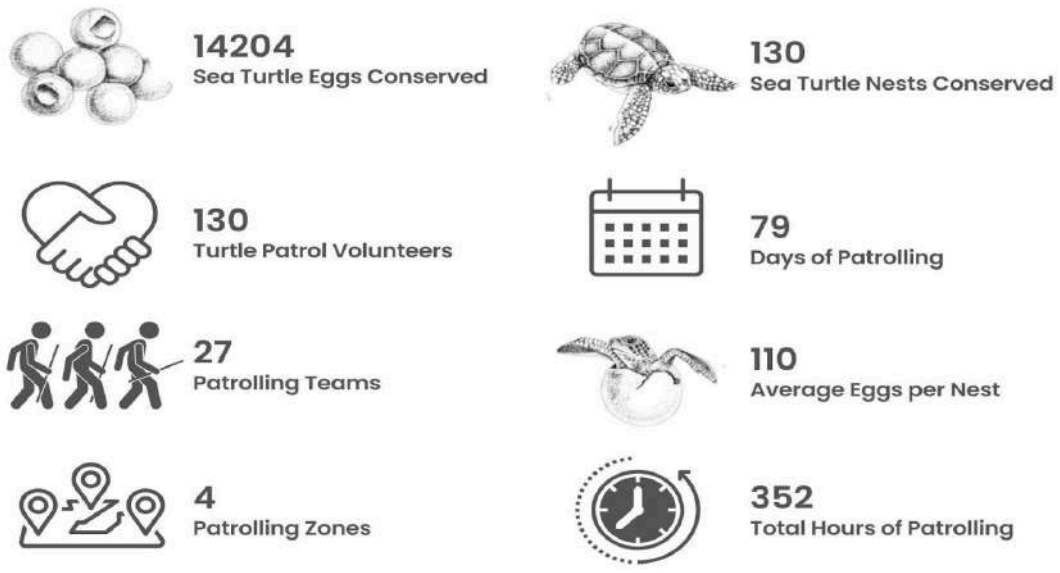

Figure 1: Impact of the 2024 turtle patrol efforts, nesting statistics and conservation outcomes

Lunar Phases and Nesting

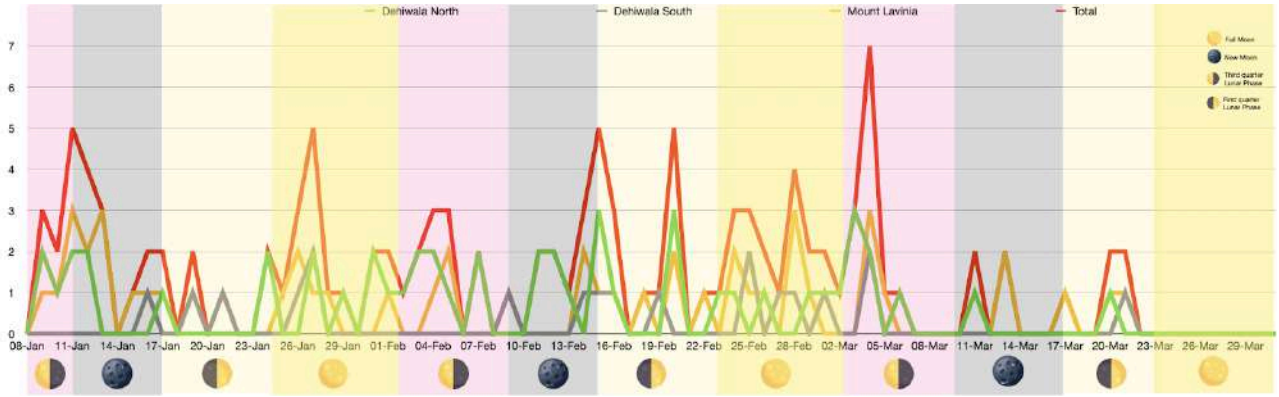

Figure 2: The distribution of Turtle nests across various lunar phases throughout the entire turtle patrolling period.

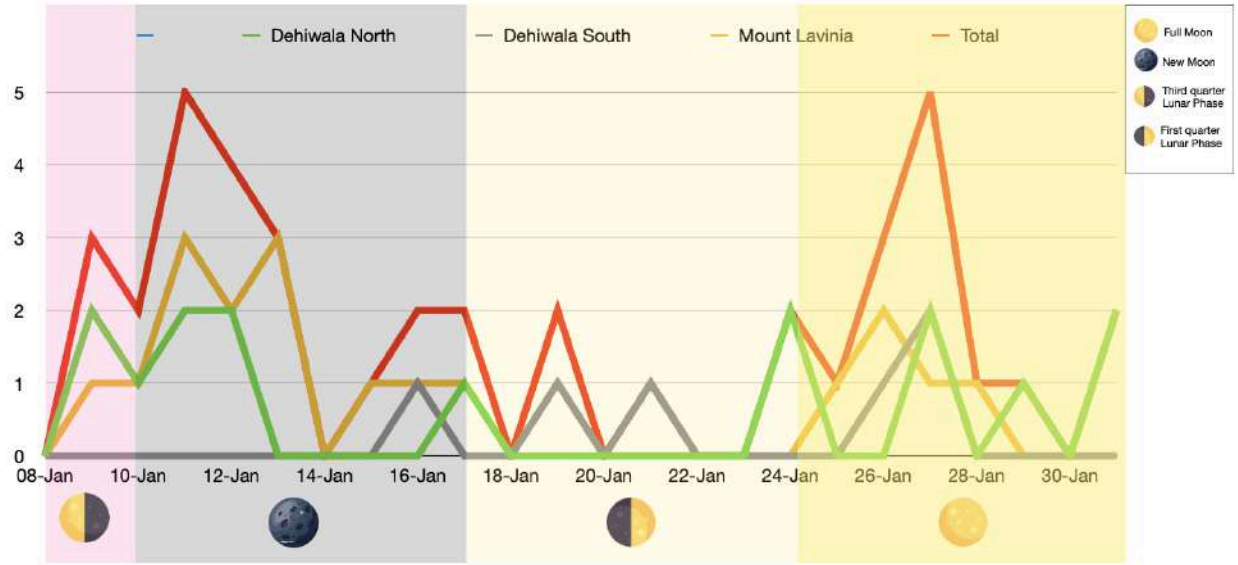

Figure 3: The distribution of Turtle nests across various lunar phases throughout the month of January. Higher numbers of Nests were found in Full moon and New moon lunar phases.

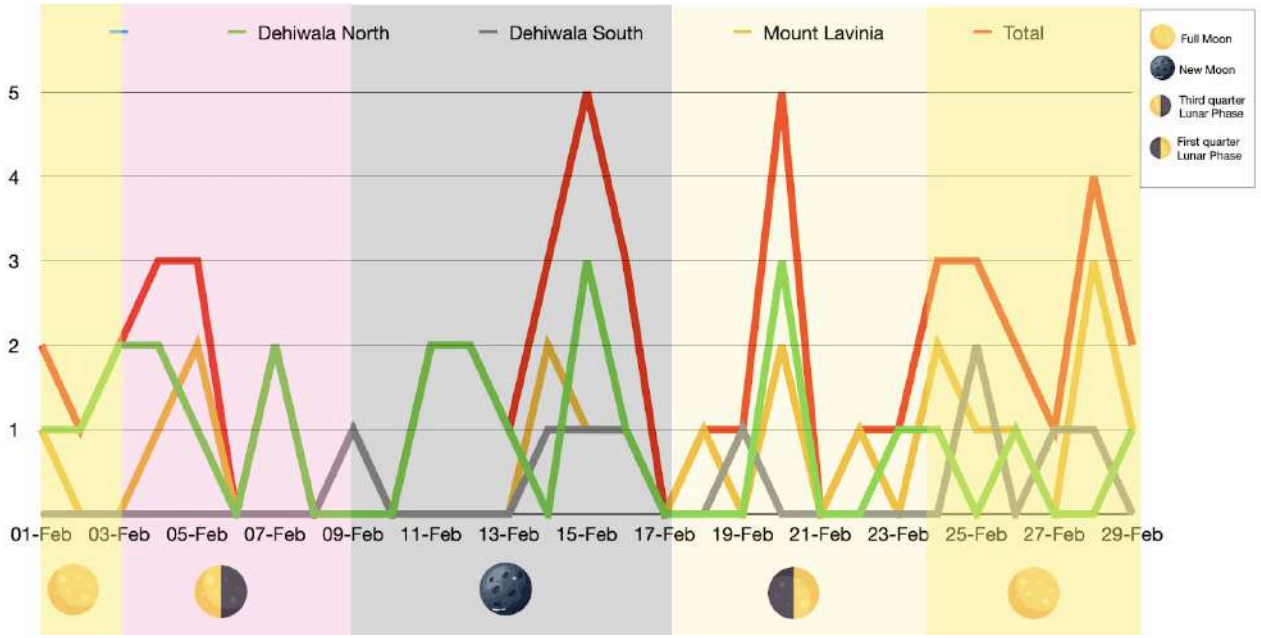

Figure 4: The distribution of Turtle nests across various lunar phases throughout the month of February. Higher numbers of nests were observed in the New Moon, 1st Quarter and Full moon period.

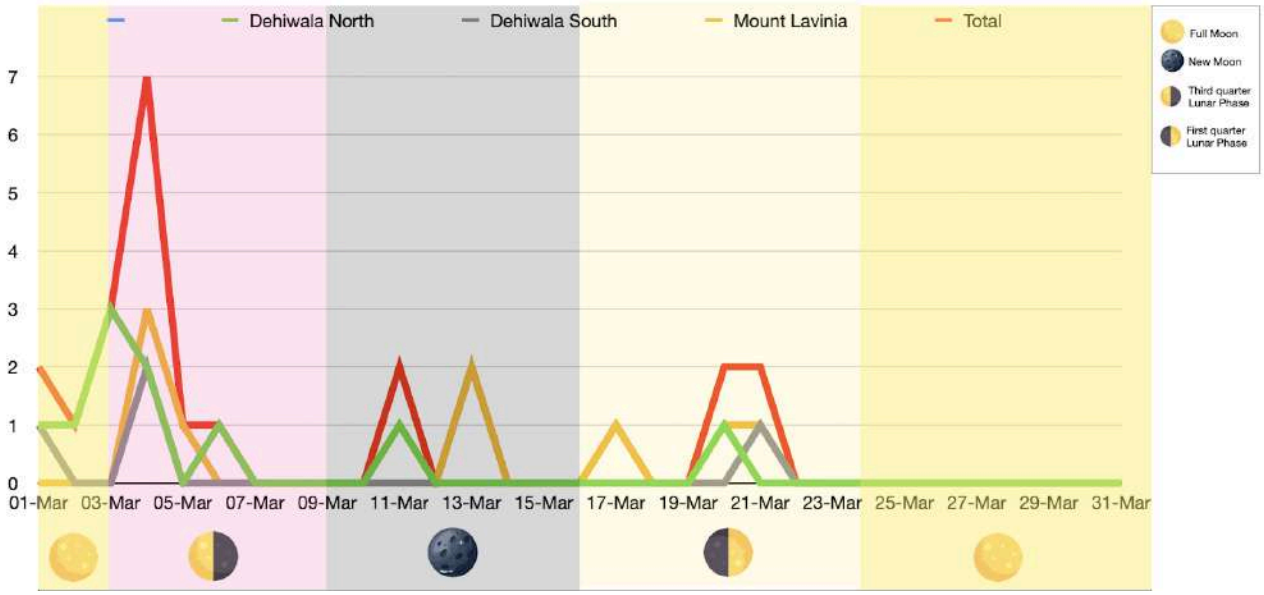

Figure 5: The distribution of Turtle nests across various lunar phases throughout the month of March. Higher numbers of nests were observed in the 3rd Quarter phase and then the number of nests declined to Zero.

When considering the nesting pattern in the month of January, it was observed that there were a high number of nests found during full moon and new moon periods (Fig. 2). Reasoning that the tendency for nesting in the absence of the visible moon may be related to predation since several species have been found to show a preference for foraging on dark nights to avoid predators, and predatory behavior may change across the lunar cycle.

Compared to January, during February, it was observed that turtle nesting was spread evenly throughout the first quarter, second quarter, and full moon, with only a few nests found during the full moon phase.

In March ,at the end of the turtle nesting season, it was found that there was a dramatic decline in turtle nesting after seeing a spike in the third quarter moon phase.

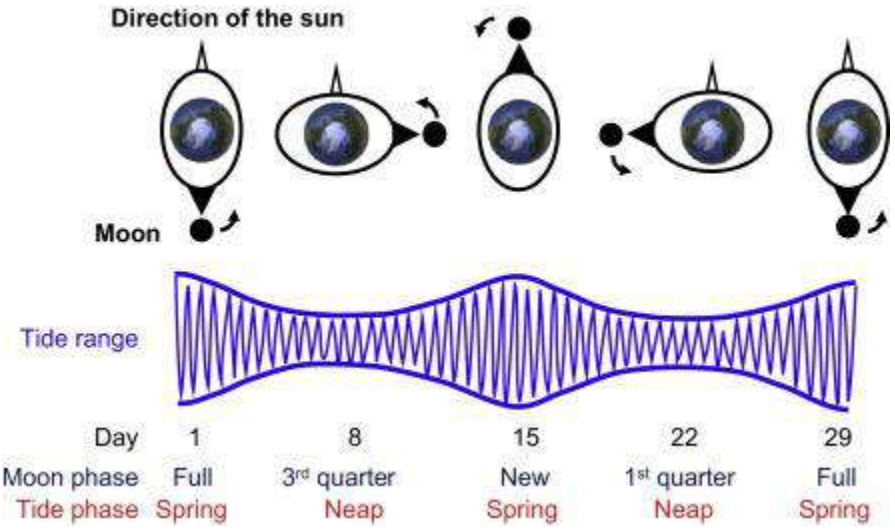

Figure 5: The relation between Lunar phases and tide patterns. In new moon and Full moon Phases the tides are much higher due to the gravitational forces.

Considering all of these results, it can be suggested that the concern that turtle nesting would increase with the full moon phase may not be true because high intensity nesting was observed during all lunar phases. However, referring to the literature, nesting during the new moon and full moon period offers the opportunity for high tides due to the centrifugal force caused by the Earth's rotation(Fig. 5). Another advantage of nesting during the period of the new moon may be an increase in prey availability to turtles post-nesting (Ekanayaka et al., 2009).

Figure 6: Google Map visualization demonstrating the relationship between nesting density and environmental factors in Dehiwala South.

Zone A: 30 nests, 5 Hatchling sites, 1 Turtle track sited, 1 stolen nest

High nesting density correlating with reduced human activity, artificial light, and urban development from the Dehiwala Coast Guard point to Deck Restaurant and Bar

Zone B: 8 nests

Low nesting density with increased presence of restaurants, human activity, and artificial lighting near the vicinity after Deck Restaurant.

Figure 7: Google Map visualization demonstrating the relationship between nesting density and environmental factors in the Dehiwala canal area and the fishing villages

Zone C: No nests present

Absence of nests due to canal presence, as sea turtles avoid nesting near canals due to unsuitable substrate, increased pollution and disturbances.

Zone D: 9 nests, 1 hatchling site, 1 stolen nest

Reduced Nesting due to to factors such as increased human foot traffic, boat activities, and other disturbances in the fishing villages

Figure 8: Google Map visualization demonstrating the relationship between nesting density and environmental factors in Mount Lavinia

Zone E: 12 Nests

Impact of increased coastal erosion resulting in areas with low to no nests in mount lavinia in the vicinity near the Berjaya Hotel

Figure 9: Google Map visualization demonstrating the relationship between nesting density and environmental factors in Wellawatte

Zone F: 9 Nests, 1 turtle track siting

After one month of patrolling in Wellawatte, it was observed that there were fewer risks, less nesting activity, and fewer turtles compared to the other locations.

Figures 6 to 9 have identified areas in the key locations with Google Map visualization demonstrating the relationship between nesting density and environmental factors in different areas. These areas are labeled through Zone A-F for easy reference. Olive ridleys were the only sea turtle species encountered during the patrol, despite the presence of five out of seven turtle species known to inhabit Sri Lanka's coastal waters.Notably, along the stretch in Zone A, there was a higher nesting density, likely due to reduced artificial light, human activity, and urban development (fig.6). Zone D (fig. 9) and Zone B (fig. 7) exhibited low nesting density, possibly influenced by the presence of artificial lights, increased human and foot traffic, and boat activities.No nests were observed along Zone C (fig. 8).Moreover, low nesting along the stretch from Zone E, primarily attributed to coastal erosion (fig. 10). Additionally, the data for other areas were limited, with a few nests observed, but insufficient for comprehensive analysis. Zone F after one month of patrolling in Wellawatte, it was observed that there were fewer risks, less nesting activity, and fewer turtles compared to the other three locations therefore, the available data is insufficient for comprehensive analysis.

Discussion

Sea turtles exhibit high fidelity in selecting their nesting sites, with evidence indicating that adult females tend to return to the region where they were born for nesting. Moreover, nesters display a remarkable consistency in returning to nest within a close proximity to their previous nesting sites, typically within 0–5 kilometers. The location of a sea turtle nest plays a crucial role in determining nesting and hatching success, influencing various factors such as embryonic development, fitness, sex determination, and the regulation of predation and inundation risks. Recent studies, both empirical and theoretical, underscore the significance of new hatchlings for sea turtle population dynamics, highlighting the importance of protecting nesting habitats and ensuring successful hatching(Mazaris et al., 2009). This study corroborates several findings highlighted in the subsequent discussion and the Google Maps markings in the study relates to some of the findings that are considered to be widely known.

Among sea turtles, the Olive Ridley (*Lepidochelys olivacea*) is recognized as the most abundant species (Ariano-Sánchez et al., 2020), a finding supported by the observations made during the patrol where only olive ridleys were encountered.

In certain documented areas of Zone B, particularly those characterized by increased number of restaurants and artificial lighting, sea turtle nesting is significantly reduced or absent (fig. 7). As per a study by Yen et al. (2023), the prevalence of light pollution poses grave threats to the physiology and behaviors of sea turtles, affecting crucial aspects such as foraging, reproduction, metabolism, orientation, and migration. Coastal artificial lights not only deter female turtles from nesting but also contribute to a decrease in nesting success, the concentration of nests in specific areas, and an increase in egg predation. Furthermore, these lights disrupt the natural finding behavior of hatchlings, leading to disorientation. Observations have shown hatchlings becoming disoriented by strong artificial lights, mistakenly moving away from the ocean.

The Google Map visualization illustrates the relationship between nesting density and environmental factors in Zone E (fig. 10), highlighting the impact of increased coastal erosion resulting in areas with low to no nests. Studies indicate that marine turtles, like other animal species dependent on coastal habitats for nesting, are vulnerable to the effects of sea-level rise on beaches. With the expected intensification of beach erosion, a decline in nesting grounds for marine turtles is predicted (Chevallier, 2023). This emphasizes the importance of addressing coastal erosion as a critical factor in sea turtle nesting habitat conservation.

Furthermore, in areas such as Zone D, documented through mapping on Google Maps (fig. 9), the likelihood of sea turtle nesting is notably less which is likely due to boat strikes, a threat that has been overlooked compared to other well-discussed factors such as fisheries bycatch, climate change, habitat destruction, and poaching. Some research suggests that nesting beaches experience a higher incidence of impacts, with 59% of injuries occurring during the nesting season compared to only 5% observed at foraging sites within the same study period. While data on survival rates from boat strikes are lacking, it is evident that many sea turtles succumb to the trauma caused by these impacts, highlighting boat strikes as a significant mortality factor in near-shore turtle habitats worldwide. Moreover, human activities such as fishery and boat traffic are conducted in nearshore areas worldwide, where sea turtles feed or mate and thus pose a

serious threat to these endangered reptiles (Denkinger et al., 2013). Bycatch in small scale gillnet fisheries is also thought to be a major driver behind the declines of several sea turtle populations (Gautama, 2022).

Additionally, the above observations are also likely due to human predation and poaching of eggs pose further threats to nesting sea turtles in these areas. The presence of fishing communities and human foot traffic, particularly during peak turtle nesting hours when villagers embark on fishing expeditions in the early hours of the morning, can further disrupt nesting behaviors and contribute to the decline in nesting activity in these areas.

In addition to the aforementioned activities, numerous significant observations were recorded during the course of patrolling. Instances of malformed sea turtle eggs were observed, a phenomenon within the spectrum of natural variability. Typically, sea turtle eggs conform to a spherical shape resembling ping-pong balls, featuring a soft shell composition (fig.19). However, deviations from this norm were observed, including elongated or calcified deformities or strands. Furthermore, several ex situ nests were observed to have completely failed, with the underlying cause remaining unclear. While a heatwave in Sri Lanka during the nesting season could potentially contribute to nest failure, the exact mechanisms require further investigation. As highlighted by Gatto et al. (2023), rising global temperatures pose significant threats to sea turtle reproductive success, including increased embryonic mortality, altered offspring phenotypes, and skewed sex ratios due to temperature-dependent sex determination. However, the specific implications of these factors in Sri Lanka remain understudied, emphasizing the need for further research to study the complex interplay between climate change and sea turtle nesting outcomes. Additionally, instances were documented where poachers stole nests but left a few eggs behind, suggesting potential cultural or superstitious beliefs influencing their actions (fig.21). Moreover, one poached nest was returned to the shoreline (fig. 22), underscoring the dynamics surrounding human-turtle interactions; however, the rationale behind the decision to return the nest remains unclear. Lastly, a deceased turtle was found with eggs still inside, highlighting the vulnerability of sea turtles and the importance of ongoing conservation efforts to protect their populations (fig. 18).

Moreover, during the course of patrolling, a multitude of challenges emerged that required the implementation of comprehensive strategies. Notably, instances of poaching activities, including the discovery of potentially poached nests and the apprehension of a poacher red-handed, highlight the critical need for heightened vigilance and enforcement measures. The presence of pollution near the Gale Pansala area, exacerbated by the subsequent beaching of nurdles, underscores the profound impact of anthropogenic activities on marine ecosystems. Moreover, erosion initially evident in the Wellawatta areas and later extending to Dehiwala and Mount Lavinia after the final week of February, has severely compromised nesting habitats, hindering turtles' ability to access suitable sites for nesting. Human activities, driven by a lack of awareness, have also proven detrimental, with reports of beachgoers attempting to interact with nesting turtles through touch, flash photography, or even physical interference, necessitating educational initiatives. Furthermore, incidents of turtle entanglement in fishing nets, including one distressing case of a turtle hatchling entangled in nets left by fishermen on the nesting beach (fig.20), underscore the intricate challenges posed by human activities on turtle conservation. While these factors provide insights, their complexities require further detailed investigation to inform targeted conservation interventions effectively.

Conclusion

In conclusion, the findings highlight the impact of environmental factors on sea turtle nesting behavior. The presence of reduced artificial light and human activity correlates positively with increased nesting density, while areas characterized by increased artificial light, human presence, and proximity to fishing villages exhibit reduced or absent nesting activity. Additionally, coastal erosion emerges as a deterrent to nesting, resulting in low nests. The study reveals no significant relationship between the lunar cycle and nesting patterns. Continued patrolling efforts and intensified conservation initiatives are necessary to mitigate anthropogenic, environmental and predator impacts and to preserve nesting habitats. Further research is essential to enhance understanding of sea turtle ecology, nesting dynamics, and behavioral responses to environmental factors and further strengthening of laws and guidelines is critical to effectively protect sea turtles, their nests, and eggs.

Furthermore, the conservation of beaches and sea turtles is of paramount importance. Sea turtles, being iconic animals found in all oceans worldwide, are facing significant population declines due to various threats primarily driven by human activities. Unsustainable fishing practices, plastic pollution, and climate change pose substantial risks to sea turtle populations, emphasizing the urgent need for conservation efforts. Beach conservation plays a crucial role in ensuring the survival of sea turtles by maintaining suitable nesting environments and mitigating the adverse effects of anthropogenic activities and climate change on coastal ecosystems.

To enhance beach conservation efforts, the Wildlife Conservation Department of Sri Lanka could allocate additional human resources, particularly during peak turtle nesting seasons. Implementing measures such as limiting artificial light or using red lights, reducing noise levels, and regulating the operation hours of beachfront establishments can help minimize disturbances to nesting turtles. Moreover, conducting awareness programs to educate local communities about turtle nesting and conservation, increasing visibility of sea turtle conservation initiatives in communities, beachfront establishments, and on beaches, and encouraging beachgoers to report illegal activities related to turtles and beach conservation are essential steps towards effective conservation. Additionally, recognizing the ecological importance of nesting sea turtles in maintaining beach ecosystems and promoting dune stabilization highlights the critical role of sea turtles beyond their aquatic habitats.

Visual Insights: Turtle Patrol Highlights

Figure 11: Volunteer practical training session conducted in-field

Figure 12: An awareness program that was conducted to educate the communities living near the sea, including fishermen and those residing in fishing villages.

Figure 13: Ex-situ area featuring net-fenced enclosures, safeguarding turtle eggs and hatchlings from potential threats and predators.

Figure 14: Informative boards detailing nesting dates, egg counts, expected hatching dates, and turtle species in the ex-situ area

Figure 15: Careful extraction of eggs by coastguards from natural nests for relocation to the ex-situ conservation area

Figure 16: Female sea turtle returning to the sea after laying eggs.

Figure 17: Newly hatched sea turtles before their journey into the ocean

Figure 18: Images capturing a deceased turtle was found with eggs still inside

Figure 19: Various images capturing abnormalities and deformities in sea turtle eggs

Figure 20: Turtle hatchling entanglement in fishing nets

Figure 21: Evidence of poachers stealing sea turtle nests but sparing a few eggs, possibly influenced by cultural or superstitious beliefs.

Figure 22: Poached nest that was returned to the shoreline

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